Abstract: One of the radical changes to the landscape of the past centuries has been the creation and enormous extension of infrastructure networks. Towards the end of the 20th century, the expansion of trunk rail and road networks slowed, but did not cease. At the same time, an ever denser network of forestry roads and other minor roads, tracks and trails extended into the last wildernesses of Europe. Canals, pipelines, electricity and telephone networks added their impact to an exponential fragmentation of natural areas, while urbanisation rapidly increased the built-over area. Researchers, nature organisations and authorities have expressed their concern over the impacts of fragmentation and studies have shown the risks caused by shrinking, ever farther separated habitats and the increasing influence of edges and boundaries. But only during the past decade has there been sustained, broad scale international collaboration to review knowledge about the transport infrastructure's impact on fragmentation and especially about the means to mitigate it. Habitat fragmentation, the splitting of natural habitats and ecosystems into smaller and more isolated patches, is recognised as one of the most important global threats to the conservation of biological diversity. A short overview of the mechanisms, processes and effects on nature will be presented. This threat was the reason for the Infra Eco Network Europe (IENE) to start in 1998 an action in the framework of COST1: the action COST 341. This paper presents some background information of this action which is the base for the major findings of the European Review and the solutions recommended in the Handbook.
International Conference on Habitat Fragmentation
due to
Transportation Infrastructure
and
Presentation of COST action 341 products

Conference map
Practical information:

Conference map

In this map you will find all abstracts of the presentations ranged per session. All poster abstracts are also included.

All addresses of speakers, poster authors and the list of participants can be found at the end.

Registration

The registration will start on Wednesday the 12th from 17h till 18:30h. Thursday morning you will be able to register starting at 8:00h. The first plenary session (opening conference and presentations of the Cost 341 products) will start at 9:30. During registration there will be coffee and tea.

Lunch

Lunch is included in the registration fee and is organised in the restaurant of the Conscience Building. You will all receive 2 coupons, each for a meal at the restaurant in the building and one drink.

Reception and Poster session

On Thursday, from 17:30 till 19:00h there is a reception and the poster session. All posters will be displayed during the 2 days of the conference, but during the reception there will be time for some extra explanation.

Conference Dinner

At 20:00 we’ll be expecting those who have registered for the conference dinner at ‘La Manufacture’. You can find a map on the website of the restaurant www.manufacture.be. But there will be a plan at the reception of the conference.

Excursion

The excursion is scheduled on Saturday the 15th of November. For those who have registered for the excursion; we’ll be expecting you at 8:30 in front of the Conscience Building. The full programme will be available at the reception, but for those with a flight on Saturday; we’ll do our very best to be back at the Conscience building at 15:30. I’ll see to it that you can leave your luggage in the building and pick it up after the excursion. Then you can go directly the station and take the train to the airport.

Travelling to and in Brussels

For getting around Brussels you can use the Metro; in annexe you’ll find a map of the metro in Brussels. There are several possibilities for those who plan some site seeing, but one single ticket cost 1,40€ and you can buy them in every station at the ticket machines or a ticket office.
Plenary session : presentation of the Cost action 341
Chaired by Mr. Hans Bekker, Cost action 341 chairman

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<td>11:00 - 12:30</td>
<td>Presentation of the , the European Review by Ms. Marguerite Trocme, Scientific Officer from the Swiss agency for Environment, Forest and Landscape (CH)</td>
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<td>Presentation of the European Handbook, by Mr. Bjorn Iuell, Norwegian Public Roads Administration (N)</td>
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<td>Infra Eco Network Europe and the COST341 database, by Mr. Dick van Straaten, Institute for Nature Conservation- IENE Chairman (BE)</td>
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<td>“Linking roads and land-mosaic pattern for clues to habitat-fragmentation effects: road ecology at work “ by Mr. Richard T. T. Forman, Harvard University, Harvard Design School, USA</td>
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Official opening

Anders HH Jansson, Chairman PIARC C14
Committee on Sustainable Development and Road Transport

Plenary session

Abstract

It is said that when the European Commission asked Finland to report the number of forests in our country, the answer was: one only. That forest covers most of Finland. Indeed, if one sums the forest area and the marshes, the sum is somewhat over 100%. So then, we need not worry about habitat reduction and fragmentation? There will always be enough forests, enough wetlands to provide space for all the flora and fauna of Finland?

As we all know, even though population and habitation pressure in Finland is radically less than, for instance, in Belgium, we still have numerous species on the brink of extinction or endangered, rare birds, flowers or butterflies; diversity is continuously being reduced on almost any scale of measurement. In Finland too, the impacts of human habitation and activities spread not only through landscape changing into built-up areas but also through industrial forestry and agriculture, infrastructure networks and their long-range impacts, pollution and barrier effects.

Of course, we should not make the mistake of expecting some kind of ever unchanging “Nature” to exist where we have not happened to build our cities, or expecting that no species may ever disappear or experience changes to its habitats. Such changes always happen and we are only a very recent actor in the sometimes drastically catastrophic history of our globe. But we seem to have the capacity to produce radical, unmanageable changes in a very short time and our impacts grow cumulatively with considerable speed.

I would again like to quote the EEA indicator report, “Environmental signals 2001” concerning land take and impacts on biodiversity:

“Land is under continuous pressure for new transport infrastructure: between 1990 and 1998 some 33 000 ha, about 10 ha of land every day, were taken for motorway construction in the EU. …Most areas in the EU are highly fragmented by transport infrastructure. The average size of contiguous land units that are not cut through by major transport infrastructure ranges from about 20 km² in Belgium to nearly 600 km² in Finland, with an EU average of about 130 km².”

One of the radical changes to the landscape of the past centuries has been the creation and enormous extension of infrastructure networks. Towards the end of the 20th century, the expansion of trunk rail and road networks slowed, but did not cease. At the same time, an ever denser network of forestry roads and other minor roads, tracks and trails extended into the last wildernesses of Europe. Canals, pipelines, electricity and telephone networks added their impact to an exponential fragmentation of natural areas, while urbanisation rapidly increased the built-over area.

Researchers, nature organisations and authorities have expressed their concern over the impacts of fragmentation and studies have shown the risks caused by shrinking, ever farther separated habitats and the increasing influence of edges and boundaries. But only during the past decade has there been sustained, broad scale international collaboration to review knowledge about the transport infrastructure's impact on fragmentation and especially about the means to mitigate it.

Finland does not make for a very good example of such efforts; there has been and remains a certain lack of urgency in the administrations concerned. But we do have some experience. Some of it will be taken up later at this meeting, but I'd like to refer to what we have, because I think it is still fairly typical of what has been done in our countries.
As I started work at the Finnish Road Administration in the early 90s, I was told about a beetle study made by four Nordic professors of zoology. They had been looking at beetle populations on different sides of roads along a specific latitude in the Nordic countries, assessing population changes and possible genetic impacts. We never got to see the results; the Finnish professor concerned declared that it was their private research and not intended for application or publication. Since then, researcher attitudes have changed somewhat. Finnish studies have dealt with embankment impacts on bird populations, road kills, ecological passages and their monitoring, elk migration routes’ interaction with the road network and, lately, road alignment impacts on flying squirrel habitats. On the other hand, there are also studies on road verges and highway junction areas as plant and insect habitats.

Two early embankment studies gave somewhat conflicting results: both showed that building an embankment over the upper end of an important birdlife area did have an effect on bird populations, but in one, much of the impact was attributed to road noise, and in the other, there was no significant noise contribution. The follow-up study of the Main Road 7 fauna passages has shown that animals will soon learn to use well designed passages. The results of the monitoring of insect and other populations will be published this year. The road kill study indicated that around 4 million birds, a million each of amphibians and mammals and 0.2 million reptiles are annually killed on Finnish roads. Road kills may have a significant influence on some bird populations.

Lately, administrations have had reason to look at biology with slightly more urgency than before. The flying squirrel has become the symbol animal of the late ‘90s, with a considerable effect on how roads and other projects proceed. These squirrels, in the present EU found only in Finland, have an interesting way of being found along alignments, thus disturbing the peace of road builders and other developers. Through the Natura 2000 programme as well as an increasingly effective interpretation of the nature directives already in existence, the EU functions as a kind of nature protection backstop, making protection goals real also for the decision-making process.

National research programs on biological diversity, such as the FIBRE program, serve to develop a better understanding of our own natural conditions, and the research program “Eco-efficient society” looks for less wasteful and better adapted development solutions. We also see a trend towards developing methods to avoid fragmentation. One method builds on mapping ecological corridors for regional planning. The regional plans are, among other things, normative for new major road alignments, and the mapping can give a better understanding of how to avoid conflicts between fauna routes and infrastructure. Mitigation is increasing; fauna passages are included in new projects. As yet, however, there are no funds to redevelop existing roads in this respect.

As chairman of the World Road Association (PIARC) Committee on sustainable development and road transport, I should, of course, have a global view of habitat fragmentation, but I have found that to have a view, one needs to know where one stands. This prompts me to try to understand the situation in Finland, before delivering advice to the community at large. I feel that this also is an essential characteristic of the work that has been done in this COST project, where so many countries have contributed their experience and data to lay the basis for a truly European handbook, and I think this will ensure the success of this work.
Welcome

Mr. Cor Dierckx,
Advisor of the Flemish Minister of Mobility, Public Works and Energy

European Habitat fragmentation due to infrastructure. Cause, Counteracting and Co-operation

Hans Bekker as chairman of Management Committee COST 341
Road and Hydraulic Engineering Institute, Directorate-general of Public Works and Water Management, Ministry of Transport, Public Works and Water Management, The Netherlands

Keywords: COST 341, Infra Eco Network Europe, habitat fragmentation, causes and measures, co-operation, approach

Plenary session

Abstract

Introduction

Habitat fragmentation, the splitting of natural habitats and ecosystems into smaller and more isolated patches, is recognised as one of the most important global threats to the conservation of biological diversity. A short overview of the mechanisms, processes and effects on nature will be presented. This threat was the reason for the Infra Eco Network Europe (IENE) to start in 1998 an action in the framework of COST1: the action COST 341. This paper presents some background information of this action which is the base for the major findings of the European Review and the solutions recommended in the Handbook.

Causes

Habitat fragmentation is mainly a result of changes in land use, but a major impact also results from the barrier effect caused by the construction and use of linear infrastructure of transportation systems. This problem has been recognised all over Europe, but the impact differs from country to country. Beside all kind of nuances in cultural identity and national policies the construction, the maintenance and use of infrastructure (road, rail and waterway) differs. Numbers of road victims, vulnerability and composition of species or landscape, these all are items which differ per country.

In Belgium and the Netherlands collisions with wildlife are a small percentage of the total number of damage at cars. But in the Scandinavian countries the danger of severe accidents with the bigger game species as moose and red deer means a big part of the claims by assurance companies.

Counteracting

The barrier- and fragmentation effects of infrastructure can be minimised during several phases of development and use, and often (partly) to avoid if considered in the early phases of planning. The awareness of the problem is growing. That means a growing tendency of political authorities to deal with this problem in a practical but effective way.
European Habitat fragmentation due to infrastructure - Cause, Counteracting and Co-operation

However, there is still a need for yet a systematically approach, retrofitting existing infrastructure where necessary, and integrating concerns on fragmentation in the planning of new ones. All the different phases are part of a overall approach, from the first steps of strategic planning, through the integration of roads in the landscape, the use of mitigation measures such as over- and underpasses for different animals, the developing field of compensatory measures, and to the use of different methods of monitoring and evaluation of the chosen solutions. In the countries involved choose for different solutions for the same problem.

Co-operation

The project 341 Habitat fragmentation due to transportation infrastructure started in 1998. 16 European countries and one NGO (European Centre for Nature Conservation) have been officially involved in the initiative.

The main objectives of the action are (Memorandum of Understanding, 1998):

- to promote a safe and sustainable pan-European transport infrastructure through recommending measures and planning procedures in order to conserve biodiversity and reduce vehicular accidents and fauna casualties.
- to increase the awareness of the problem
- to offer practical solutions and to exchange knowledge and expertise through workshops and presentations
- to bring together the different groups involved

The first main product of the project is a European Review on habitat fragmentation on a European level, based on state-of-the-art-reports from the participating countries. The project found a strong awareness of the problem throughout Europe and that a diversity of approaches to counteract and solutions have been tested. The European Review will be introduced by Marguerite Trocme.

The second important outcome of the project is the handbook Wildlife and traffic - A European handbook for identifying conflicts and designing solutions. This is a solution-orientated handbook, based upon the accumulated knowledge of a broad range of experts from the participating countries and from numerous international contacts. It gives practical guidance to the various actors involved in the planning, construction and maintenance of transportation infrastructures. It will be introduced by Bjorn Iuell

Other less prominent, but very important results are the state of the art reports, the database and the final report. And not easy to measure is the importance of the built up network of experts and colleagues from all kind of disciplines.

IENE (Infra Eco Network Europe), a network of experts and authorities within the field of habitat fragmentation caused by construction and use of linear transportation infrastructure, was the applicant of COST 341. Several of the IENE experts were part of the COST 341 management committee and IENE offers the framework in which the dissemination take place.
Habitat Fragmentation due to Linear Transportation Infrastructure: The European Review

Marguerite Trocmé, 
Swiss Agency for the Environment, Forests and Landscape, Switzerland

Editors: Sean Cahill, Hans (J.G.) De Vries; Helena Farrall; Lennart Folkeson; Gary Fry, Claire Hicks; Johan Peymen; Marguerite Trocme

Keywords: COST 341, fragmentation, mitigation measures, policy

Plenary session

Abstract:

This European Review is one of the products of COST 341 ‘Habitat Fragmentation due to Transportation Infrastructure’, a European Commission (EC) funded research project involving sixteen European countries. It is based on information contained within 13 National State of the Art Reports. The European Review explains the problem of habitat fragmentation due to transportation infrastructure in Europe and presents the types of solutions currently applied ie. avoidance techniques and mitigation and compensatory measures. Furthermore it elaborates on the wider economic and political aspects of habitat fragmentation and provides recommendations on how the problem should be addressed in the future.

The changes in land use, and reduction in area of natural and semi-natural habitats, with their resulting fragmentation are threatening Europe's biodiversity. Many plant and animal species, and their genetic diversity, are currently declining or threatened with extinction. Transportation infrastructure is often considered to be a principal cause of fragmentation today. In the future 20,500 km of roads and 23,000 km conventional and high-speed railway lines are being planned in Europe. Roads and railroads are fragmenting much of the remaining natural habitat in Europe, degrading through their barrier and disturbance effects the carrying capacity of ecosystems and imposing a high mortality rate on wildlife populations.

Today most of the mitigation measures taken in Europe concentrate on reducing vehicle/wildlife casualties. Such measures include fencing, the use of reflectors, adaptations of the habitat along roads and signalization.

The awareness that beyond fauna casualties, roads create also barriers for wildlife goes back to the 1970's. A that time in the Netherlands the Directorate-General for Public Works and Water Management started building tunnels for badgers (Bekker & Canters, 1997) under roads. These were accompanied with fencing and have proven to be very effective at limiting mortality.

In 1973 France published the first technical report on how help large game cross roads (CTGREF, 1973). However these first fauna passages were mostly undersized and were later found inefficient. Today with better locations and dimensions more adapted to the target species, the new generation passages are a success. More than a hundred wildlife overpasses have been censused through Europe.

Today the principles of avoidance, mitigation and compensation are embedded in European and national administrative policies and legal frameworks. Currently, the most important instruments in this respect are: the EC Directives on Environmental Impact Assessment (EIA) and Strategic Environmental Assessment (SEA), the Habitats and Birds Directives and the Pan-European Biological and Landscape Diversity Strategy (PEBLDS).
At identified bottlenecks, some European countries are beginning to retrofit existing roads with fauna passages. Defragmentation policy is gradually being introduced in Belgium, Estonia, Hungary, the Netherlands and Switzerland.

Nevertheless, it is obvious that throughout Europe the science of addressing the impact of habitat fragmentation due to transportation infrastructure is still in its infancy and will require more concentrated effort in the near future. The key to success is the adoption of a holistic approach that allows the whole range of ecological factors operating across the landscape to be integrated within the planning process. The problem of fragmentation and its solutions are universal, therefore joint research and combined international efforts are required. To develop adequate tools for assessing, preventing and mitigating against the ecological impact of infrastructure requires interdisciplinary work.

Wildlife and traffic - A European Handbook for Identifying Conflicts and Designing Solutions

Bjørn Iuell, co-ordinator of the COST 341 Handbook working group
Directorate for Public Roads, Norwegian Public Roads Administration
Environmental Strategy Division,

Keywords: COST 341, transportation infrastructure, habitat fragmentation, planning, landscape, mitigation, ecological compensation, monitoring, evaluation.

Plenary session

Abstract:

Introduction
Habitat fragmentation is mainly a result of changes in land use, but a major impact also results from the barrier effect caused by the construction and use of linear infrastructure of transportation systems. The project COST 341 Habitat fragmentation due to transportation infrastructure (will be presented by Hans Bekker) has produced an overview for the European situation (the European Review will be presented by Marguerite Trocme), and one of the findings is that there is a need for practical advise on how to avoid or minimise the fragmentation effects of roads, railways and waterways. This paper presents an overview of the handbook produced by the project.

The Handbook
The handbook Wildlife and traffic - A European handbook for identifying conflicts and designing solutions, is a solution-orientated handbook, based upon the accumulated knowledge of a broad range of experts from the participating countries and from numerous international contacts. It gives practical guidance to the various actors involved in the planning, construction and maintenance of transportation infrastructures.

The barrier- and fragmentation effects of infrastructure can be eliminated or minimised in different ways and during several phases of its development and use. If the “right decisions” are taken in the early phases of planning, fragmentation problems can often be avoided. The barrier effect can also be reduced by integrating the infrastructure into the surrounding landscape, or by building secure and sufficient crossing points for wildlife. During use and maintenance of existing infrastructure, consideration should focus on how to improve the permeability of the infrastructure and to de-fragment landscapes.
Since the different phases in "the life of a infrastructure" are usually more or less separated and need different approaches, the more practical parts of the handbook are structured to make it easy for people to find the relevant information dealing with the different phases.

Chapter 3 describes briefly the different ecological impacts of transportation infrastructure, as habitat loss, barrier effects, fauna casualties, pollution and the key issue of the handbook; habitat fragmentation.

Chapter 4 explains how to develop integrated solutions and how to avoid fragmentation, and underlines the importance of early consideration of habitat fragmentation in infrastructure construction projects.

The chapters 5-7 provide concrete advice for each stage of transport infrastructure planning, designing, construction and implementation.

Occasionally it is not possible to avoid fragmentation at the planning level nor can the effects be entirely mediated by special mitigation measures. In such cases we are forced to examine the possibility of the ecological compensation measures described in chapter 8.

To be able to profit from examples of good practice and to provide the basis for codes of good practice, we need to monitor the success of the various methods for mitigating the effects of habitat fragmentation. Chapter 9 provides detailed guidelines on how to monitor the success of mitigation measures and their maintenance.

Infra Eco Network Europe and the COST341 database

Mr. Dick van Straaten, IENE Chairman
E. Turcott-Quintero & Gert Van Spaendonk,
Institute of Nature Conservation, Flanders Authority, Belgium

Plenary session

Abstract

The Infra Eco Network Europa is an international group of experts, representing 22 countries. IENE was established in 1996 after the international conference "Habitat fragmentation, infrastructure and the role of ecological engineering" (held on the initiative of the Directorate-General for Public Works and Water Management in the Netherlands). The goal of IENE is to promote a safe and sustainable pan-European transport infrastructure through recommending measures and planning procedures to conserve biodiversity and reduce vehicular accidents and fauna casualties. The network of IENE is coordinated by a coordination centre, a steering committee and for each participating country a national coordinator. Until 2000 the coordination centre of the IENE was financially supported by two government institutions: the Ministry of Traffic and communications (the Netherlands: 1996-1998) and during the period from 1998 and 2000 the Swedish National Road Administrations (Swedish Government: 1998-2000). Since August 2000 the Flanders Authority (Mobility unit of is funding the coordination of the IENE organization (hosted by the Institute of Nature Conservation) until the end of 2003.

The member countries are: Austria, Belgium, Czech Republic, Denmark, Estonia, Finland, France, Germany, Hungary, Italy, Ireland, Netherlands, Norway, Poland, Portugal, Romania, Russia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

The COST341-database is one of the deliverables of the COST341-action. The aim of the database is to integrate and disseminate the knowledge and data on habitat fragmentation due to transportation infrastructure into a comprehensive and on-line accessible (searchable) database. At the moment, the database is reachable on the Internet at http://www.iene.info/1database.htm.
The scope of the COST341-database concerns four items:

- **Literature**: database on books, (scientific) articles (magazines), reports concerning habitat fragmentation due to transportation infrastructure, focus on ‘grey literature’;
- **Measures**: mitigation measures focused on fauna passages (good examples, new types...);
- **Existing databases on the subject Habitat fragmentation and linear transport infrastructure**;
- **Projects on the subject**: research projects, applied projects, construction and development.

In Internet application is set up to search the database and is established by the Database Working group of the COST341-action. In the future, the efforts and cooperation of the actual IENE members to feed the COST341-database should be encouraged. The internet application and navigation and database maintenance (input and validation) will be improved and optimised by IENE organisation on their website.

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**Linking roads and land-mosaic pattern for clues to habitat-fragmentation effects:**

**road ecology at work**

**Richard T. T. Forman**, Harvard University, Harvard Design School, USA

**Keywords**: Barrier effect; habitat fragmentation; land mosaic; road ecology; road network; spatial model

**Plenary session**

**Abstract**

The coalescence and emergence of road-ecology science, when combined with engineering and planning, promises a future where safe efficient human mobility is effectively meshed with natural processes and diversity. Habitat fragmentation effects are important in most landscapes, and the portion due to roads with traffic, although a little-understood frontier, may be large. Based on studies in the USA (and elsewhere), three scales are evaluated...road location, segment, and network...and basic arrangements of roads and land pattern are then evaluated.

First, at a location or site, a road (surface, roadbed and roadside), e.g., may only block movement of adjacent small ground animals, or may produce long-distance effects on the movement of fish or the drainage of floodwater in flat terrain. Similarly, vehicular disturbance such as noise may create a narrow or a wide barrier (filter) to movement by many terrestrial vertebrates.

Second, a road segment (that integrates these location effects) exhibits a road-effect zone, which doubtless often serves as a barrier between habitats. The road-effect zone is produced by the sequential pairs of land cover and topography adjoining a road segment, by three directional transport mechanisms (wind, water, and habitat suitability), and by changing traffic volumes. Together these produce a highly variable width of the road-effect zone along a road segment.

Third, a road network integrates overall road density, network form (e.g., the presence of large roadless areas, fine grids, and spur roads), traffic-flow hierarchies, and land covers within enclosures. The network creates habitat enclosures and indicates the cumulative fragmentation effect of roads in a landscape or region.

Roads of different types are variously arranged across a natural-vegetation matrix, a large patch, small patch, hedgerow corridor, stream corridor, and combinations thereof. Simple spatial modeling supports the hypothesis that habitat fragmentation effects due to roads vary from little to large, depending on the juxtaposition of roads and land mosaic pattern.
This synthesis suggests that planning and mitigation for road building/widening, road removal, and traffic flows can have a major effect on reducing fragmentation effects in the landscape. Improving land-mosaic pattern and adding road-crossing structures for animals provide further benefits. Mitigation solutions for road locations are much needed and sometimes undertaken. However, more evaluation of options at the road segment and network levels by road ecologists should help create a viable long-term mesh of transportation and nature for society.
# Conference session : Policy
Chaired by Mrs. Tatiana Damarad

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Environment and Nature Protection Tasks Ensuring Sustainable Development of Transportation and Public Roads through the Eyes of an Engineer

Mrs. Dora Fenyes, prof. István FI,
Budapest University of Technology and Economics, Department of Highway and Railway Engineering

Keywords: planning principles, practical developing, transport co-operation, diversity.

Conference session: Policy.

Abstract:

The transportation of people and goods inflicts many, often overstated, negative impacts on the environment. Besides perceived or actual evaluation, it is a fact that public transport is vital for the community and is the most important form of multinational co-operation. Beyond, it is an ever more typical feature of the European citizen, that the public road network is used more extensively for private travels (tourism, culture, sport, recreation) than for official trips.

The aim of this presentation is to try to establish a compromise that yields a necessary yet rationally sufficient public road network system within a carrying nature and environment that provides a living space that optimally ensures wildlife survival.

Transportation is a local, regional but increasingly an European issue. The European Union treats the relation of transportation and environment so that it manages the present and protects the future. The core meaning of the community strategy, set out in the "sustainable mobility" principle, is that transportation should play its very significant role in social and economic development in a way, that it does not cause any additional environmental damage.

Main premises of this strategy:

- development of transportation will always affect the environment;
- despite all efforts, increase of transport and traffic cannot be stopped in the coming years;
- a common transportation-environmental policy is necessary that deals with the above.

In this field the principle of subsidiary is of primary importance, since the practical application of strategies aiming at diminishing environmental impacts cannot be realized without national, regional and local initiatives.

As part of the strategy, the following measures are preferred:

- decrease transportation needs;
- propagate "soft" transportation modes;
- replacing private transport with public transport;
- road tolls;
- installing electronic traffic control systems;
- high speed railway construction;
- developing systems facilitating more balanced distribution of seasonal and regional traffic;
- formulating concepts taking regional demand more extensively into consideration.

The problems of road transport and environment are going to be elaborated from the aspects of maintenance and operation, and building and development, distinguishing in both groups between the primarily settlement related and primarily outskirts related tasks. The main aims of this article to be pointed out those environmental planning methods and their practical engineering means which are suitable to keep balance between the living world and the different transportation modes in the near and in the far future.
Defragmentation Strategy in Flanders

Marleen Moelants la.
Project team Ecological Engineering
Administration of Roads and Traffic
Ministry of the Flemish Community, Belgium

Keywords: Defragmentation Strategy, territorial approach, animal casualties, distribution of fauna, small landscape entities, other keywords are marked in red

Conference session: Policy

Abstract:

In Flanders few new roads are built. Our road network is almost completed. Landscapes and therefore also animal communities are already fragmentated for a longer period. Most of our big roads were built since 1965-1975. Most of our defragmentation projects are situated on existing roads. This is not always easy. To built a larger eco tunnel or an eco duct, traffic has to be re-organised.

In order to start defragmentation projects in a well-considered and well-oriented way our administration has worked out a Defragmentation Strategy. This strategy includes different methods for organising future projects and managing budgets. It has to implement defragmentation ideas and typical infrastructure in the daily routine of the administration.

Fragmentation has a great impact on the landscape in Flanders. Our largest nature reserves are mostly fragmentated by transport infrastructure, residential areas and recreation activities. It is obvious that the most important fragmentation black points are situated in ecologically high valuable areas. Because of the low amount of this rather small areas, defragmentation of only these sites is not enough. Animals don't stop at the border of nature reserves. Complementary measures have to be taken in migration areas as well.

The Defragmentation Strategy works out five methods:

1. Until now we only focused on the defragmentation of some highways. But it is not enough to build passages under a highway when a parallel road creates another barrier. It is better to start studies to defragmentation a larger territory. For this territorial approach we will have to cooperate with different partners. This kind of studies will take much diplomacy and much time.

2. In addition of aiming a specific region it is important to have more information about the distribution of fauna. Since 2000 out road patrollers register animal casualties on community-roads. Together with other information about the distribution of fauna, existing maps can be completed.

3. The most import way of working is when building new roads or rebuilding existing roads. Environmental Impact Assessments are the best instrument to propose defragmentation measures for new roads.

4. Starting from 2003 we assess every road project in order to integrate small passages on many spots. This approach asks for an implementation in the daily routine of road engineering. At regular times roads must be maintained or restored. This gives an opportunity to provide defragmentation measures. This passages will not only be built when passing protected areas. We also focus on small scaled agricultural landscapes with many hedges and tree rows. Small passages (tubes and amphibian tunnels) will be built at height of these small landscape entities and culverts can be provided with passages for small animals (continuous river banks). As a result of this way of working many more passages will create opportunities for local species, on spots that where not studied. Therefore it will be important to monitor this passages in order to learn for the future.
Defragmentation Strategy in Flanders

5. Until now we worked out our own projects or we worked together with other partners. In the future we want to maintain this way of working.

6. In order to organise this Defragmentation Strategy (especially 3.) information has to be easy accessible. Therefore we will make up a kind of Handbook with specifications, technical plans, addresses, photo's, etc. This digital handbook will be published on our internal website. In this way texts can be used easily.

The method (3) to integrate defragmentation measures in every road maintenance project, is not used in Europe until now. In the other countries defragmentation is an issue when building new roads. This method has to emphasize the ecological structure of hedges, rows of trees, valleys, etc., but maybe the measurements will not be used because there location was not properly studied.

Stakeholders and the Irish Roads building programme

Brian Cullinane, Gerard O’Leary
National Roads Authority, Ireland
Eugene O’Brien,
Civil Engineering Department, University College Dublin

Conference session: Policy

Abstract:

The Irish National Development Plan for the period 2000 - 2006 is designed to provide the foundation for economic progress, improved competitiveness, balanced regional development and social inclusion. The Plan provides for an investment of an unprecedented €51.5 billion in 1999 prices. A significant proportion of this is earmarked for the improvement of the national road network, which is well below the standard of our OECD partners. The National Roads Authority is charged with managing the development of the national road network and has developed a framework for the planning phase of road building called the National Roads Project Management Guidelines. The Guidelines aim to identify constraints and engage stakeholders at the earliest point in the planning process.

Two significant phases in the framework, the Constraints Study and Route Corridor Selection phase are non-statutory requirements and precede the environmental impact assessment process. In addition, the Authority has agreed a Code of Practice on Archaeology with Duchas, the National Heritage Service. Guidelines have been drafted on the assessment of the effects of road building on the natural environment and guidelines on the integration of ecological considerations into landscaping treatments. Relevant stakeholders have been engaged very early on in the drafting process, representing a significant departure from the traditional approach to consultation. The Project Management Guidelines, the Code of Practice and the series of individual sectoral guidelines represent a new approach to sustainable development in the road transport area in Ireland.

This paper will provide a historical background to the controversies that have occurred in Ireland where the needs of transportation have conflicted with the needs of wildlife. The new cooperative approach that followed is described and the plans for the management of wildlife and transport in the future.
Converging goals on rural road policy. Combining efforts for nature conservation, road safety and rural tourism

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Keywords: Habitat fragmentation; rural roads; nature conservation; road safety; rural tourism; policy

Conference session: Policy

Abstract:

In the discussion on negative effects of transportation infrastructure on nature, often is focussed on motorways and rural highways. In the Dutch national report for COST-341 special attention is asked for ecological impacts of rural road networks. They represent the major part of the total road network, due to their total length and high density. These roads, and the traffic on them, are an important cause of habitat destruction, fragmentation and road kill. On the other hand the verges can contribute to the landscape values of an area.

Dutch nature conservation policy places great emphasis on the development of a National Ecological Network of nature areas linked by ecological corridors. Roads and other infrastructure not only form a barrier between nature core areas, they also fragment these core areas. This has serious negative impacts on the quality of these areas. For many species size and quality of their habitat is more important than the possibility of movement between separated areas. Fragmentation within core areas therefore demands special attention. These specific fragmentation problems mainly occur at local or regional scale. To reduce the negative effects of habitat fragmentation by rural roads (in core areas), the regional network of roads is to be looked at. Traffic volumes should be concentrated at a limited number of roads. Other rural roads should be used by destination traffic only. It can be very hard, or even impossible, to realise this by nature conservation policy only. Too many interests (governmental and public) are involved. Therefore it can be interesting to link up with other issues and policy goals that deal with rural road networks, like road safety, accessibility and outdoor recreation. Combined efforts are likely to gain more support. It is therefore interesting to have a closer look at other policy domains.

In the Netherlands the implementation of the Sustainable Safety Programme has been set up to improve road safety. The implementation of the Sustainable Safety Programme includes a (hierarchical) categorisation of roads. Within the Sustainable Safety Programme many rural roads have to be adjusted to support safety and speed control. Measures for instance include construction of small roundabouts and rumble strips. Special attention is paid to prevent rat-run traffic.

If de-fragmentation policy and road safety policy are compared, many similarities can be found. Besides the intended positive effects on road safety the measures of the sustainable Safety Programme can also have positive ecological effects. Lower traffic volumes and lower speeds will reduce disturbance effects and might result in lower numbers of road kill. The measures will also increase the value of the area for outdoor recreation (walking, cycling). This illustrates that it is well possible to converge goals for nature conservation, road safety and rural tourism. If mitigation measures for fragmentation due to rural roads can be linked with goals of road safety and outdoor recreation they most likely will gain more support. Besides more funds will be available.
Converging goals on rural road policy. Combining efforts for nature conservation, road safety and rural tourism

The paper will describe the different policies on rural road networks, the suggested measures in these policies and the implementation of these measures. We will describe to what extent they support each other and which differences there are. Based on this, we will give recommendations for a more integrated approach. The experiences from this case in The Netherlands can be used in other countries that are dealing with issues of road safety, nature conservation and accessibility related to rural road networks.

Fine tuning the Pan-European Ecological Network and the Trans-European Network on Transport

Speaker to be determined,
European Centre for Nature Conservation (ECNC)

Conference session: Policy

Abstract:

The Pan-European Biological and Landscape Diversity Strategy - endorsed at the Third "Environment for Europe" Ministerial Conference in Sofia, Bulgaria (1995) - aims to halt the degradation of landscape and biological diversity across the European region by 2010. An important activity of the Strategy is the establishment of the Pan-European Ecological Network. The two most important European instrument to build this Pan-European Ecological Network are Natura 2000 under the EU Habitats Directive and the Council of Europe's Bern Convention Emerald Network.

Agriculture, forestry and transport are - as far as the terrestrial part is concerned - the three main sectors that affect the realisation of the Pan-European Ecological Network. Infrastructure also has a significant impact on nature, through habitat fragmentation to rail and road accidents resulting in fauna casualties, etc. Often, old to be upgraded or new to be created transport infrastructure intersects with core areas of important ecological corridors in the Pan-European Ecological Network, including Natura 2000 sites.

As a result of the upcoming accession of 10 new EU members states the Trans-European Network will further expand and billions of Euro’s will be invested in this expansion.

Fine-tuning of the Pan-European Ecological Network including Natura 2000 and the Trans-European Network will become a matter of utmost importance. However, the EU’s White Paper on European Transport Policy of 2001 does highlight biodiversity or habitat fragmentation as a concern. Plans for European transport infrastructure and European ecological infrastructure are still developed in too much in isolation, and interaction between sectors in too many cases only occurs while implementing the plans.

The value of the Pan-European Ecological Network for land use sectors derives from the fact that it is a dynamic concept that goes beyond protected areas and it complies with the thinking in networking in other sectors, such as road and rail infrastructure, information and communications technology networks, etc. The Pan-European Ecological Network offers potentials to put priorities for nature conservation literally on a map, and in recent years the first interregional Pan-European Ecological Network maps have appeared.
Fine tuning the Pan-European Ecological Network and the Trans-European Network on Transport

The Ministers of all European countries endorsed at the “Ministerial Declaration” of the 5th Ministerial “Environment for Europe” conference in Kyiv, May 2003, a Biodiversity Resolution. This political resolution states, amongst other things, that “by 2008, all core areas of the Pan-European Ecological Network will be adequately conserved and the Pan-European Ecological Network will give guidance to all major national, regional and international land use and planning policies as well as to the operations of relevant economic and financial sectors.”

The ambitions in realising and extending both the Pan-European Ecological Network and the Trans-European Transport Network are substantial, and in order to avoid grave future conflicts and wasting of time and energy, policy-makers, planners and technicians dealing with the establishment of the Pan-European Ecological Network should join forces and substantially increase communication. They should learn from each other, and should deal with challenges and problems in a proactive and anticipatory way.

Code of Practice for the introduction of biological and landscape diversity considerations into the transport sector

Len Wyatt
representing Council of Europe Group of Specialists for transport and the environment, UKt

Keywords:
Biological Diversity, Landscapes, Roads, Railways, Waterways, Policies.

Conference session: Policy

Abstract

The Code of Practice published by the Council of Europe contains information and 33 recommendations for those working with linear transportation networks (e.g. roads, railways and waterways). Its intention is to contribute to the reversal of the decline of landscapes and biological diversity; and the development of more sustainable transportation networks, across the Pan-European region.

It is aimed at elected representatives, decision makers, practitioners and other interested parties.

Topics covered include:
- The Pan European Transport Network and relevant policies
- Common principles in relation to best practice for roads, railways and waterways
- Measures to address the effects of linear transportation and the opportunities for conservation and enhancement that may arise.
- The need for monitoring, research, and information.

Developed by a group of experts, supported by five technical reports; the Code was endorsed by the Ministerial Conference “Environment for Europe” in Kyiv in May 2003.
## Conference session : Effects of Infrastructure

Chaired by Mrs. Katja Pobolsjaj on Thursday  
Chaired by Mrs. Verena Keller on Friday afternoon

| 14:00 - 15:30 | Recent Habitat Fragmentation due to major roads to a reduction of gene flow in ground beetles, by Ms. Irene Keller, Zoological Institute, University of Bern, CH |
| 14:00 - 15:30 | Habitat suitability model and prediction of favourable wolf habitat in Scandinavia, by Mr. Jens Karlsson, Grimsö Wildlife Research station, SW |
| 14:00 - 15:30 | Effects of unfenced (high-speed)-railway lines on wildlife, by Dr. Antonio Righetti, PiU, CH |
| 15:30 - 16:00 | Coffee Break |
| 16:00 - 17:30 | Under what conditions do fences reduce the effects of transportation infrastructure on population survival?, by Mr. Jochen Jaeger, Ottawa-Carleton Institute of Biology, CA |
| 16:00 - 17:30 | The barrier impact on migratory moose of highway E4 in the High Coast area, Sweden, by Mr. J.O. Helldin and Mr. Andreas Seiler, Swedish University of Agricultural Sciences, SW |
| 16:00 - 17:30 | Road killed animals in Japanese Expressway, by Mr. Takashi Shinoda, Japan Highway Corporation, JAP |

| 14:00 - 15:30 | Effects of roads on the abundance of birds in Swedish forest and farmland, Phd. J.O. Helldin, Grimsö Wildlife Research Station, SW |
| 14:00 - 15:30 | Permeability of highway net of the Czech Republic for big mammals, identification of conflict points and proposed solution, by Dipl. Eng. Vaclav Hlavac, Agency for Nature Conservation, CZ |
| 14:00 - 15:30 | Ecotoxicological effects of motorways on soil invertebrate communities, by Dr. Ruslan Butovsky, All-Russian Research Institute for Nature Protection, RU |
Recent habitat fragmentation due to major roads leads to a reduction of gene flow in ground beetles

Ms. Irene Keller, Carlo R. Largiader, Wolfgang Nentwig,
Zoological Institute, University of Bern

Keywords: Fragmentation, ground beetles, population genetics

Conference Topic: Monitoring/Research methods

Abstract

Although habitat fragmentation is suspected to threaten the long-term survival of many species, few data are available on its impact on the genetic structure and variability of invertebrates. We assessed the population genetic structure of the two flightless ground beetles *Carabus violaceus* and *Abax parallelepipedus* in a Swiss forest, which was divided into several fragments by a highway and two main roads. One to three samples were collected from each fragment and analysed at 5 - 13 microsatellite loci.

In *Carabus violaceus*, the largest amount of genetic differentiation was observed between samples separated by roads and in particular the highway. The number of roads between sites explained 44% of the variance in pairwise FST-estimates, whereas the age of the roads and the geographical distance between locations were not significant factors. Furthermore, the genetic variability as measured by allelic richness was significantly reduced in a small forest fragment isolated by the highway.

The impact of the roads on population structure was less pronounced in *Abax parallelepipedus*, and mainly detectable in the sample from the smallest forest fragment. These findings were consistent with the high abundance of the species observed in the field, as the speed of population divergence is directly dependent on the effective population size. Our results support the hypothesis that large roads can be strong barriers to dispersal for insects.

Habitat suitability model and prediction of favourable wolf habitat in Scandinavia

Mr. Jens Karlsson
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Grimåö Wildlife Research Station

Keywords: wolf, home range, roads, habitat suitability, mortality, Sweden

Conference session: Monitoring / Research

Abstract

Today many species are affected and threatened because of habitat destruction and fragmentation. This is also true for wolves in many parts of the world, for example southern and central Europe. The situation in Scandinavia, however, differs somewhat from southern and central Europe. Here, habitat fragmentation destruction and fragmentation are perhaps symptoms of the problem, but not the cause.
The probability of wolf-colonisation in Scandinavia seems to be a combination of habitat preference and habitat suitability. Radio-tracking studies (with one position every 30 minutes for 10 day periods at a time) revealed that at individual scale, wolves significantly avoided built-up areas and larger open grounds (> 2 ha), but moved independent of roads of all categories. At territory/temporal scale, the density of built-up areas significantly decreased over time as the shape of the territory changed. However during the same period open grounds and road density in the territories stayed the same. At landscape scale the densities of open grounds, built-up areas and tertiary roads were all lower inside territories than outside. Thus wolves avoid built-up areas at all tested scales. Open grounds and tertiary roads are only “avoided” at landscape scale, that is, the densities of open grounds and tertiary roads are lower within known wolf territories than outside. A reasonable conclusion is that areas with low densities of built up areas are preferred by wolves for colonisation, whilst low densities of open grounds and tertiary roads are strong indicators of habitat suitable for wolf-colonisation. Roads per se are not avoided by wolves, but can serve as vectors for human related mortality. Direct mortality from car collisions was of minor importance, being only 4% of the total mortality, and human/pet related diseases (scabies) 12.5% of the total mortality among radio collared wolves. Data from this study suggest that illegal killing is the most important cause of human related mortality.

Effects of unfenced (high-speed)-railway lines on wildlife

Dr.; Antonio Righetti, Guy Berthoud, Bertram Georgici, Heinz Malli, Eliane Leuzinger, Barbara Schlup.
Partner innen/in Umweltfragen, Switzerland

Keywords: railway infrastructure, accidents, obstacle/barrier effect, wildlife, positive and negative aspects, COST 341, direct and indirect data collection, guidelines, checklists.

Conference session: policy and practice

Abstract:

Several studies have looked into the effects of motorways on flora and fauna in the last years, while only little attention has been paid to railway lines. Moreover, most comparable studies on railroads focused on accidents with wildlife although railway infrastructure is affecting the fauna in many ways. Some of these effects may even be positive: For instance, railway lines can be very attractive habitats for thermophile species or may function as important biological corridors. However, the negative aspects predominate: Railroads are unsurmountable obstacles for many amphibian species, they affect the spatial exploitation of wildlife when they are fenced and finally they cause a comparatively high amount of dead animals.

Objective of the study: There is an urgent call for action, since railway network will gain importance as a result of the increasing demand of mobility all over Europe. Therefore, the subject of "railway-wildlife" was taken up by PIU GmbH/ECONAT (task force), in collaboration with Bertram Georgii (VAUNA e.V.) and Heinz Malli (BioEx), within the scope of COST 341: Commencing in 2001, the effects of track number, and frequency and speed of trains on habitat quality and spatial exploitation by wildlife was investigated along ten sections of railway line in Switzerland (8 sections), Germany (1) and France (1). The study focused on larger dispersing mammal species, such as the European red deer, roe deer and wild boar, which occasionally cause serious rail accidents.

Methods: Data collection involved various methods including indirect methods (interviews with hunters and gamekeepers) and direct methods (transect and spotlight counts and provision of data by relevant authorities and railway companies). The structure of habitats adjacent to railway lines was also recorded.
Results: As a minimum, railway lines may represent merely a surmountable artificial obstacle rather than a barrier in the strictest sense. This was the case when habitat quality was favourable on both sides of the railway line, train frequency was low, and sufficient over- or underpasses were present. Train speed appeared to have no significant impact under such circumstances. A real barrier effect may occur at wider railway lines (4 tracks) where train frequency is high and no suitable wildlife over- or underpasses exist. Railway lines may then form borders of territories, which are crossed only occasionally, especially by younger animals.

The results of the present study should be of use for the assessment of future constructing projects. Appropriate guidelines and checklists are suggested for this purpose. It is essential to include habitat quality into the assessment of the effects of railway lines on wildlife. The consequences may then differ from one case to another. It is also important which species of animals should be considered and whether the railway line should be assessed as merely an obstacle or as an unsurmountable barrier.

Under what conditions do fences reduce the effects of transportation infrastructure on population survival?

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ETH Zurich, Switzerland:

Dr. Lenore Fahrig
Ottawa-Carleton Institute of Biology, Carleton University, Landscape Ecology Laboratory

Keywords: barrier effect, collisions, dispersal, extinction risk, fences, landscape connectivity, landscape dissection, landscape fragmentation, mitigation measures, modelling, roads, road avoidance, road configuration, road ecology, spatially explicit population model, stochastic simulation model, traffic mortality

Conference session: Effect of Infrastructure

Abstract:

The transportation infrastructure network affects animal populations in three adverse ways. It acts as a network of barriers to movement ('fence effect'), enhances mortality due to collisions with vehicles, and decreases habitat size. We study the relative importance of the first two effects, using a spatially explicit individual-based model of population dynamics. We discuss our results with respect to the suitability of fences intended as a mitigation measure to reduce traffic mortality.

First, we focus on the effects of a single road in a homogeneous environment to compare ‘fence effect’ and traffic mortality. Does putting up a fence along the road enhance the survival probability of the population? Our results show that a fence can either enhance or reduce survival probability, depending on the degree of road avoidance and the proportion of animals killed while trying to cross the road. We present a method to identify the conditions under which a fence would enhance survival probability.

Second, we study animals that require two different types of habitat (i.e., landscape complementation) and compare the conditions under which a fence would be beneficial with the situation discussed before.

Third, we compare different configurations of transportation networks in the landscape. We ask if different spatial arrangements of the same amount of traffic lines (e.g., ‘bundling’ of traffic lines) have different consequences for the strength of both the ‘fence effect’ and road mortality as well as for their relative importance.
We then again identify the conditions under which fences would be advantageous. In summary, our results indicate that putting up fences along traffic lines might be a useful interim mitigation measure until more suitable measures can be applied. However, fences must be used with caution because they may increase extinction risk for species that have large area requirements and small population sizes or that need access to different types of habitat that are separated by the transportation infrastructure. Therefore, it is important to exactly identify the conditions under which fences can be beneficial and to consider alternative measures or the use of fences in combination with other measures.

The barrier impact on migratory moose of highway E4 in the High Coast area, Sweden.

J.O. Helldin, Andreas Seiler, Hans Jernelid, Per Grängstedt
Swedish University of Agricultural Sciences, Dept. of Conservation Biology, Grimsö Wildlife Research Station

Göran Cederlund
Svensk Viltförvaltning

Keywords: moose, monitoring, mitigation measure, fauna passage, effectiveness, barrier effect, EIA, Sweden

Conference session: Monitoring / Research

Abstract:

The new highway E4 along the Baltic coast of Sweden cuts through seasonal migration routes for moose (Alces alces) that move several kilometres between summer habitats in the inland and coastal winter habitats. Large seasonal differences in moose densities together with high numbers of moose-vehicle collisions suggested a strong migratory behaviour. To counteract barrier effects of the fenced road and increase traffic safety, two moose underpasses and several broadened road underpasses have been constructed.

As the road was opened for traffic, a monitoring study was initiated to evaluate the effect on moose and the efficacy of fences and underpasses. The study contained mark and recapture of moose, estimation of moose density by faecal counts, inventories of browsing damages and available forage, snow tracking along the road, and track counts in underpasses. We could show that during winter, migrating moose accumulated west of the highway barrier, reaching densities of more than twice that of the eastern, coastal habitats. Browsing damages on young forest stands west of the road consequently increased from 5% to over 40% during the three year study period. Underpasses were used only occasionally by moose (about 1.5 tracks per month) and there was no seasonal or directional difference in the frequency of tracks. This suggests that only stationary but not migratory moose were utilizing underpasses. In addition, snow tracking revealed that many moose were reluctant to enter the underpasses and instead preferred to cross the fenced road. The conclusion was drawn that the mitigation measures have not been effective in counteracting the barrier effects of the new highway. We discuss possible consequences to moose management and make recommendations for future infrastructure planning in the region.
Road-killed animals in Japanese expressways

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Japan Highway Public Corporation

Yukitoshi Fujishima
Road environment division, Japan Highway Public Corporation

Keywords. road kill, wild life, expressway, countermeasures

Conference session Practice

Abstract:

In Japanese expressways, car-animal collisions occur in more than 30 thousands cases a year. These accidents are caused by expressways which damage and separate wildlife habitats. Japan Highway Public Corporation (JH) is in charge of approximately 2,100 km of expressway construction, and some 7,000 km of its operation in 2003 January. JH has investigated car-animal collision, and taken several countermeasures in practice, for wildlife conservation and for safety driving. Here, Japanese road kill- number, species, trend, countermeasures will be described.

In 2001, there were 33,791 case of road kill in expressways. It means that five road kills occurred per kilometre in the year. Raccoon dog is the most killed animal in expressways- 13,167 cases and forty per cent of total road-killed animals. They usually come into road for night time, seeking for foods, especially forage for domestic animals roadside farm, crops in field, garbage from houses. Small gaps between barrier fences and ground, or drainage ditch enable raccoon dogs to go into road. They often freeze in which they meet headlights of cars, and it lead to road kill. Moreover, secondary road kill occurs. Crows and kites are often killed (4,507 cases), because they seek for killed animals on road.

In last ten years, the number of road kill has increased (22,338 in 1992 to 33,791 in 2001). One of most important reason of increase is for extension of expressway network (5,248 km in 1992 to 6,898 km in 2001). Especially, large part of expressway, which opens recently, passes through mountain area where a lot of wildlife lives. On the other hand, some biologists point another reason that a few species of wildlife- deer and monkey for example has extended their habitat, and their population in specific area has increased recently.

JH has taken four countermeasures against for road kill- conservation of animal path, barrier fence, road patrol, and sign for driver.

First, several types of animal path are conserved when expressways are constructed. Ground above tunnels, space under bridges are used as animal path effectively. Though culvert boxes, overpasses, and culvert pipes are constructed for people use mainly, wildlife animals also use them. Ecological investigations before construction along expressways make the animal path more effective.

Second, barrier fence along roadside is set and improved for animals. In mountain area or field, barrier fence is set for animals to keep out from expressways, though barrier fence is usually set to keep people off. Moreover, the small gap between fence and ground is stopped with meshed fence for raccoon dogs, and higher type of fence (2.5 meters height) is set for deer.

Third, road patrol prevents secondary road kill. In order to keep road clear, periodic routine patrol- several times in a day, and emergency patrol are operated. These patrols find dead animals on road, and take them carefully to be out of road.

Fourth, and the last, signboard are posted for drivers in order to make them more careful for wildlife.

These countermeasures are effective, but they cost much to some extent. Comprehensive study on road kill is necessary to get more knowledge and information about road-wildlife interaction. It will decrease cost for the countermeasures, and it enable to construct more ecological and economical expressway for better relationship between people and wildlife.
Effects of roads on the abundance of birds in Swedish forest and farmland

Mr. J. O. Helldin and Mr. Andreas Seiler
Dept. of Conservation Biology
Grimsö Wildlife Research Station

Keywords: Ecological Impact Assessment, Effect Zone, Noise, Road Ecology, Traffic.

Conference session: Effect of Infrastructure

Abstract:

We studied birds in forest and farmland adjacent to roads; primarily to test a model to determine the width of the "effect zone", the area along a road in which breeding bird density is reduced because of traffic noise (M. Reijnen et al., 1995. 'Predicting the effects of motorway traffic on breeding bird populations'. DLO-Institute for Forestry and Nature Research, The Netherlands). Birds were counted in spring, along transects perpendicular to larger roads in South-Central Sweden in 1998-1999.

In farmland, a lower abundance of birds within the road effect zone was observed, both for some target species and for all species combined. Data were however not consistent in this respect. In forest, no general difference in bird abundance with distance to road could be established. We found a tendency for lower abundance proximate to roads in six species, but the opposite tendency in four. This pattern could be explained by the different habitat requirements of the species. Accordingly, the predictions derived from the model were only partly correct, and we conclude that the model may not be directly applicable under the present conditions. We suggest that habitat changes as a consequence of road construction under some circumstances can override the negative effects of traffic noise on the surroundings, and argue that also the potential positive effects of roads should be considered in road management.

Permeability of highway net of the Czech Republic for big mammals, identification of conflict points and proposed solution

Mr. Vaclav Hlavac
Agency for Nature Conservation and Landscape Protection of the Czech Republic

Keywords: highway, permeability, Czech Republic, conflict point, big mammals, passage

Conference session: Effects of Infrastructure

Abstract:

Busy overland roads, especially highways, create barriers for migration of wild animals, causing fragmentation of their habitat and populations. Isolated populations are unstable and an increasing density of highway network is becoming the chief risk factor for the existence of some species. There are about 1000km of highways in the Czech Republic and its density will increase rapidly in near future. Therefore big attention is paid to this topic in the Czech Republic in last time.

A large study concerning the habitat fragmentation due to highway network was carried out during last four years (1998-2002). The research was focused on following questions:
Permeability of highway net of the Czech Republic for big mammals, identification of conflict points and proposed solution

- Which species of big and medium size mammals can be affected by habitat fragmentation due to transportation infrastructure?
- What are the minimum parameters for fauna passages for different species?
- What is the permeability of existing highway network for different species?
- Is it possible to identify “critical sections” on the existing highways?

In the first step the actual data about distribution and migration behaviour of badger, fox, otter, beaver, wild cat, lynx, wolf, bear, roe deer, red deer, wild boar and moose were collected. The level of endanger caused by habitat fragmentation was established for different species.

The determination of minimum parameters of fauna passages was carried out on the sample of 100 bridges during the period 1999-2001. The snow tracking and "sand bed" methods were used for this research. For the purpose of observation, 93 underpasses 5-60 m wide, six overpasses 6-8 m wide and one overpass 70m wide were selected.

The observations confirmed that the best parameter for the expression of the suitability of underpasses was the index: Width x Height / Length.

The observations confirmed a considerable difference between the uses of underpasses with identical indexes located on different types of landscape. In 1998-2003 an intensive research programme connected with physical controls of all highway bridges over the whole Czech Republic was carried out. The conclusions of this research suggest that the present highway and high-speed road network does not represent a significant barrier for animals of the size of fox, badger or otter. For animals of the size of roe deer the highway network is permeable in 40% of its total length. A large number of sectors, significant from roe deer migration point of view, remain completely impassable. In many sectors highways and high-speed roads present an entirely impassable barrier for large animals such as red deer and elk. The total extent of entirely impassable sectors for this category of animals represents about 70% of the entire length of these roads.

Seven sections on the highway network of the Czech Republic were identified as critical from the point of view of habitat fragmentation for big mammals. As permeability of these sections is crucial for future existence of populations, the plan for restoration of permeability for all target species is being prepared in this year.

Ecotoxicological effects of motorways on soil invertebrate communities

Dr. Ruslan Butovsky
All-Russian Research Institute for Nature Protection (ARRINP)

Keywords: motorways, soil, invertebrate communities, heavy metals, tolerance

Conference session: Monitoring/Research

Abstract:

The research of soil invertebrate communities was undertaken in seven roadside ecosystems in Central Russia, Belgium and the Netherlands. In stressed macroarthropod communities we observed the decrease of abundance of non-specialized predators, chewing phytophagans, saprophagans and increase of abundance of rhyzophanags, sucking phytophagans and specialized predators. In microarthropod communities we observed the decrease of abundance of oribatid mites and collembolans; and increase of relative abundance of acarid, gamasid, tarsonomid and pygmephorid mites. In both size communities we observed highly sensitive (carabid beetles, oribatid mites) and highly tolerant (aphids, acarid and gamasid mites) groups.
Ecotoxicological effects of motorways on soil invertebrate communities

Heavy metal contents in soil invertebrate species was species- and group-specific. It was obvious, however, that some groups were more tolerant than the others. In all studied roadside ecosystems the ability to accumulate copper decreased as follows: isopods > spiders > earthworms = insects. In Russian ecosystems the ability to accumulate zinc decreased as follows: isopods > spiders > insects; in Belgium and the Netherlands: earthworms > spiders > isopods > insects (Butovsky, 1998). In putative invertebrate food-webs non-specialized predators (Carabidae) contained less copper and zinc, than specialized predators (Syrphidae, Coccinellidae, Gamasidae) and parasitoids (Aphidiidae, Pteromalidae) that could be related to different feeding strategies (Butovsky, van Straalen, 1995). In roadside communities zinc was accumulated mainly by saprophagans, chewing and mining phytophagans, specialized zoophagans and parasitoids (CF > 5). Non-specialized zoophagans have a medium accumulation pattern (1<CF<5). The tolerance of soil invertebrate communities to heavy metals was based on universal mechanisms active on community (trophic structure, species diversity etc.), populational (abundance, mass and sex structure of populations) and organism levels.
# Conference session: Networks and Connectivity

Chaired by Mr. Andreas Seiler

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<td><strong>Thursday afternoon</strong></td>
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| 14:00 - 15:30 | Predicting Fragmentation on wildlife habitats of future planned infrastructure in protected metropolitan space, by Mr. Seán Cahill, Parc de Collserola, ES  
Modelling functional landscape connectivity using arcview Cost-Distance, by Mr. Frank Adriaensen, University of Antwerp, BE  
Towards Sustainable networks: setting priorities in restoring habitat connectivity across transportation infrastructure, by MSc. Edgar A. van der Grift, Alterra, NL |
| 15:30 - 16:00 | Coffee Break |
| 16:00 - 17:30 | Importance of Habitat Corridors for Large Herbivores and vice versa, by Dipl.-Ing.agr. Joerg Tillmann, Christian-Albrechts-University of Kiel, GE  
Interaction between Roads and Wildlife Ecology, by Ms. Mary Gray, Federal Highway Administration, USA  
Mapping of Transportation barriers in midde and southern Moravia, by Mr. Jiri Dufek, Transport Research Centre, CZ |
| **Friday Afternoon** |                                                                         |
| 14:00 - 15:30 | Habitat Corridors for Germany, by Ms. Marita Böttcher, Federal Nature Conservation Agency, GE  
Localisation of Fauna Passages-How to find the optimal location, by Ms. Carme Rosell, Minuarte, ES  
Migration potential as a tool for technical and economical optimization of the migration passages planning process., by Dr. Petr Andel, Evernia, CZ |
Predicting fragmentation effects on wildlife habitats of future planned infrastructure in protected metropolitan green space. The case of Collserola Park in Barcelona

Seán Cahill, Francesc Llimona, Anna Tenés, Parc de Collserola, Barcelona, Spain

Keywords: Collserola park, habitat fragmentation, green space, wildlife, metropolitan area, transportation infrastructure, roadkills, SIG analysis, simulation, prediction

Conference session :: Networks and Connectivity

Abstract

Collserola Park is situated within the greater metropolitan area of Barcelona, close to the Mediterranean coastline. The park occupies some 8,000 ha of predominantly Aleppo pine (Pinus halepensis) and Holm oak (Quercus ilex) woodlands with a high diversity of wildlife habitats. Despite its overall metropolitan context, the park contains a surprisingly high diversity of fauna, and is an important area for birds such as raptors, as well as amphibians, reptiles and mammals.

Over the past few decades there has been a rapid growth in urban and industrial development in the Barcelona metropolitan area. As a consequence, many wildlife habitats in Collserola park are now effectively isolated from those of other nearby natural areas by a ring of major transportation infrastructures and urbanised ground. A series of roads, including a fenced motorway and a railway, also cross the park within its boundaries leading to internal habitat fragmentation and limiting wildlife movements to certain areas. There is also a network of limited-access forest roads and tracks which lead to increased disturbance in sensitive areas and may further intensify habitat fragmentation for certain species.

The General Metropolitan Plan for the Barcelona area envisages the development of further new infrastructure within and around the park in the future. Existing data obtained from routine monitoring and specific studies carried out on several species of fauna in the park over recent years has provided abundant information on wildlife requirements in Collserola. Data has also been compiled on roadkills in the park on a day to day basis for more than a decade. Consideration of these all data, in combination with detailed GIS analyses of future scenarios which simulate the planned infrastructures foreseen, has allowed for a prediction of likely habitat fragmentation effects and other impacts on certain wildlife species in Collserola Park.

If undertaken in the future, certain planned new infrastructures could seriously jeopardise the long-term viability of certain wildlife populations in Collserola park and undermine its overall ecological integrity. The possibility of this occurring is increased by the fact that exchange with outlying natural areas is extremely limited. Urbanisation processes beyond the park’s boundaries, facilitated by infrastructure development, are also leading to significant habitat loss and alteration in remaining metropolitan green space, thus lowering threshold levels for sensitive species within the park.
Modelling functional landscape connectivity using Arcview Cost-Distance

Frank Adriaensen, Erik Matthysen
Laboratory of Animal Ecology, University of Antwerp, Belgium
Hubert Gulinck
University of Leuven, Laboratory for Forest, Nature and Landscape Research, Belgium

Keywords: Landscape model, Effective distance, Cost Distance, Connectivity, Isolation, Environmental planning

Conference session: Networks and Connectivity

Abstract:

The growing awareness of the adverse effects of habitat fragmentation on natural systems has resulted in a rapidly increasing number of actions to reduce current fragmentation of natural systems as well as a growing demand for tools to predict and evaluate the effect of changes in the landscape on connectivity in the natural world.

Recent studies used 'least-cost' modelling (available as a toolbox in GIS-systems) to calculate 'effective distance', a measure for distance modified with the cost to move between habitat patches based on detailed geographical information on the landscape as well as behavioural aspects of the organisms studied.

We will discuss the modelling technique as well as some results of the application of the method to a small-scaled agricultural system subject to different scenarios in a land re-allotment project (e.g. tree lines along road sides) and to the construction of a wildlife bridge across a highway.

The model is shown to be a flexible tool to model functional connectivity in the study of the relation between landscape and mobility of organisms as well as in scenario building and evaluation in wild life protection projects and applied land management projects. Since ‘effective distance’ has the same units as Euclidean distance (m), this effective distance may be a straightforward way to include landscape and behavioural aspects in other models (e.g. population viability models), that include distance as a measure for isolation.


Towards sustainable habitat networks: setting priorities in restoring habitat connectivity across transportation infrastructure

Edgar van der Grift MSc, dr. Rien Reijnen, Rogier Pouwels MSc, Fabrice Ottburg , Sipko Hensen.
Alterra, Department Landscape Ecology, The Netherlands

Keywords: habitat fragmentation, population viability, sustainable habitat network, mitigation measures, wildlife passages, Dutch long-term Defragmentation Programme, road, railroad, waterway

Conference session: Networks and Connectivity

Abstract

In The Netherlands much effort has been put into restoring habitat connectivity across roads, railroads and waterways over the last two decades. Wildlife overpasses and underpasses have been designed to facilitate the movement of wildlife at several hundred locations throughout the country. However, at many locations transportation infrastructure is still a major cause of habitat fragmentation. To prioritize actions to restore habitat connectivity across transportation infrastructure through the construction of wildlife passages - as part of the Dutch long-term Defragmentation Programme, initiated by the Dutch Ministry of Agriculture, Nature Management and Fisheries, the Dutch Ministry of Roads, Public Works and Water Management, and the Dutch Ministry of Housing, Spatial Planning and the Environment.
Towards sustainable habitat networks: setting priorities in restoring habitat connectivity across transportation infrastructure

We studied the potential effect of these mitigation measures on the viability of wildlife populations. Our specific objectives were to: (1) determine at which locations mitigation measures at transportation infrastructure would result in a significant increase in population viability, (2) determine locations where, apart from the construction of wildlife passages, additional measures are necessary to increase population viability, and (3) provide recommendations for planning defragmentation initiatives in transportation corridors.

We used the model LARCH to assess potential habitat configuration and network population viability for ten indicator species, sensitive to infrastructure as barriers. High-priority locations for defragmentation were distinguished at infrastructure transects where network population viability shifted either from non-viable (extinction probability >5% in 100 years) or vulnerable (extinction probability 1-5% in 100 years) towards highly viable (extinction probability <1% in 100 years) solely due to the removal of the barrier-effect of the infrastructure, i.e. the construction of effective wildlife passages. Furthermore, high-priority locations were distinguished where roads block either the forming or re-enforcement of key populations or Robust Ecological Corridors.

Preliminary results showed that about 50% of roads can be classified as critical road transects of which 15% were determined high-priority locations for defragmentation. Due to the construction of effective mitigation measures total number of network populations will decrease 33-51%. The area with highly viable network populations will increase about 20-30% for small species with low dispersal capacity, and over 90% for medium-sized to large species with high dispersal capacity.

Our study indicates that, because the loss of network population viability is sometimes exclusively the result of the presence of transportation infrastructure, restoring habitat connectivity across these barriers should be given high priority by both policy makers and infrastructure managers.

Importance of Habitat Corridors for large Herbivores and vice versa - Design of a Habitat Corridor Network for northern Germany


Keywords: large herbivore, red deer, GIS, habitat corridor network, biodiversity, wildlife management

Conference session: Networks and Connectivity

Abstract

Large herbivores are prone to eradication by civilisation. The factor determining this fact from the species site are comparatively low reproduction rates and specific habitat requirements. In the past game meat played an important role for human nutrition. With the shift from using the land as hunters and gatherers towards utilising the land in a locally fixed, spatially restricted (neighbours) manner as farmer the large herbivores were not only looked upon as natural resources itself but also as competitors for natural resources and as a nuisance in landuse systems. This in addition with the loss of habitat led to extinction for example of the European bison (Bison bonasus) or the moose (Alces alces) or to massive legally constituted habitat restrictions for other species for example of the red deer (Cervus elaphus). Their role as "key species" sank more or less into oblivion until recently. Our investigations in northern Germany show that large herbivores can still play the role as "key species" even in our cultural landscapes and are therefore of great importance for conservation or reestablishment of biodiversity. Spatially varying impact on the vegetation and the soil surface create specific, from small to large scale, habitat "staging" that are obligate or at least supportive to certain species. Acting as vector for plants by endozoochoric or epizoochoric transport of diaspores or even as vector for invertebrates they facilitate and support recolonisation- and dispersal-processes.
Thus they are of great significance for the population ecology of certain species and because of their comparatively spacious movement pattern and migration events they quasi function as "shuttle service" between scattered more or less suitable (quality / quantity) habitats. The management and respective conservation of large mammals is becoming increasingly a challenge in the highly cultivated and fragmented landscape of Germany. The establishment of a habitat corridor network would provide an adequate measure for a sustainable integration of large mammals in a dynamic cultural landscape.

Exemplary for Germany we developed a habitat corridor network for red deer in Schleswig-Holstein (northern Germany) considering its situation in the European context. Using a GIS we evaluated the current landscape outside the official red deer management areas concerning its suitability as habitat also taking likely future changes in landscape (traffic infrastructure, degree of recreation, agriculture, forestry) into account. From this backdrop of the potentially suitable habitat we selected those areas that would least likely conflict with the objectives of landowners (i.e. public lands, nature conservation areas etc.) and tried to adapt these to a habitat corridor network connecting its current populations. Suggestions for the establishment of wildlife overpasses are made.

In cooperation with land-users (especially hunters) we developed spatially explicit management scenarios (hunting, wildlife viewing, agriculture, forestry, nature conservation) for this corridor network satisfying both economic and ecological objectives. This concept of a habitat corridor network for large herbivores is an innovative approach in nature conservation for Schleswig-Holstein. Our investigations showed that this concept, in combination with adaptive wildlife-management strategies, is an promising option to sustainable integrate large mammal species and their respective ecological key role in dynamic cultural landscapes.

Interaction Between Roadways and Wildlife Ecology

Mary Gray (Environmental Program Specialist), Alex Levy (Ecologist), Federal Highway Administration (FHWA), USA

Keywords: Roads / laws, regulations, guidance / wildlife ecology/ planning

Conference session: Networks and Connectivity

Abstract:

Federal and some state wildlife agencies are becoming more involved in transportation issues related to wildlife concerns. Numerous policy and regulatory programs are in place to protect important habitats and wildlife. The FHWA, Environmental Protection agency, U.S. Fish and wildlife Service, NOAA fisheries Service and the U.S. Army Corps of Engineers at the federal level, and numerous state agencies through state regulatory programs, are working together with state transportation agencies to improve the environmental quality of our transportation programs.

From a motorist safety perspective, the number of collisions with wildlife and the human injury and fatality associated with these accidents, as well as the financial costs are significant. Indications are that the number of accidents is increasing. However, in the areas where these impacts were comprehensively addressed, wildlife collisions have almost been eliminated. Over the long term, the savings associated with reduced human injury/mortality and vehicular damage could offset the cost of mitigation measures.

Although positive things are happening, they are happening slowly. However, the direction is toward increasing acceptance of the need to consider wildlife related issues and continued improvement of efforts to address these issues. Wildlife measures compete with all of the other transportation needs for funding. Consequently, dedicated funding would help to expedite the intentions of the context sensitive solutions and streamline initiatives through early planning and commitment of funding for ecological and wildlife measures.
Mapping of transportation barriers in Central and Southern Moravia

MSc Jiri, Dufek, MSc Jiri Jedlicka, PhD. Vladimir Adamec, Transport Research Centre, Czech Republic,

Keywords: fragmentation, barrier effect, network, database,

Conference session: Networks and Connectivity

Abstract:

The barrier effect of Southern and Central Moravian Transport Network is investigated by the way of bridges and culverts field exploration on selected roads and railways: two highways: D 1 (Prague - Brno), and D 2 (Brno - Bratislava - Slovak Republic), three dual carriageways R 46 (Vyškov - Olomouc), R 35 (Olomouc - Lipnik), and R 52 (Brno - Mikulov) two international roads E 50 (Slavkov - Buchlovice), and E 461 (Brno - Svitavy) and two railway corridors (Brno - Česká Třebova and Brno - Břeclav). In the meantime, the permeability of 158 bridges and culverts was found out at mentioned roads and railways, in years 2001 and 2002. The following parameters as evaluation criteria have been monitored: communication type, traffic restriction, found fauna species (in/under object or in surrounding), type of observation (tracks, cadaver, occurrence, etc), traffic intensity, geographic description of habitat, object dimensions and drawing, "underbridge" morphology and character, description of obstacles, watercourse regulation, road surface, biotope significance. Good and bad examples of objects and common mistakes at constructions will be presented in the poster. The database of objects has been done. After the finalisation of this database, the most conflict points will be selected and the measures that should lead to the improvement of permeability will be proposed. Czech Ministry of Transport supports the project.

Habitat corridors for Germany

Marita Böttcher , Bundesamt für Naturschutz (Federal Nature Conservation Agency), Außenstelle Leipzig, Germany

Keywords: road network, habitat corridor network, fragmentation, spatial planning, landscape planning, mitigation impact, wildlife overpasses

Conference session: Networks and Connectivity

Abstract:

The planning of a national and international road network, monocultural land use patterns and progressive settlement supported by measures of the EU federal- and state legislation are leading to a progressive consumption and fragmentation of landscape. This consumption of landscape accounts for 130 ha/d in Germany. Beside this direct consumption and fragmentation of habitats, landscape quality is substantially impaired by pollution through chemicals, light and noise. As a result this increasingly leads to isolation, qualitative deterioration of habitats and accelerates loss of biodiversity. Barriers and gaps in habitat network prevent compensating improvements to grip. Up to now Germany is still missing concepts, strategies and methods which will bring together activities to create a habitat corridor network on the federal level as well as part of an European ecological network. All the different administration levels in Germany need guidelines to implement the respective concepts and strategies. The existing legal regulations like the CBD or the FFH-directive support the development of habitat corridors. While determining FFH-areas the functional connection of these areas are only secondarily treated.
Habitat Fragmentation due to Transportation Infrastructure – IENE 2003

Beside these international requests the new federal conservation act contains concrete aims and principles on conception, planning and realisation for the connection of habitats. Further aims of the conservation act are the avoidance of fragmentation by spatially combining linear infrastructure projects and also the preservation and restoration of undeveloped, areas without settlement. The implementation of these aims and principles in spatial planning has to be realised by landscape planning. The same principles have to be applied if concrete projects are planned and realised by mitigation impact. One measure in this context is the planning of wildlife overpasses (and underpasses) with the goal to mitigate fragmentation effects of transport infrastructure. The problem is, that the ecological functions of wildlife overpasses will be lessened if the requirements for proper functioning are not integrated in concepts of other land use plannings. The planning and also the realisation of habitat corridors need to consider all landuser groups with their special land use strategies in general concepts and strategies. To be successful with new strategies to avoid fragmentation and respectively mitigate fragmentation effects of linear transportation infrastructure and to be successful with the actual implementation of the habitat corridor concept in the landscape planning scheme in Germany all the different interests (agriculture, forestry, wildlife utilisation) in the landscape have to be taken into account.

Therefore the Federal Nature Conservation Agency (BfN) and the Deutsche Jagdschutzverband (DJV) with the expert advice of the Department of Landscape Ecology, University of Kiel in November 2002 held a conference with representatives of all administration levels, landusers and scientists in order to discuss a habitat corridor network for Germany and initialise to develop adequate strategies for a fast implementation. To fit this German habitat corridor idea into the European context of a pan European idea for nature conservation first steps in co-operation and know-how exchange with the neighbour countries were made.

The output of the conference will be published in the end of 2003 in the publication series: Schriftenreihe für Landschaftspflege und Naturschutz. It gives a comprehensive overview over the current situation in Germany from the scientific- to the field practice- and the administration level. Also it presents the measures for a fast implementation of the habitat corridor concept as an innovative approach of nature conservation in Germany and the broader context. Innovative in the sense of new scientific concepts in nature conservation and also in the sense of integrating the objectives of the various claims to the landscape.

Localisation of Fauna Passages- How to find the optimal location

Carme Rosell, Planas, Vicenç, Navàs, Ferran
MINUARTIA, Estudis Ambientals, Spain
And
Departament de Biologia Animal. Facultat de Biologia. Universitat de Barcelona

Conference session : Networks and Connectivity

Abstract:

During the last few decades, the construction of wildlife passages and landscape bridges designed to help fauna cross transport infrastructures has increased all over Europe. A lot of information is currently available about the characteristics of the structures that determine their effectiveness as fauna passages for different target species. In many countries, handbooks and norms have provided technical instructions and recently this information has been compiled in the handbook COST 341. Wildlife and Traffic. A handbook on identifying conflicts and designing solutions (Luell et al 2003). Nevertheless, one difficulty that remains is the identification of the best locations for these structures, which means identifying wildlife corridors and those places more intensively used by different target species during their movements.

A model based on landscape features GIS analyses (DISPERSA model) has been developed and is currently being tested in Catalonia, in the North Eastern Iberian peninsula.
The basis for the analyses was provided by a previous field research that identified relevant habitat and landscape features associated with bird and medium-size mammal abundance during dispersal and periods of high movement activity which in this area coincides with the autumn. Using a multivariate method, the study established that some features exist which were associated with higher species abundance (Brotons and Rosell, 2001). The DISPERSA model analyses different landscape attributes, assigning different values depending on three combined characteristics: type of land cover, relief structure (linear guide-ways, such as presence of ridges and valleys) and presence of streams. By means of the GIS analysis, an index of wildlife dispersal interest is assigned to each part of the territory, and identifies sectors with a high index value where an increased presence of animals is expected, especially during dispersal and high mobility periods. The maps generated by this means of analysis allow the identification of existing barriers and dispersal wildlife corridors and also the determination of the location of conflict points when a new infrastructure is overlapped. In case that the affection of these wildlife corridors cannot be avoided by changing the route, the conflict points will require the adoption of measures aimed at helping wildlife to cross and maintaining the connections between adjacent habitats of both sides of the infrastructure. It must be emphasised that the response to the landscape features depends on the target species. For this reason, it is fundamental to identify clear target species when the analysis is carried out in order to provide an effective assessment tool for the identification of the location of the most sensitive places where measures must be adopted to ensure the linkages between core areas and to facilitate their functional connection.

Migration potential as a tool for technical and economical optimization of the migration passages planning process

CSc. Petr Anděl, EVERNIA, Czech Republic

Abstract

In order to respect the stochastic character of the animal migration and proposed measures, it is practical to use the migration potential (MP) theory during road design stages. Migration potential is defined as the probability of functionality of a migration profile. A migration profile is functional if it is being used by the animals and provides safe migration through an overland road.

The functionality of a migration profile is determined by two factors:

Ecological - expressed as the Ecological Migration Potential (MPE). This is determined by the properties of the migration route prior to the road construction. Its future use must be considered with a view to the development of the larger region. MPE gives the probability of use of the migration route in the so-called zero event, i.e. when no road is built.

Technical - expressed as Technical Migration Potential (MPT). This is determined by the properties of the migration passage, its design, dimensions and other aspects. MPT gives the probability of full use of the migration construction by the animals, i.e. the probability that the original extent of migration will be maintained after the road construction.

The total migration potential is defined as the multiple of the ecological and technical migration potential: \( MP = MPE \times MPT \).
Migration potential as a tool for technical and economical optimization of the migration passages planning process

Notes:

All forms of migration potential, being stochastic quantities, have values within the interval <0;1>. MP=0 represents an extreme situation where the passage of animals through a migration construction is impossible; MP=1 represents an idealised situation where an important and regularly used route has not been affected by an overland road at all. The actual stages between the two extremes may be classified and described.

Classification of migration potential

<table>
<thead>
<tr>
<th>Migration potential</th>
<th>Utility classification of migration profile</th>
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<tbody>
<tr>
<td>1.0 - 0.8</td>
<td>Entirely functional, approaching ideal solution</td>
</tr>
<tr>
<td>0.8 - 0.6</td>
<td>Above-average, high utility, only small limitations</td>
</tr>
<tr>
<td>0.6 - 0.4</td>
<td>Average, medium utility, with obvious limiting components</td>
</tr>
<tr>
<td>0.4 - 0.2</td>
<td>Under-average, low utility, number of limiting components</td>
</tr>
<tr>
<td>0.2 - 0.0</td>
<td>Functionless, approaching total impenetrability for migrating animals</td>
</tr>
</tbody>
</table>

The definition MP (MPE x MPT) is based on the mathematical rule which provides that the resulting probability of two independent occurrences (A1 and A2) which occur simultaneously equals the multiple of their individual probabilities (P = P1 x P2). This is consistent with the logic of the problem in hand. It follows that the technical design of the construction cannot increase the total migration potential above the level prior to the road construction.

The concept of migration potential stresses the equal status of the technical and ecological components. It is obvious, and the fact is quantified here, that no good migration construction can be built where the ecological as well as the technical conditions are favourable. For example, in a place where there is a regular and verified animal migration (MPE=0.9) but for technical and spatial reasons, the proper technical solution is impossible (MPT=0.2), the final effect will be only low (MP=0.9 x 0.2=0.18). On the other hand, where there is a very low natural animal migration due to disturbing factors (MPE=0.2), not even an excellent technical solution (MPT=0.9) can provide a highly functional profile (MP=0.18).

The concept of migration potential is based on a quantitative estimation of the level of functionality and usefulness. Despite all the problems presented by the estimation method, it forces both the components equally to quantify their capacity within the given profile. An example is the advantage of this method in evaluating migration routes. Within the framework of the regional systems of ecological stability (USES), the existing bio-corridors are often not distinguished from those planned, the functionality of which cannot be estimated. The distinction is possible by establishing an MPE for each migration route.

Migration potential is also a useful measure for cost-benefit analysis for the design of migration constructions. It is possible to compare the cost and the expected effect expressed by the migration potential for each proposed alternative. This makes it possible to use scarce financial resources only for those areas where there is a realistic expectation of actual benefit.
# Conference session: Evaluation and Monitoring

Chaired by Mrs. Carme Rosell

## Friday morning

<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
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| 9:00 - 10:30 | Effectiveness of fauna passageways at main roads in The Netherlands, by Ms. Geesje Veenbaas, Road and Hydraulic Engineering Division, NL  
The effectiveness of Trans - Canada highway mitigation measures in BANFF National Park, Alberta, Canada., by Mr. Anthony Clevenger, Western Transportation Institute, CA  
Preliminary results of the first highway-construction mitigation measure monitoring programme in Greece, by Mr. Mertzanis, Arcturos, GR |
| 10:30 – 11:00 | Coffee Break                                                                                     |
| 11:00 – 12:30 | The follow-up Research at a E18 Pernaja; three years monitoring of underpasses., by MSc. Seija Väre, Helsinki University of Technology, FI  
Overview of animal detection and animal warning systems in North America and Europe, by Mr. Marcel P. Huijser, Western Transportation Institute, Montana State University, USA  
Maintenance of mitigation measures for fauna: give it priority, by Ms. Annette Piepers, Ministry of Transport, Public Works and Water Management, NL |
Effectiveness of fauna passageways at main roads in The Netherlands

Geesje Veenbaas.
Road and Hydraulic Engineering, The Netherlands

Jeroen Brandjes and Gerard Smit,
Bureau Waardenburg bv, Consultants for Environment & Ecology

Edgar van der Grift,
Alterra, Green World Research, The Netherlands

Keywords: fauna passageways, monitoring, mammals, amphibians, population viability, roads, red deer, badger, crested newt

Conference session: Evaluation and monitoring

Abstract

Many different types of fauna passageways have been constructed in The Netherlands, and many more will be constructed within the next twenty years. In the past decade the Road and Hydraulic Engineering Division of the Dutch Ministry of Transport, Public Works and Water Management commissioned several investigations to assess the use and effectiveness of these fauna passageways. Next to gathering knowledge about animal species who use these mitigation measures and who don’t, the aim of the research was to discover the most important factors affecting the use and effectiveness of fauna passageways. The results are used to improve lay-out, design and maintenance of both existing and planned passageways.

Recent studies have given a fairly good picture of the use of badger tunnels (fauna pipes) by badgers. However, a question that remained was which other animal species use these passageways and what factors affect this use. To answer this question, some 50 fauna pipes were investigated during two periods: 8 weeks in the autumn of 2001, and 8 weeks in the spring of 2002. Track boards with inking pad and paper sheets, specially developed for this study, were inserted into the fauna passageways. In addition as a control a track board was placed in the proximity of each tunnel. All 50 fauna pipes were used by animals during the research period. The pipes were used by a total of 14 target species: hedgehog, red fox, badger, beech marten, polecat, stoat, weasel, brown rat, wood mouse, red squirrel, hare, rabbit, toad (species unknown) and frog (species unknown). Non-target species that used the pipes were cat and raccoon. The use of these pipes by salamanders has not been proved, although tracks of salamanders were recorded on some of the control sheets located in the immediate vicinity of each pipe. Most species, with the exception of mice and amphibians, seem to use the fauna pipes deliberately. Most species use the pipes to the same degree in spring and autumn. However, only badgers used the pipes considerably more often in spring, whereas brown rats used the pipes considerably more often in autumn.

Pipe use by badgers did not have a significant negative effect on the use of the same pipe by other animal species. This suggests that some use by badgers does not exclude the use by other species. However, when a pipe was used by cats a significant negative effect on the use by other mammals (e.g. mice) was found. Mustelids and amphibians used pipes with a length of 40 metres or less more frequently than longer pipes.

With the investigation of fauna passageway use, the question remains unanswered about the effectiveness of these passageways to guarantee population viability. In order to find an answer to this question, a monitoring project was started for three species: red deer, badger, and crested newt. For red deer ecoducts [wildlife overpasses] are supposed to facilitate genetic exchange between populations intersected by roads. Badger pipes and walking strips in culverts or beneath bridges are supposed to increase population viability of badgers and crested newts respectively.
In the first stage of the project potential study areas were determined where the effectiveness of fauna passageways at the level of populations can be assessed. The next step will be to design and conduct a monitoring programme to answer the question whether defragmentation efforts are sufficient to ensure population viability of the wildlife species addressed.

**Research and Monitoring the effectiveness of Trans Canada Highway Mitigation Measures in Banff National Park, Alberta,**

**Anthony P. Clevenger,**  
Western Transportation Institute, Montana State University  
Bryan Chruszcz, Karl Gunson  
Parks Canada  
Jack Wierzchowski,  
Geomar Consulting

*Keywords:* Banff National Park, GIS model, habitat fragmentation, large mammals, performance evaluation, road mortality, Trans-Canada Highway, wildlife passages,

*Conference session:* Evaluation and Monitoring

**Abstract:**

In the last 50 years, the Trans-Canada Highway (TCH) has transformed into a major commercial highway and become Canada’s economic lifeline, connecting goods and people from the Atlantic coast to the Pacific. The TCH runs through Banff National Park (BNP), Alberta, and during this time the national park also has become a major tourist destination, attracting more than 5 million visitors per year, thus creating heavier traffic demands on an already bustling highway. Banff and neighbouring Yoho National Park are the only national parks in North America that have a major four-lane transportation corridor bisecting them. In 1998, the TCH in Banff carried on average more than 14,600 vehicles per day year-round, peaking at more than 30,000 vehicles per day during summer. Consequently, this major highway can have a significant impact on the mountain park ecosystem. Hence, reducing road-related mortalities and potential barrier effects of the highway on animal movement makes good ecological sense and is an obvious necessity.

In November 1996 we began a 5-year investigation in BNP. Our primary study area was situated in the Bow River Valley along the TCH corridor in BNP, located approximately 100 km west of Calgary. The first 45 km of the TCH from the eastern park boundary (phase 1, 2, and 3A) is four lanes and bordered on both sides by a 2.4 m high wildlife-exclusion fence. The remaining 30 km to the western park boundary (phase 3B) is two lanes and unfenced. Plans are to upgrade phase 3B to four lanes with mitigation within the next 5 to 10 years. Twenty-two wildlife underpasses and two wildlife overpasses were constructed between 1980 and 1998 to permit wildlife movement across the four-lane section of TCH. Our secondary or extensive study area extends along the TCH from the Kananaskis River (Highway 40) west of Calgary, to the western boundary of Yoho National Park. Other highways in the study area include Highway 40 in Kananaskis Country, Highway 93 in Banff and Kootenay National Parks.

Wildlife-vehicle collisions have been a problem in the mountain national parks and a cause for concern among park managers and transportation planners for many years. The long term trend and prospects are for increasing traffic volumes on the TCH and other primary roads in the parks. Development of practical highway mitigation will rely on an understanding of patterns and processes that result from highway accidents, which involve elk Cervus elaphus and other wildlife. We analysed the patterns of elk mortality on roads and characteristics of all wildlife-vehicle collisions. We assessed how effective fencing and wildlife crossing structures were at reducing wildlife road-kills and buried vs. unburied fencing was at preventing animal intrusion onto the right-of-way.
Research and Monitoring the effectiveness of Trans Canada Highway Mitigation Measures in Banff National Park, Alberta,

We investigated the key factors influencing the decision of animals to use wildlife crossing structures and where and when to cross a busy unfenced, unmitigated section of highway. We addressed these issues using more than six years of data obtained from systematic, year-round monitoring of BNP wildlife crossing structures. We present several GIS approaches we have developed to model animal movements across transportation corridors in the Central Rocky Mountains. These models are based on empirical and expert data and represent useful tools for resource and transportation planners charged with determining the location of mitigation passages. Finally, we provide conclusions from key objectives of the research and make recommendations for resource managers and transportation planners responsible for maintaining existing mitigation measures and designing future measures.

Preliminary results of the first highway-construction mitigation measure monitoring programme in Greece

A., Mertzanis, Iliopoulos, Y., Isaak, I., Karamanlidis, A., Y., Riegler, A., Riegler, S., Tragos, T.
ARCTUROS, Greece

Keywords: Highway construction, mitigation measures, monitoring programme, brown bear, wolf

Conference session: Evaluation and Monitoring

Abstract

Throughout the world, traffic volumes have increased markedly in the past two decades (United Nations 1992) and the increasing area occupied by recently constructed roads is affecting wildlife populations. For many mammal populations, the main demonstrated impact of roads to date has been in terms of increased disturbance or mortality. Avoidance of otherwise suitable habitats in close proximity to roads has been shown to occur for brown bears (Ursus arctos) and wolves (Canis lupus) in the U.S.A. (McLellan and Shackleton 1988, Mace et al. 1996, Mech et al. 1988). For some mammal species, roads have been shown to act also as a considerable barrier to dispersal (Mader 1984). Roads can therefore have a significant effect in fragmenting wildlife populations and eventually lead them to local extinction (Fahrig and Merriam 1994). Increased awareness of environmental problems caused by infrastructure construction has moved engineers, ecologists and policy makers to develop planning concepts to deal with the impacts on nature and landscape. If avoidance of a certain project is not feasible, mitigation measures can be undertaken as a second planning concept. In the context of the recently acquired environmental awareness, the hellenic NGO Arcturos planned (after 9 years of fight and negotiations with the state authorities on the suitability of the highway alignment) and is currently coordinating and implementing the first highway-construction mitigation measure monitoring programme in Greece. The aim of the involvement of Arcturos during the current phase of the programme is to evaluate the status of brown bear and wolf populations in the study area prior to the planned construction of the Egnatia highway. The final objective of the current phase is a comparative evaluation of the foreseen effectiveness of the mitigations measures versus the present status and ecological requirements of the target species.

Study area

The study area extends over almost 1000km² of a mixed forest and agricultural ecosystem and is located in the north-western part of Greece, in Pindos mountain range. The current alignment of the Egnatia Motorway, which is one of the largest infrastructures projects in Europe, foresees the dissection of an area of outstanding importance for several important priority species of the Hellenic mammal fauna and avifauna (i.e. bear, wolf etc.) and for priority habitat types, according to E.U. Directive 92/43.
Materials and Methods

The assessment of the status of the local brown bear and wolf populations includes:

- the monitoring of movement patterns of the target species within the study area
- the investigation of the genetic composition of the local brown bear population
- the estimation of the local population sizes
- the evaluation of the study area in respect to its suitability for the target species.

These aims are achieved by the following array of methods:

1. The monitoring of the movement patterns of the target species is primarily achieved by the use of GPS telemetry and to a lesser extent by indirect observations (remote controlled photo cameras, infrared video equipment).
2. The investigation of the genetic composition of the local brown bear population requires the collection of biological samples for DNA analysis. These samples (scat, hair, blood) are collected upon chance during fieldwork, but also during capture of animals for radio tagging and through the installation of hair traps. Samples are consequently analysed in the laboratory using standard genetic procedures.
3. The estimation of the local population sizes of the target species is based on the results of a number of methods. These include the results of the genetic investigation, the results of the systematic collection of signs on female bears and cubs of the year and wolf packs and the results of a mark-capture experiment.
4. During this phase of the monitoring programme a detailed mapping and the collection, amongst other, of data concerning the forest vegetation, physiography, topography, land use and human presence in the study area will take place. This information will be merged into a Geographical Information System network that will finally enable in combination with statistical procedures, the evaluation of the habitat suitability of the study area.

Results

During the first year of the monitoring programme the field team of Arcturos has managed to collect some preliminary data on the status of the brown bear and wolf populations in the study area. A small number of individuals of the target species have been radio collared, thus enabling the monitoring of their movement patterns, mainly during the summer months of 2003. In addition, the first remote controlled cameras have been setup and are in use.

During extensive fieldwork in the study area numerous signs of bear and wolf presence (tracks, scat and hair samples) have been collected, which in combination with material gathered through the operation of several hair traps has permitted us some preliminary insights in the genetic and population status of the target species in the area.

Finally, the detailed mapping of the study area has been completed and a high number of data regarding the suitability of the area collected.

Acknowledgments:

This study is part of an overall cooperative project titled “Monitoring & Assessment of impacts on big mammals and their habitats due to the construction and operation of the Egnatia Motorway, on Panagia - Grevena section (4.1), Northern Greece”. This project involves two NGO’s (Arcturos & Hellenic Ornithological Society) and four Faculty Departements (Genetics, Ecology, Forestry, Wildlife Management) from two Universities: Aristotelian University of Thessaloniki, University of Thessalia. This study was launched in October 2002 while the whole project started in February 2003.

We thank EGNATIA ODOS S.A. and the Hellenic Ministry of Environment, Planning & Public Works, for co-financing and initialising this innovative project which is implemented for the first time in Greece before the construction of a highway.
The follow-up research at E 18 Pernaja, three years monitoring of underpasses

M Sci Seija Väre.
Helsinki University of Technology and YS-Consultants Ltd

Conference session: Evaluation and Monitoring

Abstract

Europe highway E18 cut wide forest area at Pernaja in two pieces. The road was fenced with wildlife fence for the traffic safety. The research was started before the road was built and it continued during the construction period. The 14.5 km highway was opened to traffic in year 1998 and at the same time started the follow-up research on underpasses with the big and medium sized mammals. The only way for big animals to cross the fenced road area, was the use of underpasses. There were 11 underpasses, which were built for local traffic, but they were suitable also for animals. Animals have learned to use passages because they search them actively. The species, which have been observed at passages, are the moose, the white-tailed deer, the lynx, the mountain hare, the brown hare, the red fox, the racoon dog, the stoat, the red squirrel, the pine marten and the badger. Observations at the district have also been made from the weasel, the roe deer, the wolf, the wild boar and the brown bear.

Now after three years experience of follow-up, the amounts of animals, which have used the fauna passages, have grown from year to year. The total amount in the first whole year 1999 was 441 animals from which 70-80% was moose. In the second year 2000 the amounts have grown to 548 animals and the third year number was 541. The amounts of animals have become even, but the proportion of moose has still grown. The design of underpasses affects to the amounts of users. The small moose bridge transmits twice or three times as much moose traffic, than the usual narrow frame bridge. The big moose bridge underpass transmits about 80% of all animal traffic. For the smaller wild animals and game the most important thing is the proximity of the underpasses rather than the design.

Any notable changes has not happened in the population of moose in Pernaja forest area or at Eastern Uusimaa in the consequence of the fenced highway. The densities of moose have remained the same as before the road building. The underpasses have become a part of the territory of local moose and they are also a part of the route, when moose move from the winter pastures to the summer pastures and vice versa.

New information about the movements of moose has also been attained. The movement pattern of moose is repeated from year to year. The yearly weather changes can be seen in the results. The wandering to winter pastures starts, when the permanent snow covers the ground and frost begins.

Literature

The follow-up research at E 18 Pernaja, three years monitoring of underpasses

As a conclusion the research gave the evidence that these underpasses have been well adapted among animals and the animal costs in road constructions have been justified and correct. The underpasses have become a part of the territory for the local moose and they are also a part of the wandering route of moose. The animal accidents have reduced and the traffic safety can also be improved by warning drivers about the acute time of animal accidents. The benefits are in traffic safety, but also in the nature. These constructions reduce habitat fragmentation at local and regional level.

Overview of animal detection and animal warning systems in North America and Europe.

Marcel P. Huijser & Patrick T. McGowen
Western Transportation Institute, Montana State University,

Conference session: Evaluation and Monitoring

Abstract

Animal-vehicle collisions affect human safety, property and wildlife. In the United States the total number of deer-vehicle collisions was estimated at more than 1 million per year. These collisions were estimated to cause 211 human fatalities, 29,000 human injuries and over one billion dollars in property damage a year. Similar figures are available from Europe. Here the annual number of collisions with ungulates was estimated at 507,000, causing 300 human fatalities, 30,000 human injuries and over one billion dollars in material damage. These numbers are likely to have increased even further over the last decade. In most cases the animals die immediately or shortly after the collision. In some cases it is not just the individual animals that suffer. Road mortality also affects some species on the population level; some species may even be faced with a serious reduction in population survival probability. In addition, some species also represent a monetary value that is lost once an animal dies.

Historically animal-vehicle collisions have been addressed by putting up signs that warn drivers for potential animal crossings. In other cases wildlife warning reflectors or wildlife fences have been installed to keep animals away from the road. However, conventional warning signs appear to have only limited effect because drivers are likely to habituate to them, wildlife warning reflectors may not be effective, and wildlife fences isolate populations. In some selected areas wildlife fencing has been combined with a series of wildlife crossing structures. In most cases however, such crossing structures are limited in number and width, mostly because of their relatively high costs. In this paper we review a relatively new alternative to wildlife crossing structures; animal detection and animal warning systems that are located in the right-of-way. Animal detection systems detect large animals as they approach the road. When an animal is detected, signs are activated that warn drivers that large animals may be on or near the road at that time. Animal warning systems operate on a slightly different principle as they detect vehicles, not the animals. When a vehicle is detected the animals are alerted through a range of audio and visual signals from stations placed in the right-of-way. This paper lists all animal detection and deer warning systems in North America and Europe known to the authors in September 2003. In addition, we describe the main characteristics of the systems and we review them with respect to operation and maintenance issues, system effectiveness, and how such systems may be applied in combination with other mitigation measures.

Habitat Fragmentation due to Transportation Infrastructure - IENE 2003
Maintenance of mitigation measures for fauna: give it priority.

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Keywords: maintenance, fence, fauna passage, organisation, inspection

Conference session: Maintenance

Abstract:
To bring down the number of fauna casualties on highways and to decrease the barrier effect of highways for fauna, the Directorate-General for Public Works and Water Management in the Netherlands builds fences and fauna passages. Yearly a budget is available for defragmenting nature areas dissected by existing highways. For new highways, the construction of fences and fauna passages is an integral part of the total project. The total fence length along highways in the Netherlands amounts up to 600 km. Over 600 fauna passages have been realised varying from badger tunnels, small and large fauna tunnels and overpasses to adaptations of existing constructions as bridges, viaducts and culverts. In future another more than 500 fauna passages will be built (including adaptations to existing constructions).

For fauna passages to be used effectively it is necessary that they are built and maintained well. Holes in fences, water or garbage in tunnels reduce or nullify their effectiveness. Regular inspection is needed to determine the state of the provisions. From time to time it is noticed in the Netherlands that the inspection, the way of construction and the maintenance applied is not as good as it should be. The Directorate-General for Public Works and Water Management gets complaints, the Minister receives letters, there are negative reports in the press. The solution has to be addressed either in the construction phase or in the phase of inspection and maintenance.

To improve the inspection and maintenance phase of fauna provisions the Road and Hydraulic Engineering Division (the advisory division of the Directorate-General for Public Works and Water Management) has set up a special project. The project started in spring 2002 with a preliminary study. A questionnaire was sent to employees of the Directorate-General for Public Works and Water Management responsible for the maintenance of fauna provisions with questions about their way of working and problems experienced. The questionnaire got a very high response indicating that the importance of well functioning fauna provisions is recognised. The results of the questionnaire show that the inspection and maintenance related problems largely stem from organisation and management issues, causing a lack of sufficient manpower and budget priority. Besides, lack of knowledge on provision maintenance, poor accessibility of some provisions and lack of communication between organisation parts responsible for the construction and those responsible for the maintenance are seen as bottlenecks by the employees questioned.

A broad approach is necessary to solve the identified problems. Several strategies will be followed for embedding the inspection and maintenance of fauna provisions in existing ways of working within the Directorate-General for Public Works and Water Management. Therefore the second part of the project will, a.o. focus on:
• implementation of the inspection and maintenance of fauna provisions in the overall planning process of the organisation;
• defining guidelines for new innovative maintenance contracts with contractors;
• implementation of fauna provisions in an organisation wide information system for the storage of data on maintenance objects;
• addressing the subject in relevant discussion platforms within the organisation;
• publishing a brochure with pictures of examples of good and bad maintenance practice.

This part of the project will take place in 2003. Results will be presented at the conference.
## Conference session: Mitigation and Compensation

Chaired by Mr. Hans De Vries

### Friday Morning

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### Friday Afternoon

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Insect migration and patch dynamics: How to shape habitat corridors and wildlife overpasses

Heinrich Reck, Björn Schulz, Ecology Research Centre Kiel, Dept. of Landscape Ecology Christian-Albrechts-Universität zu Kiel, Germany

Keywords: dispersal, insects, grasshoppers, modelling, habitat corridor network, fragmentation, impact regulation, habitats directive, wildlife overpasses, landscape planning

Conference session: Mitigation and Compensation

Abstract:

The analysis of biocoenotical dynamics and dispersal processes within a patchy pasture landscape (Schrautzer et al. 2002) in comparison to the results of experiments on species mobility within different vegetation mosaics, within herbaceous strips and on roadside verges (Reck, Schulz in prep., Rietze & Reck 1997) leads to new approaches in shaping wildlife overpasses and habitat corridor networks (Schoeps & Reck 2002).

Traffic-caused habitat fragmentation especially affects species which are not capable to fly and depend on active dispersal. Most species of this type are insects and most of them as e. g. grasshoppers like Chorthippus apricarius (one of our model species) neither pass on spatial information between individuals nor are they expected to learn about spatial structures and keep a map in mind. Therefore demands on mitigation measures against barrier effects or demands on shaping effective wildlife corridors should differ from demands deduced from the abilities of comparatively high intelligent vertebrates.

The main external factors that influence the migration and dispersal of such types of insect species are location, shape, size, spatial distribution and diversity of habitats. As a basis for understanding and modelling dispersal of target species (Lorenzen in prep.) e. g. for impact assessment and regulation according to the German Nature Conservation Act or to the Habitats Directive it is essential to have knowledge about habitat-dependant migration types (undirected versus directed movement), the probability of habitat changes, the attraction of different habitat types and the role of barriers and corridors. Therefore different experiments on species mobility were carried out and the movement processes of several target species were recorded. The particularity of one of our main research areas was that the habitat patterns and habitat changes were driven by grazing mammals. This led to unexpected dispersal processes, unexpected dispersal distances and unexpected dispersal corridors. According to the results (and the aim to enable effective dispersal and maintain metapopulation structures in European fragmented landscapes) the planning of corridors must combine demands derived from mosaic-cycle theory, from the necessity of an effective, habitat-shaping density of large mammals and their respective migration as well as from the habitat demands of invertebrate target species.

One first result is the integrative plan to mitigate and compensate effects of the new motorway A143 (with broad wildlife overpasses connected to a partially new built landscape corridor system). The next step will be an integrative approach on state level in Schleswig-Holstein where the existing habitat network concept will be supplemented by establishing suitable living conditions for large herbivores in higher density. The reestablishment of red deer populations could be an important step. (see Tillmann_abstractIENE)
Insect migration and patch dynamics: How to shape habitat corridors and wildlife overpasses

References


Getting bat flight paths across infra structure

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Dipl. Biol. Lothar Bach, Germany

Dr. Robert Brinkmann, Germany

Keywords: bats, Chiroptera, survey methods, flight paths, mitigation, tunnels, green bridges,

Conference session: Mitigation and Compensation

Abstract:

All European bat species (Chiroptera) use their habitat as a complex network of different functional habitats: roosts, flight paths and foraging areas. Species differ in their home range and in scale on which their commuting flights take place, from several hundreds of meters to many kilometres. Fragmentation of landscape, and thus of their network, is a problems for bats. Even in the case of undisturbed quality in foraging habitat and roosts, disconnection of flight paths is expected to lead to a decline in populations.

Their high status in conservation policy is illustrated by the special European Bats Agreement under the Convention of Bonn, their position on annex II and/or IV of the European Habitats Directive, as well as their position in national legislation and red lists throughout Europe.

In recent years different methods, including bat detectors, radio-tagging and netting, are used to assess bat networks in landscapes where development and planning of infra structure was taking place. This approach has proven to be vital for the assessment of impact of infrastructure on bat habitat, such as possible loss of roosts or foraging grounds, or disconnection of flight paths, in the frame work of EIA as well as the assessment of impact on special areas of concern under the Habitat directive.

Concrete mapping of flight paths allowed to pin point the possible conflicts in the landscape: crossing of flight paths and planned routes. Observations on the behaviour of bats around existing infra structure suggested the possible use of structures such as tunnels, with no or low traffic, or green bridges as a means to mitigate disconnection in planned routes and regain connectivity in existing infra structure. In different projects in Europe such measures for mitigation now for the first time are being planned and fine tuned with respect to the different species, the concrete landscape use of the species in the planning areas, and their integration in the existing ecological landscape infra structure.
Different design and ideas can be demonstrated. Monitoring of their acceptance is needed to further develop the designs. A working group of bat experts and consultants in environmental planning is exchanging and gathering information on the behaviour of bats with respect tunnels and bridges around existing infra structure, as well as specially designed measures, as a basis for development of the designs.

Amphibian mitigation measures on Hungarian roads: design, efficiency, problems and possible improvement, necessity and suggestion for a coordinated European environmental education strategy

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Mr., Zsolt, Vogel,,
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Keywords: amphibians, road kill, mitigation measures, tunnels, environmental education, Hungary

Conference session: Mitigation and Compensation

Abstract:

Transportation infrastructure poses a great impact on wildlife through e.g. habitat fragmentation and road kills, which is especially important at the local level. To lessen these effects on different animal groups game bridges, game passages and wildlife tunnels have been built in many European countries, especially on new roads. While the implication of such mitigation measures is becoming a routine task, the evaluation of their monitoring is rather rare, especially at the national or regional scale.

In Hungary the first wildlife-oriented construction was made at Parassapuszta in 1986, which aimed to direct amphibians into culverts under the existing main road. Modern mitigation measures has been implied since the middle of the 1990s along motorways. In 1998 a new, long-term conservation survey has been launched with a focus on existing roads near national parks and large wildlife reserves. The main aim was to determine where amphibians, a mostly threatened vertebrate group, are overrun in large numbers and suggest technical solutions for those sites. Altogether a 1,410 km road network has repeatedly been investigated and on the basis of a six unit scale made according to the number of killed amphibians, estimated population sizes and traffic density, twenty-six road sections were put into the highest category. As a result, amphibian tunnels and fences have been built in the Ipoly valley, which also triggered the construction of temporary and permanent mitigation measures elsewhere.

As an integral part of the national survey, all wildlife-oriented constructions were studied in Hungary to set up a national data base, describe and evaluate the efficiency of different mitigation measures on amphibians, make guidelines for maintenance and recommendations for future constructions.

Altogether twenty-four mitigation measures, sixteen amphibian tunnel systems (altogether thirty-eight tunnels), together with the two game bridges and three game passages existed in the country, were investigated. The breeding migration was the most intensively studied period but sites were also visited in other seasons, e.g. in summer. Site visits included the investigation of the constructions (tunnels, fences and their connections), road kills along adjacent road sections and the estimation of amphibian population sizes in neighbouring habitats.
Amphibian mitigation measures on Hungarian roads: design, efficiency, problems and possible improvement, necessity and suggestion for a co-ordinated European environmental education strategy

At present, mitigation measures for amphibians exist in five of the nineteen counties in Hungary helping one-five million amphibians annually to cross roads safely. While basic parameters e.g. tunnel diameter or concrete as tunnel material are mainly identical, a great diversity of technical solutions was recorded. Even tunnels under the same road 10 km away from each other differed e.g. in fence material and tunnel - fence connection as they belonged to different road authorities. Most inventions, however, could be appropriate for their planned function, malfunctioning was mainly due to the inadequate positioning and fixing of tunnel - fence connections and the lack of maintenance, which is regularly needed between the end of February and the middle of October under the given climatic conditions.

The comparative study of two amphibian tunnels with different acceptance (and thus, approach) by the relevant authorities (e.g. national park directorates) and local residents proved the importance of environmental education. It is especially helpful at the local level and if mitigation measures are put on lower roads. Based on this experience, a coordinated European education strategy on the ecological effect of roads is suggested with special focus on three target groups, decision-makers, local residents and the general public. Besides publication of material (films, posters, brochures, etc.) for general purpose, personal contacts, also with the help of NGOs, to convince people on the importance of mitigation measures and make them support e.g. their local wildlife tunnel are necessary for improving the functioning of mitigation measures on transportation infrastructure.

Fauna passages and other things: an overview of measures to mitigate habitat fragmentation by transport infrastructure

Dr. Verena Keller
Swiss Ornithological Institute

Conference session: Mitigation and Compensation

Abstract

The European Handbook on Wildlife and Traffic presents a wide variety of mitigation measures. They can be broadly grouped as 1) measures that primarily aim at reducing habitat fragmentation by providing links between habitats on either side of the infrastructure and 2) measures where the emphasis lies on reducing the number of animals killed by traffic.

The most important measures are fauna passages, from wide overpasses and underpasses designed for large animals or for linking habitats to smaller passages designed for particular species such as badgers, otters or amphibians. The talk gives an overview of fauna passages and other mitigation measures on the basis of the European Handbook.
Abstract:

Habitat fragmentation caused by new transport and housing infrastructure can not only be mitigated by reducing the barrier effects of the projects on-site or constructing ecoducts: Off-site compensation measures can also provide a contribution to improving the habitat network by creating new linkages between formerly isolated habitats. Up to now, the existing compensation practice in Germany - legally based on the Impact Regulation in the Nature Conservation Act - often failed to achieve this goal because compensation measures were dispersed over the landscape and lacked spatial and conceptual coherence. Therefore it's one of the main objectives of German Nature Protection Authorities to improve the efficiency of compensation measures prescribed by the Impact Regulation.

The concept of mitigation or compensation pools ("Flächen- und Maßnahmenpools"), is of great importance in this context: Land for compensation measures is been acquired in areas, where ecological functions can be enhanced. This land can be used for compensation measures, when they are needed to mitigate the effects of projects. In some cases, nature conservation measures are realized even before impacts occur, so that "complete solutions" can be offered to the causers of impacts. The aim of this approach is to realize compensation measures, that enhance ecological conditions in coherent areas, reduce time-lag effects of compensations where possible and under the bottom-line overcome the limitations of "patchwork compensation". Pools can be used to build up corridors between existing habitats or improve the conditions in degraded parts of habitat networks. This can be an adequate off-site compensation for negative impacts on habitat structure, especially where no on-site solutions are available. In general, the pool approach allows to take scales in account, that normally stay unassessed when designing compensation measures.

Experiences with the pool approach have been made e.g. in the USA (Wetland Mitigation Banks) and since a couple of years in Germany. One of the central problems of compensation pools is to find an adequate form of organization. A wide range of tasks is to be solved:

- Finding and assessing areas with suitable potentials for compensation purposes,
- building up a regional network with authorities, land-owners and land users to make the acquisition of land or the establishment of conservation-oriented use-limitations possible,
- develop concepts for the pool areas as a whole as well as for the implementation of compensation measures in detail,
- get the compensation measures across to the causers of impacts, especially authorities and companies that deal with transport infrastructure; this tasks requires methods for finding adequate compensation for given impacts,
- organize the pool and all of it's transactions in a economically sound way.
In the project "Kulturlandschaft Mittlere Havel", all these aspects of the pool approach are developed and tested by establishing an agency for compensation land and measures ("Flächenagentur"), that builds up a couple of pool projects for the region between the towns Brandenburg/Havel and Potsdam (Federal State Brandenburg). The Chair for Landscape Planning is commissioned with the scientific accompaniment of the project. This accompaniment contains evaluation of the pilot-project as well as proactive development of tools for the ecological tasks the agency has to face. The presentation will give an overview about the results of the project so far based on a short introduction to the pool approach of compensation.

Compensating for ecological impacts of road development: eight years' experience with Highway A50 (Eindhoven-Oss, Netherlands)

drs. Ruud Cuperus, Ministry of Transport, Public Works and Water Management, Directorate-General of Public Works and Water Management, Road and Hydraulic Engineering Division, the Netherlands


Keywords: compensation measures, highway A50 (Eindhoven-Oss, Netherlands), implementation compensation plan

Conference session: Mitigation and Compensation

Abstract:

Ecological compensation is a relatively topic in Dutch nature conservation policy. It embodies a tripartite strategy for dealing with the ecological impacts of large-scale development projects: avoidance, mitigation (reduction) and compensation (substitution) of the adverse ecological impacts. Ecological compensation is defined here as the substitution of ecological functions or values that are impaired by (highway) development. It may require 'no-net-loss' of habitat conditions (i.e., soil and hydrology), habitat types (area and quality), populations of single species or species groups (numbers), or ecological functions (occurrence), in so far as they are ecologically significant or characteristic for a specific ecological site.

Since 1993, the Dutch National Structural Schema for the Rural Areas has set the ecological compensation principle. The Structure Plan lays down the following criteria for applying the Dutch compensation principle: (1) the initiator is responsible for implementation of the compensation principle; (2) the legitimacy of a development must first be established before addressing the compensation measures; (3) the occurrence of impacts is to be avoided as far as possible, with any effects preferably being mitigated and, only in the last resort, compensated for; (4) compensation implies no-net-loss of area or quality; (5) impacts on habitats should be compensated for in terms of the same or, if not feasible, equivalent quality; (6) if physical compensation is unfeasible, financial compensation is obligatory.

This paper reviews the implementational aspects of the ecological compensation plan for Highway 50 (Eindhoven-Oss), the first of its kind to be executed in the Netherlands as part of a structural nature conservation policy. The review concludes that after full implementation of the Highway 50 compensation plan as scheduled, the 'no net loss' criterion will probably not to be satisfied and that ecological compensation is not in fact amenable to a programmatic approach of this kind. For more effective implementation of the compensation principle, it is recommended that a clearer administrative framework be developed at the national level, as well as some form of policy guidelines on farm-based conservation. Future compensation plans should also specify more precisely what deviations in implementation are acceptable under the terms of 'no net loss'.
Reducing the effects of habitat fragmentation on navigable waterways in Flanders, Belgium

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Ministry of the Flemish Community
Environmental and Infrastructure Department
Waterways and Maritime Affairs Administration (AWZ)

Keywords: navigable waterways, habitat fragmentation, barrier effect, corridor function, ecological engineering

Conference session: Mitigation and Compensation

Abstract

Flanders has in total 1540 km of waterways. One of the most dense networks of waterways in the world. The Waterways and Maritime Affairs Administration, shortly AWZ, is responsible for the management and the day-to-day administration of the navigable waterways in the Flemish region.

Waterways have a dual character. On the one hand, they can be impassable barriers for animals and plant seeds. On the other hand, rivers and their accompanying vegetation structures act as a guiding line and migration corridor for many species.

For minimising the problems of habitat fragmentation due to waterways and canals a whole package of measures has been developed by engineers and ecologists. Rivers and canals, their banks and verges, can function as infrastructure corridors between certain areas within an bigger ecological network. These corridors may potentially conduct the movements of animals and plant seeds. They may also serve as a refuge to organisms that are not able to survive in the surrounding landscape.

AWZ stimulate the corridor effect of waterways and the adjacent vegetation structure by using nature friendly techniques. Nature friendly bank revetments and reinforcements, fish spawning areas or shelters for fish and other aquatic fauna, and verge management plans are mitigation measures that have been made.

Vegetation is managed with the aim of increasing the ecological value and conserving and developing the biodiversity alongside the waterways, but also to prevent erosion on dikes.

Further, the risk of animals and people drowning in artificial waterways or canalised rivers has been reduced by creating special fauna-exits. For species such as roe deer and badgers, fauna exit devices has been build. Softening the slope of the banks by building nature friendly bank structures can also help animals and people to climb out of the canal or river.

In addition, constructions such as sluices and weirs form a physical barrier to the movement and dispersal of many species, including fish. For AWZ, solving fish migration bottlenecks on its ports, waterways and canals is one of the priorities of ecological engineering. A plan for the restoration of the migration ways for fishes has been set up.

During the last decade the policy of AWZ has led to more attention to and concern for the environmental aspects of rivers and waterways, such as conservation and nature development. AWZ is incorporating nature aspects into its own policy, by means of the set up of zoning plans for each waterway. In these plans, AWZ is planning to optimise the cohabitation and the development of the main functions of waterways, including ‘nature’.

Also, AWZ is working towards a sustainable development and an integrated approach of the multiple functions of the waterways.

Last but not least, shipping of goods and people on the waterways can contribute to minimise the fragmentation effect by roads and railways. Besides, shipping is the most environmental friendly transport modus.

Nancy Newhouse, Sylvan Consulting Ltd.,

Keywords: Wildlife Protection System, warning system, wildlife accident mitigation, research, British Columbia, infrared, deer, behaviour, speed.

Conference session: Mitigation and Compensation

Abstract:

The Wildlife Protection System (WPS) is designed to use QWIP or FLIR infrared cameras to detect the presence of wildlife on or near the highway. When wildlife is detected, flashing lights are triggered warning drivers to reduce speed and anticipate wildlife on the roadway. The first trial of this system was initiated in the summer of 2002 in Kootenay National Park, British Columbia, Canada. In the trial, two cameras were mounted on a 6m pole at either end of a 2 km stretch of highway. Adjacent to each pole was a trailer containing a computer (with tracking software), radar guns, and a conventional video camera. Continuous (24-hour) infrared and conventional video footage was recorded. In addition, an "event log" was generated in an excel spreadsheet that recorded each animal detection and traffic speeds before and within the test zone.

The objectives of this project are to:

1. Determine the accuracy of the "Wildlife Protection System" at detecting wildlife and warning motorists.
2. Determine the speed response of drivers to wildlife activated warning lights.
3. Document wildlife behaviour near highways using 24-hour infrared video footage in order to develop more effective wildlife collision mitigation strategies.

A number of technical difficulties prevented the system from becoming continually operational in 2002. Range of the camera is dependent upon its location (height and position relative to center line), type of lens, and the right-of-way terrain. Successes from this preliminary trial include confirmation of the camera's ability to track wildlife within a one kilometer range, and collection of infrared video data, providing a unique opportunity to study wildlife behavior on and near road systems.

Significant upgrades to software were made in October 2002 and revisions to increase the camera software's accuracy in detection of wildlife and differentiation between wildlife and other heat sources are on-going. In anticipation of further tests this spring, work is also continuing on the physical maintenance of the camera and power sources. The 2003 tests will focus on continued assessment and refinement of the technical aspects of the Wildlife Protection System, evaluating the effectiveness of the warning lights in altering driver speed, and documentation of wildlife behavior in the test zone.

If the test trials are successful as envisioned, this new technology should be used to reduce wildlife-vehicle collisions. The Wildlife Protection System offers several advantages over conventional mitigation strategies including:

1. Wildlife cannot become habituated as they do to scents, reflectors, and other deterrents because the system focuses on the actions of motorists, rather than animal behavior.
2. Drivers are less likely to become complacent to the warning system because it is only triggered temporarily when wildlife is present.
3. This system does not interfere with the natural movement of wildlife, nor require the construction of overpasses or underpasses to allow for highway crossings.
The portable infrared video recording system could also be used as a research tool for wildlife accident mitigation such as documenting wildlife crossing rates prior to construction of new highways to determine best locations for overpasses and tunnels (if they are deemed necessary) and assessing the effectiveness of other existing mitigation tools, such as reflectors and repellents by documenting wildlife behavioral response. The trailers are also fully portable, unobtrusive, and provide 24 hour/day recordings, so could be employed in a broad range of other off-highway wildlife research on animal behaviors.

Funding for this project was provided by a coalition of partners including the Insurance Corporation of BC, Innovative Transportation Technology Inc., Parks Canada and the Columbia Basin Fish and Wildlife Compensation Program.

The Wildlife Accident Reporting System (WARS) in British Columbia

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Keywords: Wildlife, mortality, accident, reporting, system, WARS, analysis, risk, transportation, geographic, information, infrastructure, highways, habitat, mitigation, species, stewardship, safety

Conference session: Mitigation and Compensation

Abstract

As transportation-related wildlife mortality becomes an increasingly important environmental stewardship issue for transportation agencies, the need to establish comprehensive wildlife accident reporting systems is becoming critical. Without timely and accurate information to quantify the magnitude of wildlife mortality and determine its geographic and temporal characteristics, mitigation efforts are compromised from financial, functional and operational perspectives. Key to any successful wildlife accident reporting system is a structured data collection framework with quality control components.

The British Columbia Ministry of Transportation (BCMoT) has been operating its Wildlife Accident Reporting System (WARS) for over 20 years. Through BCMoT’s network of private maintenance contractors, detailed species and location data on wildlife accidents is systematically collected on a daily basis on major highways in British Columbia. Over time, WARS has become a critical component in BCMoT’s continuing efforts to safeguard the motoring public by reducing wildlife mortality on existing highways and the potential for wildlife mortality on new highways.

WARS enables BCMoT to:

• identify accident-prone locations and accident trends;
• direct mitigation efforts in a cost-effective manner;
• evaluate the effectiveness of mitigation techniques;
• provide data for highway planning purposes;
• model and forecast accidents;
• examine relationships of traffic and climate on species-specific accidents;
• develop accident risk profiles for highway corridors; and
• establish policies and strategies for accident issues and mitigation initiatives.

With WARS, BCMoT is working to maximise the use and effectiveness of its existing warning system infrastructure in a manner supported by statistically significant data, and not speculation or unfounded assumptions. Monitoring accident rates and locations over time helps BCMoT identify developing problems in a timely manner. WARS also directs BCMoT’s attention to high wildlife accident locations to reduce the operating costs of its private maintenance contractors.
Information contained in the WARS database provides a unique opportunity to examine the highway/wildlife habitat interface. WARS enables highway planners to reduce the fragmenting effect of highway corridors on wildlife habitats by ensuring wildlife migration routes which cross highway alignments are identified and protected. Efforts are made to protect critical populations of rare or endangered species by providing structures for the animals to cross highways safely.

WARS contributes to a better understanding of province-wide scale wildlife migration patterns, population dynamics, and habitat needs. WARS has provided data for Canadian federal government departments, Government of British Columbia ministries, wildlife advocacy agencies, non-government organisations and wildlife researchers working in neighbouring Canadian provinces and American states. The WARS database provides a rare and invaluable collection of wildlife-related motor vehicle accident information on a large number of different species of both large and small wild animals that cannot be assembled from any other data sources.

Throughout North America, many state and provincial transportation agencies are struggling to deal with rising numbers of wildlife accidents. This situation is due in part to increases in traffic volumes and vehicle speeds as well as wildlife population growth. Many state and provincial transportation agencies are also facing growing demands by the public to address the issue of transportation-related wildlife mortality. Any effort by these agencies to respond in a timely and effective manner will require the systematic collection and analysis of wildlife accident data if investments in accident mitigation are to be optimised.

The BCMoT WARS system, with its long established, extensive multi-species, geographically-referenced database, represents a successful model for wildlife accident data collection and analysis. Given its fundamental simplicity, ease of implementation and low operational cost, the BCMoT WARS model is suitable for transportation agency needing to document and analyse wildlife mortality on roads, highways and railways in urban and rural settings. The BCMoT WARS model can be implemented by most transportation agencies within their existing organizational maintenance reporting structures.
<table>
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| 9:00 - 10:30 | The wild Reindeer Project, Mr. Bjorn Iuell, Norwegian Public Roads Administration, NO  
              | Chance and Limits of co-operations in Habitat Fragmentation issues, by Dipl.-Ing. Mark Wöss, Institute for Wildlife Biology and Game Management, AT  
              | Public/ Private Cooperation can create Critical Linkages for wildlife, large and small along I-90 in Washington state, USA, by Ms. Mary Gray, Federal Highway Administration, USA  |
| 10:30 - 11:00| Coffee Break                                                           |
| 11:00 - 12:30| How long does it take to recognise a problem? Amphibians and Roads in Slovenia., by Ms. Katja Pobolsjaj, Center for Cartography of Fauna and Flora, SI  
              | Who's interested in de-fragmentation except rabbits?, by Mr. Luc Janssens, Dep. Of Environment and Infrastructure, BE  
              | Sustainable Roadside Verges, by Ms. Lisa Dolan and Dr. Padraig Whelan, University college Cork, IRL  
              | Stakeholders cooperation on the issue of Habitat fragmentation due to transportation and the role of Communication, by Ms. Tatiana Damarad, ECNC, NL  |
The Wild Reindeer Project

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*Keywords:* Fragmentation, disturbance, co-operation.

*Conference session:* Cooperation

**Abstract**

The major wildlife problems associated with transport infrastructure development in Norway are undoubtedly the negative effects on reindeer populations, both the direct barrier effects of roads fragmenting populations and the indirect impacts caused by disturbance.

The problem is a classic example of functional fragmentation caused by disturbance. Before both road and rail links were built across the country, the Norwegian wild reindeer population was an open population divided into 7 sub-populations. Today it is further divided into 23 separated sub-populations.

Wild reindeer are more sensitive to disturbance than the other large deer species and tend to be extremely shy of human activities. The disturbance from road traffic can reduce the reindeer's use of areas for large distances either side of roads.

The result of this avoidance is a reduction in the “available” grazing resources, which in winter consist mainly of lichens, in wide zones parallel to roads, and an equivalent increase in grazing pressure in a zone at some distance from roads leading to an over exploitation in this zone. Because lichens need 20 - 30 years to recover after intensive grazing, the wild reindeer are especially vulnerable to barriers that reduce their possibilities to reach new grazing grounds.

Of this reason, and because increased traffic and snow accumulations from ploughing are reducing contact between two important areas north and south of the road, the Norwegian Directorate for Nature Management has suggested closing down the part of the Hw 7 that goes through the wild reindeer areas on the Hardangervidda mountain plateau in the winter months. The Norwegian Directorate for Public Roads has been asked by the government to investigate the consequences in co-operation with The Norwegian Directorate for Nature Management, not only for the wild reindeer, but also for the socio-economic effects and the consequences for local and regional transport.

In 2002 scientists from the Norwegian Institute of Nature Research (NINA) were engaged in a 5-year study to undertake research on patterns of utilization of the lichen grazing resources and on the movement of wild reindeer in the areas close to the road. 16 animals are equipped with GPS-transmitters providing continuous detailed data on their position.

Because the fragmentation is the result of the cumulative effects of different disturbance sources, the project will look into the relative level of disturbance from other sources than road traffic. Power lines, the settlement of cottages and alpine areas, and the recreational use of the area by skiers, hikers and snow scooters all contribute to the disturbance of the wild reindeer. It's therefore necessary with a common effort from all these actors if the wild reindeer shall resume the use of the old grazing grounds and migrations patterns.
Chances and limits of cooperations in habitat fragmentation issues. 
Realization status of recommendations from Austrian studies

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Keywords: spatial planning, cooperation, interest groups, Austria, motorways, wildlife corridors

Conference session: Cooperation

Abstract

In 1997 a new Austrian federal directive aiming at the avoidance of traffic accidents caused by game species has been published. For the first time this directive contained a chapter about passageways for furred game (RVS 3.01; Forschungsgesellschaft fuer das Verkehrs- und Strassenwesen 1997).

But the application of this directive caused difficulties in practice: No concrete instructions were given supporting the decisions about location and amount of green-bridges. For that reason the Ministry of Economic Affairs initiated a study „Efficient green-bridge insertion in Austria“ assigned to the Institute of Wildlife Biology and Game Management, BOKU - University of Natural Resources and Applied Life Sciences Vienna.

The main purpose was to find out the permeability of the existing network of motorways and the requirements for crossing possibilities (e.g. green-bridges) for game species in Austria. This study was completed 2001 and now provides basic information about barrier effects and permeability of motorways on game species in Austria.

The study includes also recommendations for the most efficient placement and construction requirements for wildlife passageways.

Another study at the BOKU - University of Natural Resources and Applied Life Sciences Vienna was completed 2002 and examined the question in how far satellite and aerial images can provide details on the distribution of wildlife corridors in a landscape.

With the collected data and information from aerial/satellite images and terrestrial surveys a resistance model for indicator species was developed. Resistance models of this kind can be used to check the effects of current and planned transportation infrastructure on the permeability of landscapes for wildlife. The resistance models can also be used to visualize the consequences of regional planning strategies within a wildlife corridor area.
Public/Private Cooperation can create Critical Linkages for Wildlife Large and Small Along I-90 in Washington State USA

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Key words: Cooperation, highway barriers, connectivity, and corridors

Conference session: Cooperation

Abstract

A habitat Linkage assessment was completed for I-90 at Snoqualmie Pass In Washington State in 2000. It identified crossing opportunities for both large, high mobility species and small, low-mobility species along the highway. Provisions for such crossing opportunities, particularly in areas adjacent to late successional forest, may facilitate old forest ecological functions involving small mammals.

A highway improvement project is providing an opportunity to construct these crossing. Interstate 90 is the major east-west corridor linking the Seattle/Puget Sound area with eastern Washington and the rest of the country. A construction project addressing many of the operational problems east of Snoqualmie Pass including deteriorating pavement, sharp curves, and delays due to avalanches and rock slides. An additional lane in each direction will be added making this a 6-lane facility. In addition to the standard road improvements, wildlife connectivity is being given tremendous attention.

Washington State Department for Transportation has been working for over a year with the U.S. Forest Service, Tribes, Private environmental groups, Washington State Department of Ecology and U.S. Fish and Wildlife Service and many others to acquire needed right-of-way, locate and design crossing structures and update information of where wildlife is crossing. This multi-agency effort is unprecedented in the U.S. The results of this cooperative effort will be presented clearly illustrating the benefits of working together to improve wildlife connectivity.

An intensive mapping exercise has already been completed. These maps have been used to identify key areas where crossing structures can be installed. An important design element that has not been dealt with on other crossing projects is the quantity of snow that accumulates for between four and six months. Up to 10 feet of snow can be on the ground for many months potentially blocking passage for wildlife. This issue must be addressed for the structures to be successful. Crossing are being designed for high and low mobility wildlife as well as fish.

How long does it take to recognise a problem? Amphibians and Roads in Slovenia

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Conference session: Cooperation

Abstract

The problem of habitat fragmentation due to infrastructure and the impact on biodiversity is already generally acknowledged worldwide. The paper will present the overview of the last decade of activities regarding this problem in Slovenia, with amphibians as a target group. Namely, amphibians are recognised as one of the main indicator groups of small animals when we talk about impact of infrastructure on habitat fragmentation and road kills.
The emphasis will be to show the process of building the cooperation between different stakeholders such as policy-makers, biologists, engineers, NGO's and the general public, in solving this problem.

When Slovenia become independent in 1991 and few years later started the process of accession to EU, the large activities in adopting new and modern legislative took course. At the present the Slovene nature conservation legislation applicable for amphibian conservation includes the statutory acts, in particular the Nature Conservation Act (1999) and Environmental Protection Act (1993).

The key executive act concerning biodiversity is the Decree on the protection of endangered animal species (1993) by which all amphibian species except Fire Salamander (Salamandra salamandra) are protected by law. In connection with the developing of infrastructure is very important the Decree on Environment Impact Assessments (EIA) (1996), as a part of the Environmental Protection Act, which determines the contents of EIA studies that include also the EIA for animals, plants and their habitats.

In the last decade the road transport has rapidly increased, since Slovenia is situated at one of Europe's main cross-roads. To meet the increased transport demand, new infrastructure is currently planned and developed, where a major challenge is to pay the attention to environmental concerns in the planning process. Planning follows the procedures laid down in the laws of spatial planning and on the regional and national level is carried out by Ministry of Environment, Spatial planning and Energy and at the local level is the responsibility of municipalities.

The process of environmental audit is now well established in the EIA process for the new highways program, but there were several intermediate steps. At the beginning the biologists were included only as an expert support for Nature Conservation Authorities and they were not actively included in the planning stage. As the EIA process developed, the biologists are now part of the planning stage from the start and the mitigation measures are included early in the process. The cooperation between road construction authorities, nature conservation authorities, planners and biologists was well established. As a result of these activities amphibians were recognised as one of the main target groups for defragmentation and other mitigation measures in highway construction.

In the mean time there was growing activity for amphibian conservation through newly established Societas herpetologica slovenica, the national NGO established in 1996. The topic of amphibians and roads was presented to wider public through media campaign, and there were also some educational projects for schools, some of them with international character. As a result the first national workshop on "Amphibians and Roads" problem was organized in November 1999 in cooperation with Societas herpetologica slovenica, Slovene Museum of Natural History and Center for Education of Slovene Road Firms. The participants were all representatives of the whole spectre of stakeholders.

The next important step in developing the cooperation was in the year 2000 the one-year project "Amphibians and Roads" of Centre for Cartography of Fauna and Flora financed by Ministry of Transport and Communications, Directorate for Roads. The main goal was to prepare the baseline for a national strategy of mitigation and conservation measures for amphibians on public roads.

The project was divided in two parts: preparing an overview of amphibian road mortality in Slovenia and preparing of the proposal for national strategy and national directives which will be included in the national road regulative concerning road maintenance and management. Raising people awareness and promoting of the amphibian conservation on roads were important part of the project. Database of amphibian "black spots" on road segments was set up. It is compatible and possibly included in the "National Roads database" of the Directorate for Roads for direct use for the preparation of environmental mitigation measures and management plans for Slovenian roads.

The follow-up project is in the year 2003 one-year project "Amphibians and Traffic in Alps-Adria Region" which is the first part of larger Interreg III A - Phare CBC Austria- Slovenia project: "Amphibienschutz im Alpen-Adria-Raum".
The effective planning and implementation of a harmonized working methodology, obtained with cross border collaboration, is of special interest. Both studies have shown that in addition to motorways, many anthropogenic factors act as barriers and reduce migration possibilities for game: Agricultural areas without natural woodland, belts of settlements, embankment constructions (e.g. Danube), railway lines and others. Therefore, local, regional and international cooperation between transport planning, regional planning, game management, agriculture, forestry and hunting, nature conservation, and corresponding research institutions should be intensified and improved.

The next step would be to apply the results of these two studies in spatial and transport planning practice. But neither is the federal directive 3.01 obligatory nor is the conservation of corridors fixed by Austrian law. Are these scientific efforts to provide information about wildlife corridors and the permeability of transportation infrastructure for the authorities futile? The Austrian example shows that it does not need to be so. Cooperation between scientists, planners, and planning authorities, landowners, hunting authorities, and local experts made it possible to take first steps towards realization and application of the results of our studies.

The Austrian federal forestry company has even founded a strategic partnership with the aim of conserving habitat connectivity. We will demonstrate that engaged partners start to be successful in the process of conserving landscape connectivity for wildlife even without obligatory directives. The recommended measurements from our two studies are on the way of at least partial realization. Examples therefore are provincial environments, where spatial planning authorities are focusing on important wildlife corridors in their spatial development programs, province of Carinthia, where a green bridge is built crossing an existing motorway, and provinces of Lower Austria and Burgenland, where a motorway project is planned fully according to the ecological guidelines concerning corridors for game animals.

Who's interested in defragmentation except rabbits?

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Keywords: defragmentation project, public support, convincing decision makers, press, local authorities
conference topic: Cooperation

Abstract

The realization of a defragmentation project is most often a process of trial and error. We will demonstrate this statement by the brief history of the defragmentation of an existing motorway in the eastern part of Flanders (province of Limburg). This motorway (E314) tears up in two some of the most important Flemish nature reserves.

The construction of this motorway, as many others in Flanders, was finished in the late seventies of last century. In those days, no defragmentation measures were taken for the wild fauna living in the neighbourhood.

Recently, the problem of fragmentation by roads, railroads, and artificial waterways is drawn more attention to. Fragmentation is one of the 13 important themes in the first Environmental Policy Plan, approved by the entire government of Flanders for a period of 5 years. Within the Flemish administration, a special entity is working on defragmentation by technical solutions such as ecoducts, ecotunnels, fish ladders, and ecological banks.

In the beginning, this defragmentation project proceeded rather pragmatically and in a more informal way. Most of the first part of the project was executed by the Flemish Environmental administration. This action forced other administrations (like the Flemish Motorway administration) to continue and counteract. The press reacted rather objectively and was very interested in this scoop.
Who's interested in defragmentation except rabbits?

A first ecotunnel for example, is spectacular and sensational. Nevertheless, some newspapers found this tunnel 'costly' and 'only useful for rabbits'.

When a more complicated part of the project began, the contacts between the environmental and the road administration, intensified during the first part of the project, were extended. A more scientific found approach was demanded and worked out by a consultancy. This independent research was needed to convince some administrative and politic decision-makers.

Everybody concerned with defragmentation felt the need of an integrated way to promote such a project. The public must be informed about the problem of fragmentation, the possibilities to counteract this problems and the further plans for the defragmentation not only of the E314 motorway but also of its whole natural surroundings. Misinterpretations of the data (economical versus ecological) in an important local newspaper caused a considerable delay. Also the organisation of regional elections stalled the project.

After those elections new responsibles must be convinced of the importance of the project. For a more official collaboration, both concerned Flemish ministers respectively responsible for nature and environment and for public works, signed a protocol on a financial, an administrative and a time planning. This agreement regulates the responsibilities of the different regional authorities concerned.

The longer the more the initiators realised that, besides these regional authorities, also local authorities and a lot of private concerned groups must be initiated in the project. The Regionaal Landschap Hoge Kempen does the promotion and support of the project to local authorities, parties and people. This Regionaal Landschap happens to be a co-operation between the local councils and the regional nature society. Their main goal is to promote active and soft forms of recreation within the boundaries of good practice of nature development, conservation and restoration. The fragmentation of nature reserves and wooded areas by roads and traffic also affects the quality of recreation negatively. Promoting defragmentation, not only for wild animals, but also for men, was a much stronger signal to obtain a broader public support.

The realisation of the defragmentation project of the E314 is well underway. The fence for roe deer and smaller animals was placed a few years ago. Last year, 3 supplementary small ecotunnels were drilled and an existing underground level passage was adapted as a larger ecotunnel. This year, an existing bridge is adapted as a mixed ecoduct-bicycle track. The regional road will be cancelled. In the near future the first ecoduct will be constructed.

This project proves that for the realisation of a defragmentation project a lot of technical, ecological and financial skills are needed. But that is not enough. Even more important are abundance of energy, perseverance, persuasion, pragmatism and good luck!

Sustainable Roadside Verges

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Key Words: Habitat Fragmentation, Ecological Landscape Design, Aesthetics, Sustainable Roadside verges, Road ecosystems

Conference session: Maintenance

Abstract:

The fragmentation of habitats due to road ecosystems is a growing ecological concern, as the rural landscape is traversed by an ever expanding road network, number of road users and diversity of user groups. Accompanying this trend is an increasing number of ecosystem based mitigation techniques, which operate at various spatial scales, aimed at the design and repair of ‘sustainable road ecosystems’
e.g. creation of linear roadside nature reserves through re-vegetation with native species (natural recolonisation, habitat translocation and ‘instant’ planting) and ecological infrastructure which allows passage of animals under and over roads (“green bridges”, eco-culverts and fish passages, amongst others), which endeavour to create, retain or enhance existing ‘corridors’ for the dispersal of wildlife through the landscape.

However, if such techniques are adopted based solely on the biological principles of ecosystem management they cannot contribute to a sustainable roadside infrastructure. This is because the landscape also has inter-subjective qualities which are perceived and valued by people and any damage to the landscape and subsequent re-vegetation of Roadside Verges (RV)s post-road construction with native only, or native and/or non-native vegetation has the potential to influence people’s regional identity, welfare and well-being by affecting their relationship with the landscape.

The identification of and a thorough understanding of human preferred visual and non-visual environmental aesthetics, including examination of the possibility that the affect elicited by scenic encounters with preferred RVs can lead people to form emotional attachments to the land and develop a greater appreciation for sustainability goals, must be incorporated into RV landscape design. Such an approach also has enormous potential to combat road deaths at a time when society is acknowledging an urgent need to counteract driver monotony and fatigue. Fatigue reflects on patterns of relations existing between the road user and the environment of the particular roadway, and it has been found that certain visual ‘encounters’ (such as views, art, landscape and engineering design features) can serve to interest the road user and even increase the strength of hazard perception, therefore, the RV as the ‘view from a car’ must be developed at the speed at which the road user is expected to drive.

However, only a handful of studies have truly examined the aesthetics of RVs. Further, very few studies have examined the potential of RVs to harbour native wildlife i.e. cost effective and less intensively managed verges re-vegetated with native species (e.g. natural recolonisation, hay strewing, or native trees and shrubs) versus intensively managed and costly re-vegetation with non-native species (e.g. bio-stabilisation using perennial rye grass or oil seed rape, exotic wildflower mixes, trees and shrubs). There also appears to be no evidence of an attempt to combine the outcome of such studies into the design of RVs, though aesthetics and roadside re-vegetation techniques for wildlife are inextricably intertwined e.g. when considering enhancing a feature of the landscape for road users, one may be affecting the “corridor” to dispersal for wildlife or vice versa.

This study is the first attempt at examining the preferred landscape aesthetics of Irish road users in order to identify optimum RV designs which strike a balance between preferred RV encounters and RVs which harbour a high diversity of native species. The ultimate product is RVs’ which are more true to sustainability goals i.e. which not only mitigate against habitat fragmentation and other ecological impacts such as road run off, pollution spills, noise etc. but also satisfy the road users experience i.e. RVs which are more likely to survive and enhance the quality of life for successive generations than roadside landscapes that do not attract any care or admiration.

A new holistic design approach is required which will offer various pathways towards the creation of sustainable RVs. However, in order to achieve this one will need to engage stakeholders through environment education and communication techniques, and to acquire cooperation from a broad range of formerly divergent disciplines including: civil engineering, landscape architecture, landscape ecology, road ecology, horticulture, landscape psychology, social science and road managers. The latter possess a key position in supporting ‘sustainable road ecosystem development’ as managers of local ecosystems, but face a great challenge in translating officially announced sustainability commitments into everyday management practices.
Stakeholders cooperation on the issue of Habitat fragmentation due to transportation and the role of Communication.

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Keywords: Stakeholders, decision-making, cooperation, interactive communication, consensus building, policy-making.

Conference session: Cooperation

Abstract

For the success with de-fragmentation we need solid ecological knowledge and proved technical solutions, however not less than that we need financial investments and political will to put this knowledge into practice. The general public approval of our de-fragmentation projects and of all related investments is also an integral part of the success.

This paper presents some ideas on stakeholders and cooperation upon the issues of habitat fragmentation due to transportation. It outlines the importance of communication in this process and describes new trends in communication: interactive communication and consensus development through stakeholder participation.

The habitat fragmentation is a complex issue, which encompasses the knowledge of various disciplines, requires actions from different levels of authorities and economic sectors. There is a large number of groups that have to cooperate in order to achieve the objective of de-fragmentation.

In general, the term stakeholders refers to all the (groups of) people or organisations:
• Whose permission, approval, co-operation or (financial) support is needed to achieve objectives;
• Who will be directly or indirectly affected by planned activities or measures;
• Who are not directly involved, but can influence opinion.

The stakeholders in the habitat fragmentation due to transport are decision-makers on transport, nature, landuse, etc; practitioners such as road engineers, construction companies, maintainers, spatial planners, landscape engineers, nature conservationists; users of infrastructure such as drivers; knowledge providers such as scientific organisation (transport, nature, landuse, etc.) and so on. The stakeholders should be carefully identified.

Achieving the objectives of de-fragmentation of habitat requires that all identified groups of stakeholders get involved in various forms of cooperation:
• Cooperation to develop better solutions
• Cooperation to ensure political and legislative support (consequently, financial support as well).
• Cooperation to ensure public support and stimulate the social pressure for solving the problem

It should be acknowledged that the problem of habitat fragmentation is relatively new nature conservation problem. It still has to be broadly recognised and accepted at all levels of relevance or by all stakeholder groups. Communication as a tool can be of great help in this aspect.
Stakeholders cooperation on the issue of Habitat fragmentation due to transportation and the role of Communication.

There is a long tradition of using communication to achieve the nature conservation aims. Communication tools such as brochures, reports, CD-ROMs, posters, films and education activities play a prominent role in communication campaign. Those tools classified as an instrumental communication tools. They are designed to transmit the information and do not bring us into direct contact with the people that we are communicating with.

When, however, the problem is too complex and there are major differences in interests, opinion, attitude, knowledge among the stakeholders, instrumental campaigns with its one-way communication allowing for little or no interactions will be of no much use. In this case we need means and methods that ensure interactive exchange of opinions such as meetings, phone calls, workshops, round tables. By using interactive communication tools is possible to provoke a dialogue and bring stakeholders to an agreement about some delicate and sensitive issues.

Consensus development through stakeholder participation is a promising new trend that takes into account the interactive character of the communication process. It is a process of negotiations, discussion and exchange of information that involves all major stakeholders in a specific issue. During the process the participants learn from each other and about each other, and hopefully manage to come to consensus about the best way forward such as action plans and policies that are acceptable to all of them.

Stakeholders that involved in interactive communication for the consensus building or in interactive policy-making usually should pass through five main phases:

- Recognising a problem;
- Analysing the problem: causes, stakeholders involved, stakeholders’ interests, relationships with other problems;
- Exploring solutions: linking stakeholders’ interests, looking for necessary resources, exploring the benefits of different measures or policy instruments, etc.;
- Implementing, monitoring and evaluating the problem-solving process;
- Recognising additional or new problems

The basis for interactive policy making is the recognition of mutual dependency: stakeholders have to realise that they need ‘the others’ to reach their goals. This makes them willing to communicate with the others.

Interactive communication and consensus building among stakeholders can be a difficult, time-consuming process. However, the potential advantages are quite clear:

- Interests of all stakeholders are taken into consideration.
- Related problems are linked.
- Better quality plans and policies are developed.
- Wide support is ensured.

Interactive communication and consensus development through stakeholder participation are generally considered to be the main direction communication concerning environmental issues, including habitat fragmentation, should take in the future in order to be effective.
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<tr>
<th>Time</th>
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<tr>
<td>16:00 - 17:30</td>
<td>Conference conclusions by Mr. Hans Bekker</td>
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<td>Speech by a representative of the Minister of Environment, agriculture and Development Cooperation</td>
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<td>Formal closing of Conference by Mr. Dick van Straaten</td>
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<td>Distribution of COST action 341 products</td>
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Roads & Fauna safety Italian project

Marco Dinetti, LIPU/BirdLife Italy, Urban Ecology Office

Keywords: Project Roads and Fauna Safety, Italy.

Poster session

Abstract:

The Project “Roads and fauna safety” is carried out by LIPU (Lega Italiana Protezione Uccelli)-BirdLife Italy, and financed by Italian Ministry of Infrastructure and Transport - Direzione Generale delle Strade e Autostrade.

In the year 2002 we have produced:
- an education and information depliant;
- a report on the Italian state-of-the-art in respect to the topic of infrastructures and biodiversity (introduction, legislation, European and international context, state-of-the-art in Italy, Italian initiatives, the actors, main actions for mitigation, conclusions, bibliography, appendix - forms of 141 Italian experiences);
- an international review of the available bibliography (547 publications: 89 Italian; 294 European, 140 American, 22 other countries).

Other future actions will be the realization of guide-line for the planning of mitigation measures along roads and motorways, monitoring of activities, courses and advices for engineers, architects, planners, administrators, and other professionals.

Program for the Monitoring & Assessment of impacts on big mammals and their habitats due to the construction and operation of the Egnatia Motorway, on Panagia - Grevena section (4.1), Northern Greece

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ARCTUROS - Civil Society for the protection and management of the natural environment and the wild life, Greece

Keywords: Motorway construction, Implementation of environmental terms, Monitoring program

Poster Session

Abstract

The Egnatia Motorway: Panagia - Grevena Section

The Egnatia Motorway is the major road construction project being carried out in Greece and, one of the largest in Europe. It constitutes one of the 14 TENT (Transportation European Network) priority projects and is co-funded by the European Union.
The 680km Egnatia Motorway is a modern motorway that will probably be the only communication link spanning Northern Greece from its western to its eastern border. From its starting point at Igoumenitsa harbour, it ends at Kipoi (Prefecture of Evros) on the Turkish border, being the only road axis at the southern-eastern borders of the European Union.

The Egnatia Motorway section 4.1, 33km long, belongs to the geographical districts of Western Macedonia and Thessaly, Prefectures of Grevena and Trikala, and it crosses the NE part of Pindos mountain range.

The alignment of Panagia - Grevena section (4.1)
This section runs through a highly important, in ecological terms, forest and agroforest ecosystem of a 900km² surface approximately, which constitutes the habitat of significant fauna species (Bear, Wolf, Deer, etc) and a priority type of natural habitat, pursuant to Directive 92/43.
The final alignment of the section can be characterised as particularly “environment-friendly”. Several structures (such as tunnels, bridges, underpasses) as well as one Green Bridge, have been foreseen as wildlife passages.

Program for the Monitoring and Assessment of the project’s impacts on big mammals and their habitats
This program is implied by the Environmental Terms of the project, following the relevant Environmental Impact Assessment Study and aims at minimizing the impacts of construction and operation of the Egnatia Motorway on the region’s ecosystem. The distinct stages of the program are the following:
• Recording of the current situation, as far as the populations and the habitat of the indicator species are concerned.
• Overall assessment of the Project’s impacts on big mammals before the commencement of construction.
• Monitoring of the results and the effectiveness of corrective measures taken during the construction and operation of the Project.
• Provided that the approved alignment does not change, proposals for the modification or further development of the environmental terms, their implementation methods, the application of corrective measures, etc, in case that these are proved to be effective.

The program will be implemented with an interdisciplinary approach and by the cooperation of various University Bodies and Ecological Organisations. The Owner of the Project is EOAE and the coordinator of the implementation bodies is the Ecological Organisation “ARCTUROS”, which will also act as the program’s consultant.
The program implementation will be achieved through the application of a plethora of modern techniques and methods, such as the use of telemetry with GPS radiocollars, thermo-sensitive or infrared cameras, bioindicator DNA laboratory analysis, the development of a Geographical Information System (GIS), etc. The coordinated use of the aforementioned methods will significantly aid in drawing certain conclusions and finding the optimum solutions for the protection of the region’s ecosystem parallel to the construction and operation of the motorway. The involvement of the public and, in particular, of the local communities in the program constitutes an important and almost imperative concern.

Afterword
On a national level, this Program is an innovative effort on the part of the Egnatia Odos AE, the Greek State and various Implementation Bodies, which introduces a different approach and a new strategy in the construction of major road axes in relation with the preservation and protection of the natural and man-made environment.
Besides, the environmental parameter in the construction of a project now constitutes a factor equally important with the technical and economic ones. Furthermore, all three coordinates should be involved in the process in such a way so as to result in a technically complete and environmentally acceptable project.
Study of the effect of the transportation infrastructures on habitats fragmentation in the future National Park "Sierra de Guadarrama" (Madrid, Spain).

Mrs. Paloma Fernández Sañudo & Mrs. Teresa Gil Gil, Environmental Research Centre of Madrid Regional Government“ Fernando González Bernáldez”, Madrid, Spain

Keywords: Habitat, Fragmentation, Natural Protected Areas, Conservation measures

Poster session

Abstract:

In the last years the transportation infrastructures have experimented a huge development. This has caused a great damage on the natural environment that sometimes is not reversible (loss and isolation of habitats, loss in exchange of genetic material...).

The aim of this study is to measure the effect of the transportation infrastructures on the natural habitats that compound the territory of the future National Park "Sierra de Guadarrama". This will serve as a useful tool for the diagnostic of the state of conservation of the area and the implementation of conservation measures. The last objective is to give recommendations for the planning and management of the natural resources in this area.

The Guadarrama Range is a very important natural area because of its high natural and cultural values. But this area is also very interesting because of its localisation. Madrid city is only about 40 Km of distance and has a population of about 5 million people. This implies a huge pressure that constantly demands more transportation infrastructures. In this area there are 25 habitats included in the Habitats Directive that compound the 65% of the Madrid Region habitats. These represent 47,832 ha, nearly the 48% of the study area and few less than 22% of Madrid Region. Five of these are priority habitats and represent the 62% of all that are in Madrid. All of these priority habitats are very small and isolated, which is an evidence of its fragility.

One of the relevant results of the study is that there is a clear differentiation between those habitats that are located at high altitudes from those that are at lower altitudes. There is a gradient of fragmentation directly related with the altitude. So the loss and isolation of the habitats at high altitudes is lower than at the other ones. This supposes the application of different conservation measures at different scales.

Animal use of passageways at a Swedish highway

Görgen Göransson, Department of Biology and Environmental Science, University of Kalmar,

Keywords: passageway, ecoduct, barrier, fragmentation, mammals, birds, insects

Poster session

Abstract

Animal use of passageways at a highway outside Malmö City (South Sweden) joining the Öresund Bridge connecting Malmö with Copenhagen (Denmark) was investigated on the third year after road was first opened (July 2000). Animals using six underpasses and one overpass (ecoduct) were recorded by tracking on sand beds (birds, mammals), live trapping (small mammals) and fall trapping (beetles and other arthropods) during summertime.
Rabbit, European hare, and feral cat were the most frequently tracked mammals but also hedgehog, red fox and roe deer were recorded as were pheasants and corvids. Small mammals trapped were screws, bank vole, field vole, and wood mice. Predominant arthropods trapped in the passageways were isopods, spiders, and insects (frequently carabid beetles). The role of the highway as a barrier will be discussed.

Permeability of highways to carnivores: spatial/temporal patterns of road casualties and underpasses as linkage elements

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Centro de Biologia Ambiental - Faculdade de Ciências da Universidade de Lisboa

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John Bissonette3
USGS Fish & Wildlife Research Unit, College of Natural Resources, Utah State University, USA

Keywords: carnivores, highways, road casualties, underpasses

Abstract

Conversion and fragmentation of natural land cover by humans is cited as one of the main factors leading to the overall decline of biological diversity and extinction of many plants and animals. Habitat fragmentation generally leads to smaller and more isolated populations that are then vulnerable to local extinction, due to stochastic events. One of the most widespread forms of modification of the natural landscape during the past century has been the construction and maintenance of roads. Many roads affect connectivity of animal populations by acting as either impermeable or semi-permeable barriers and dispersal barriers. The effects may be direct, viz., direct mortality; or indirect, viz., avoidance behaviours. As roads are upgraded to accommodate greater traffic densities, the rate of successful wildlife crossings tends to decrease significantly, and in some cases is the leading cause of local animal mortality. Efforts to increase road permeability and mitigate potential barrier effects can reduce ‘effective’ habitat fragmentation and isolation, and thereby ameliorate or arrest population decline. Mammalian carnivores display a high vulnerability to landscape change due to their low population density, low fecundity, large home ranges, and direct persecution by humans. Further, recent research has demonstrated that carnivore populations are negatively impacted by increasing road density, but respond positively to effective crossing structures. Hence, carnivores are an ideal focal species to use in the implementation of a conservation strategy for roads design that also will protect other members of the community with less stringent habitat requirements.

As part of the project ‘Modelling Habitat Connectivity For Carnivores: Implications For Conservation Planning’ funded by the Portuguese Foundation for Science and Technology (SFRH/BD/ 10600/2002), and with the support of BRISA (an enterprise responsible for exploitation and management of most highways), we designed a study to address and analyse the factors affecting the permeability and potential barrier effects of highways in order to develop mitigation techniques that can prevent the isolation and reduction of carnivore.
To accomplish this main goal, we: 1) assessed the spatial and temporal patterns of road mortality, and 2) implemented a monitoring programme of highway underpasses to document the rate and success of carnivore crossings. The study focuses on two highways (A2 and A6 in Alentejo, South Portugal) 89 km and 146 km in length, respectively. The carnivore community in Alentejo includes 10 species: fox (Vulpes vulpes), weasel (Mustela nivalis), polecat (Mustela putorius), stone marten (Martes foina), badger (Meles meles), otter (Lutra lutra), genet (Genetta genetta), Egyptian mongoose (Herpestes ichneumon), wildcat (Felis silvestris) and Iberian lynx (Lynx pardinus). Polecats, otters, wildcats, and Iberian lynx are threatened in Portugal; otters, wildcats, and lynx are of conservation concern in Europe (Annex II of Berna Convention).

Preliminary results show that in 2002, 180 carnivores of 8 species were killed, with fox suffering the highest mortality. More road kills occurred during spring and summer, coinciding with spring reproduction and dispersal of young in summer. Locations of dead animals are being analysed in relation to several landscape parameters, e.g., topography, land cover, and human pressure to detect patterns related to road casualties. Fifteen underpasses will be monitored using remotely triggered cameras, track plates, and scat surveys in and around each passage to quantify carnivore use. Results will be correlated with underpass structure and attributes of the surrounding landscape to detect relevant patterns. Based on our results, we will propose management options to enhance road permeability for carnivores in the study area.

Evaluation of Wildlife Crossing Structures on US Highway 93

**Amanda Hardy, Anthony Clevenger, Marcel Huijser**
Western Transportation Institute
Montana State University

*Keywords:* habitat connectivity, mitigation, monitoring, road impacts, wildlife-vehicle collisions, wildlife crossing structures.

*Poster session*

**Abstract**

On December 20, 2000 the Confederated Salish and Kootenai Tribes (CSKT), the Federal Highway Administration (FHWA), and the Montana Department of Transportation (MDT) signed a Memorandum of Agreement allowing for the reconstruction of US 93 on the Flathead Reservation from Evaro to Polson, Montana, United States. Because wildlife is important to the CSKT natural and cultural heritage, reducing the negative effects of the highway on wildlife was a major consideration in the reconstruction of US 93.

The project will include 42 wildlife crossing structures and 14.7 miles of wildlife-proof fencing at a total estimated cost of over nine million dollars for this mitigation alone. The magnitude of this effort is unprecedented in North America and offers an excellent opportunity to evaluate the effectiveness of wildlife crossing structures in rural environment that includes agricultural, business, residential, and recreational opportunities.

The Western Transportation Institute (WTI) at Montana State University has been contracted by FHWA and MDT to evaluate the effectiveness of the US 93 wildlife crossing structures.

The goals of the evaluation are to determine what effect US 93 wildlife crossings have on wildlife-vehicle collisions and wildlife habitat connectivity across the transportation corridor. WTI is currently collecting preconstruction data relating to these variables; these data will be compared to post-construction data to measure the effectiveness of the wildlife crossing structure installations.
Additionally, WTI will develop best management practices based on experiences encountered during the design, construction, maintenance, and monitoring of the mitigation measures to provide guidance for further research and future wildlife crossing applications. Because of the significant size of the mitigation effort, the combination with other human uses of landscape, and the importance of the evaluation for future wildlife crossing structure installation projects, we believe this information will be of interest to the international road ecology community.

**Crailo sand quarry nature bridge, Hilversum, The Netherlands larger areas of nature for people and wildlife alike**

drs. Reinoud Kleijberg ir. Erik van Jaarsveld, Arcadis The Netherlands
drs. Dick Landsmeer Goois Natuurreservaat, The Netherlands

**Keywords:** Ecoduct, habitat fragmentation, mitigation, nature bridge, Netherlands.

**Poster session**

**Abstract**

**Idea and initiative**

In the 1995, the Nature Conservation Year, an ambitious plan was hatched to create a nature bridge in the Crailo sand quarry with the ‘ulterior motive’ of putting a stop to the increasing fragmentation of natural areas in the Heuvelrug and the Gooi area in particular. The nature bridge means that the nature reservations of the Vechtstreek, the ’s-Gravelandse estates and the Spanderswoud are no longer separated from the heaths and forests of the Gooi and the nature reserves of the Utrechtshe Heuvelrug, but are joined together in a natural way. This initiative bridges - literally - four obstacles for animals and plants: the busy provincial route of the Naarderweg, the Hilversum-Bussum railway line, the NS Business Estate and the Crailo Sports Centre.

**Largest nature bridge in the world**

In 1997 the municipality of Hilversum, the province of Noord-Holland, Railinfrabeheer, NS Vastgoed and the Goois Nature Reserve signed an agreement for the realisation of a remarkable and vital conservation project: the Crailo sand quarry nature bridge - a structure that is 800 metres in length and 50 metres in width in the narrowest sections and spans the Naarderweg, the railway line, the business park and the sports centre. This makes the Crailo sand quarry nature bridge the world’s largest nature bridge. Although this is not the first nature bridge in the Netherlands, it is by far the largest bridge of its kind and the first one that can be used by people as well as animals.

**Of vital importance**

The nature bridge is essential to many animal species, whose habitats will now once again be large enough, thanks to the nature bridge. Roedeer, squirrels, moorfrogs, grass snakes, pine martens, sand lizards and alcon blue will once again have plenty of room to flourish. The newly connected area will make it possible for these species to once again occur in viable populations. This is concludes by the Alterra Research Institute in Wageningen, which carried out a thorough scientific study at the request of the Ministry of Agriculture, Conservation and Fisheries (LNV). If, in future, other ecological obstacles are also mitigated, a direct connection will be created between the Gooi area and the Utrechte Heuvelrug, which means that even larger species of wildlife can once again return.
Crailo sand quarry nature bridge, Hilversum, The Netherlands larger areas of nature for people and wildlife alike

Information in natura

The construction of this gigantic bridge will take 4 years. During this period, anyone interested in the project can visit the information barn that will be created by the Goois Nature Reserve. Presentations and displays in this barn will give visitors a good impression of the end result. From the observation tower near the barn every phase of the bridge construction can be closely viewed. In addition the website, www.natuurbrug.nl, will provide comprehensive and up-to-date information.

Some figures:

- Length: 800 metres
- Width of structures: 50 metres
- Width of banks: up to 150 metres
- Height: incremental up to 14.5 metres above sea level, 10.5 metres above NS Vastgoed terrain
- Soil required: 500,000 m³
- Development and implementation costs: approx. € 13,500,000-

- Length viaduct over railway line, NS Vastgoed terrain and access road to sports park: 135 metres
- Length viaduct over Naarderweg: 35 metres
- Highest point above NS Vastgoed terrain: 14.5 metres above sea level
- Edge of Spanderswoud: 7.5 metres above sea level
- Edge of Bussummerheide: 13 metres above sea level
- Start of preliminary study: 1995

- Project start: October 2002
- Duration: 4 years
- Planned completion: 2005
- Information barn: approx. 50 persons (also groups and schools)
- Observation tower: 12 metres
- Recreational facilities: walking, cycling and bridle path

The animal detection system CALSTROM proves itself

Christa Mosler-Berger and Jann Romer
Infodienst Wildbiologie & Oekologie, Zurich, Switzerland

Poster session

Abstract

The maintenance of animal dispersal in fragmented landscape is a priority task today. Generous solutions in form of over- and underpasses for ungulates crossing highways and railway lines are expensive and therefore restricted to the most important areas. Although Swiss highways are fenced more than 16'000 animals are killed on roads, mostly red deer and roe deer. Starting about 1993, a new animal detection system has been developed by Calonder Energy AG, Switzerland and installed on several locations, where animal vehicle collisions regularly occurred. This system provides drivers with an “active” warning of large animals nearby the road.

We investigated the efficiency of CALSTROM at seven different locations with partly differently designed warning signs. In cooperation with the local game wardens and the police we measured frequencies of animal vehicle collisions before and after installation and the effect of different warning signs on attentiveness and behaviour of drivers (decreased speed). After installation no accidents occurred at four surveyed road sections and the frequency of accidents at the other three sections was significantly reduced. Conditions for most effective installation of the animal detection system CALSTROM are discussed.
Use of Infrared Camera Video Footage from a Wildlife Protection System to Assess Collision-Risk Behavior by Deer in Kootenay National Park, British Columbia.

Nancy Newhouse, Sylvan Consulting, British Columbia,

Keywords: infrared camera, collision-risk, deer behavior, Wildlife Protection System, research, British Columbia.

Abstract:

We used video footage from infrared and conventional video cameras within a Wildlife Protection System (WPS) installed along a flat, level 2-km stretch of Highway 93 in Kootenay National Park, BC, Canada to assess collision-risk behaviors by deer during autumn, 2002. We recorded 1131 deer-minutes of behavior (number of deer multiplied by the time they were present during the sampling period).

Based on marked breaks in hourly totals of deer-minutes, we stratified the 24-hour period into night (midnight to 7 AM), midday (7 AM to 7 PM) and evening (7 PM to midnight). Both the number of deer and the duration of their stay in the highway right-of-way were greatest during the night, intermediate during the evening, and lowest during midday, so the number of deer-minutes per hour was over 2x higher at night than evening, and over 15x higher at night than midday.

Similarly, the peak in hourly rates of most collision-risk behaviors occurred during the night. However, all of the risk behaviors measured showed higher per-deer rates during midday than during the evening or at night, including presence at roadside, approaches to highway, running approaches to highway, presence on the highway surface, attempted highway crossings, running highway crossings, crossing in front of oncoming cars, and aborted highway crossings.

The hazard presented by higher per-deer rates of risk behaviors during midday was compounded by the fact that vehicle numbers were much higher during midday than evening or night.

Driving in daylight probably increases deer visibility dramatically, but being within the line-ups of cars more typical of midday presumably decreases the driver’s field of view and may increase the collision hazard associated with a driver swerving or making a sudden stop. Thus, the net risk of wildlife-related accidents may be as high or higher during midday than other times.

No reliable data are available for the test section indicating timing of wildlife-related accidents. In fact, “swerved-to-miss” types of accidents may not be recorded as wildlife-related unless an actual animal collision occurs, making any available data potentially suspect.

Systems such as the WPS, which are designed to work at all times of the day and are triggered by animal presence, offer the greatest ability to prevent wildlife-related accidents in situations similar to those we studied.

Funding for this project was provided by a coalition of partners including the Insurance Corporation of BC, Innovative Transportation Technology Inc., Parks Canada and the Columbia Basin Fish and Wildlife Compensation Program.
Mitigation Measures on new highways in Croatia for transparency for large

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Djuro Huber, Josip Kusak, Tomislav Gomercic
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Goran Guzvica, Visnja Paleka
OIKON LTD, Zagreb, Croatia

Gabriel Schwaderer
EURONATUR, Germany

Abstract

In the last few years the construction of highways in Croatia has been very intensive, especially from Karlovac to Rijeka and from Karlovac to Dubrovnik. The approval of these projects requires environmental impact studies and application of proposed mitigation measures. We studied the impact of highways on large and medium sized mammal especially on movements of large carnivores. The goal was to acquire data for future management of the populations, to ensure their integrity and gene flow. In practical situation the data from the studied highway sections were used for designing the mitigation measures on the new highways. Hence, since May 1999 we collected data on the firstly built green bridge Dedini near Delnice on Karlovac - Rijeka highway, and those data have already been used in the environmental impact study as argument to build the similar structures on the highway from Karlovac to Dubrovnik. The consequences are the 8 new green bridges. We used infrared (IR) sensors for recording animal crossings over Dedini green bridge. A total of 9471 crossings have been recorded during 563 different days of active monitors operation. Recalculated to the yearly level (365 days) it gives an estimate of a total of 6096 bridge crossings, or 16.7 per day. Concurrently we noticed 402 animal tracks, 284 of which belonged to animals taller than 40 cm: roe deer (Capreolus capreolus) 37.0%, red deer (Cervus elaphus) 28.2%, wild boar (Sus scrofa) 29.0%, brown bear (Ursus arctos) 9.1%, wolf (Canis lupus) 1.4%, and man (Homo sapiens) 5.3%. We conclude that this green bridge, as a measure to mitigate the negative effects of the studied highway, served its purpose effectively. It is also planned the monitoring of animal movements across new green bridges.

Noise Barriers and Landscape - Experiences in development of the Croatian highway system

Iva Rechner BLA, Dr. Branka Aničić,
Department of Landscape Architecture, Faculty of Agriculture, University of Zagreb.

Vlatka Krivak Badic BA,
Croatian Highways, Zagreb

Poster session

Abstract

Road infrastructure is one of the main prerequisites of every country's development. For this reason intensive construction of a number of important transport routes has been initiated in Croatia. These will connect Croatia, and primarily the Adriatic as the most important tourist destination, with Europe and the neighbouring countries (Slovenia, Austria, Hungary). As these major routes pass through very valuable and diverse landscapes, care must be taken to preserve them and maximally adjust roads and all the relevant equipment to the environment.
The Republic of Croatia is characterized by great geographic and landscape diversity and is divided into three basic regions: Pannonian, mountain, and Adriatic Croatia. The Pannonian region represents a low-lying and mostly agricultural area, where a unified and mostly regular field patterns stand in contrast to large irregular woodland areas. A large part of the central mountain area is covered with woods, and the cultural landscape is characterized by a good adjustment of economic organization to natural topography and by a high degree of structural diversity. The Adriatic region is the most sensitive to developmental alterations due to its characteristics. The value of that region is based on its natural and especially its cultural values. It is characterized by a cultivated landscape that is the consequence of different types of land - use, primarily agriculture, and reflects the changes in the social and economic conditions.

The state institution Hrvatske ceste d.o.o., wishing to build quality highways, has opted for a comprehensive approach, including legislative measures and European Union guidelines. Many studies and projects were drawn up before main routes were begun. One of them was Study on choice of noise barriers and their adaptation to the landscape. This was drawn up with the intention of showing the barrier phenomenon in the highway visual space. The aims of the analysis of their visual properties were the following: to point to the possibility of using barriers in the highway space in the most acceptable way in perception terms; to show their advantages and disadvantages with respect to shaping the road space; to propose a planning and design procedure for optimization of the landscape layout in relation to the noise protection system; and to give recommendations for shaping barriers in a series of specific situations, applicable to Croatian conditions.

It is assumed that an increasing number of travellers, especially tourists, will travel on Croatian highways in future, and the roads will be the only spatial information they will receive from their host country. Therefore a more pleasant visual space needs to be created by planning.

Within this study, sections were studied in all three, before mentioned, regions (Bosiljevo - Mala Kapela and Sveti Rok Tunnel - Mašlinica - Zadar, Brežnik Hum - Novi Marof-Gorpičan, Velika Kopanica - Županja, Lički Osik - Sveti Rok). Several alternatives of barriers were simulated on every section of the highway. For that purpose, several locations were chosen as representative.

The first two sections are located in the Karst landscape, which is predominantly green and looks natural. This is due to the following landscape characteristics: relatively large wooded areas; grass systems - pastures and meadows - predominate over field crops; the geological substratum can be seen in places, giving the landscape a rocky character; the population density is pronouncedly low and occurs in smaller clusters usually consisting of a few farm houses; houses are as a rule relatively far from the highway, which significantly facilitates noise reduction. The mountain region of Croatia has similar landscape characteristics.

The spatial context in which barriers appear as a visual phenomenon in Slavonia is different from that of other highways in the country, especially those in hilly areas. The structure is extremely simple, flat and without topographic diversity.

In view of the above conditions and with respect to the conclusions of this study, the following approach has been suggested in determining barrier type.

Due to the predominantly natural character of landscape, bio-barriers, primarily grass covered embankments, should be used wherever this is possible. These structures are economically most appropriate and they form the optimal ecological and landscape solution in the long run. In places where the workable space is reduced due to a very narrow or steep passage from the road edge to the surrounding terrain and embankments cannot be built, the possibility of putting up a bio-wall should be considered. It should be built of reinforced lawn or concrete elements or entirely of willow wattle on the side seen from the road. It is advisable to vary individual types because in this way a more interesting and more natural rhythm is achieved on barrier facades. Technical barriers are acceptable only in those places where bio-barriers cannot be built due to the lack of space.
The third type of solution is the combination of bio-barriers and technical facilities. In some situations, transparent acrylic barriers can exceptionally be used. The role of vegetation in noise protection should not be neglected. A fairly wide stretch of woods divides the road from the existing houses in several places. Here the envisaged barriers of larger dimensions could be satisfactorily replaced by making smaller interventions - additional planting or lower embankments. It would make sense to use only one colour for technical barriers along these routes. A welcome complexity in very long barriers is achieved by articulating them in several ways: construction, texture, colour and plant interpolation. In addition to the noise protection elements themselves, their spatial arrangement is also important. A concept is proposed where barriers and vegetation, alternate thus visually extending the highway space, and making the barriers look less like a foreign body in the landscape.

**Monitoring roads impact on south Douro river Iberian wolf population**

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**Keywords:** Habitat fragmentation, highway, Iberian wolf, over and underpasses, Portugal.

**Poster session.**

**Abstract**

Habitat fragmentation has been targeted as one of the most serious threats to biodiversity worldwide. Carnivores are particularly vulnerable to habitat fragmentation because of the large spatial requirements of individuals and populations. Roads adversely affect carnivores by increasing direct and indirect mortality. The Iberian wolf (*Canis lupus signatus* Cabrera, 1907) has been totally protected by Portuguese law since 1988 (Law nº 90/88) and is listed in the National Red Data Book as “threatened with extinction”. The European Directive 92/43/EEC lists Portuguese Iberian wolf population as a priority species. The construction of several dams as well as two main roads and a railway in the 1950’s in Douro river valley has split the Portuguese wolf population on two main ones. This population is estimated in about 20-30 animals divided in seven/eight packs. In this region, besides human persecution, in this region, habitat degradation (fires, logging and road construction) and lack of wild prey are the main causes of Iberian wolf extinction. Over the past years new threats have been occurring, which increased habitat deterioration of the Iberian wolf in central Portugal. The construction of new roads has increased the traffic in the area, increasing wolf mortality and population fragmentation. One example is the highway "IP3" located at the west side of the south Douro river Iberian wolf distribution. This wolf population remains exclusively on Portuguese territory, which gives to Portugal a high responsibility in assuring conditions for the future of Iberian wolf population recovery.

The main goal of this study is to identify conservation measures in order to minimise the impact of roads on this wolf population. To accomplish this goal, it is being analysed the impact of "IP3" to this species and the environmental factors associated with wolf road mortality. To analyse the impact of "IP3" each non-wildlife passage was characterized; each underpass was described with 14 variables and each overpass with 11 ones encompassing structural attributes, landscape features, and human presence. Structural variables included width, height, length, openness and aperture. The structural variables height, openness and aperture were only determined for underpasses. Landscape characteristics included habitat type at each side of the passage, percentage forest and shrub cover, distance to cover and distance to nearest passage structure. Human disturbance variables included human use of the passages, noise level and the distance to the nearest village.
These passages (4 underpasses and 7 overpasses) are being monitored, using two methods. First, one scent station was placed near one passage aperture with a sand layer around the scent, during five days a month. Footprints and other signs of wolf activity will be recorded. The second method is wolf presence signs surveys; transects were established along dirt roads and wildlife trails adjacent to the passages.

Besides the “IP3”, other national roads are being surveyed; records of wolf road mortality over the last seven years are being analysed - all dead animals will be collected and transects will be done nearby the kill spot. Practical measures will be proposed in order to enhance road permeability and minimize the risk of wolf run over.

**Modelling the effects of mitigating measures on the dispersal of threatened insect species in National Park Hoge Kempen (Flanders, N-belgium)**

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**Poster session**

**Abstract**

Effects of habitat fragmentation are known to be largely species-specific. Therefore, it is highly relevant to validate defragmentation measures for one focal species (or focal group of species) against data of others. Vertebrates (mammals, reptiles, amphibians) have attracted most attention in the framework of defragmentation efforts. Recently also invertebrates (i.e. several groups of insects), have become important conservation foci. In this vein, we evaluated possible effects of several mitigating measures on landscape connectivity of non-target, but threatened insect species.

We focused on a case-study of the nature reserve 'Mechelse Heide' - part of the the first national park in Flanders (N-Belgium) 'Hoge Kempen'. This park (5700 ha) consists of wet and dry heathland, peat bogs, forests and former mining areas. A wide range of Red List species belonging to different taxonomic groups occurs in this key area for conservation in Flanders.

Several roads traverse this National Park and form potential barriers between different parts of the area. Within the framework of the recently developed National Park, a series of mitigating measures to reduce the effect of these roads on the natural surroundings are planned. Two existing bridges will be transformed into eco-ducts, a currently busy road will be replaced by a (much narrower) bike-road, and a third eco-duct will be built. Typical role models for developing these measures are larger mammals (e.g. Roe deer).

We evaluated the use of connectivity models to predict the effects of these mitigating measures on the dispersal of insect species with different dispersal capacities and habitat use. We used the CostDistance extension (ArcView 3.2, Spatial Analyst) to calculate the functional connectivity of the landscape for four hypothetical species under different scenarios (before the implementation of mitigating measures, after removal of the road, after construction of eco-ducts, ...). We calculated the potential impact of these mitigating measures on the distribution of these virtual species.

Finally, we discuss how these models can help predict the effects of these measures on populations of real - and threatened - insect species, including the butterflies *Plebeius argus* and *Callophrys rubi*, and the grasshoppers *Ephippiger ephippiger* and *Oedipoda caerulescens*. 
Project of restoration of the Ecological corridor of Saverne

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Name of presenting author: Jean CARSIGNOL

Keywords: Habitat fragmentation / Physical barriers / Ecological corridor / Restoration / Fauna / migration / genetic flux / prefabricated channel.

Abstract

The Vosges Mountain represents a site of major patrimonial interest (Regional Naturel Park, Reserve of Biosphere, registered site of Natura 2000). The Saverne collar (the narrowest part of the mountain mass) is a supra national ecological corridor. The construction of A 4 motorway (in 1978) broke this corridor. The result is an insuperable cut. The territorial continuities are stopped and the situation of Saverne’s collar is unique in France because it is a huge mountainous chain, which is broken by a motorway.

The project of Est high-speed train is an exceptional event to recreate the ecological corridor of Saverne. The high-speed line will cross the Vosges by a tunnel (length 5 kilometers). The West entry of the tunnel is localised in the mountains at 150 meters from the motorway cut. The motorway cut is in a deep excavation (25 meters height). 600 000 m$^3$ of materials will be extracted from the tunnel. The idea is to use a part of these materials (100 000 m$^3$) to cover the gap created by the motorway and restore the ecological continuity (width 150 meters). The entire terrestrial fauna will take this passage (from insects to big ungulates like Hart and carnivore like Lynx).

The Saverne collar has a strategic position: its action is essential to have good exchanges (swarming of young mammals, genetic flux, and research of sexual partners) and to conserve the metapopulation. The importance of this site is intensified by the proximity of 2 French Natural Park (Parc Naturel Régional des Ballons des Vosges and Parc Naturel Régional des Vosges du Nord) and 1 German Natural Park (Natürpark Pfälzerwald).

The theories of landscape ecology explain precisely this isolation effect and the consequences of the dynamical and genetic fragmentation of the populations. The concept of landscape ecology shows the importance of restoring this corridor on the ECONET model.

The technical feasibility and the cost of the restoration of the corridor have been estimated. The project of cover uses prefabricated channel (false tunnel) embanked on 9 meters in height up. The width of the cover recreates will be from 150 to 170 meters. The work period is approximately one year. The cost of the project is 8 million Euro.

The study will be presented to the partners who are able to finance this ecological reconstitution. In order to succeed, the project has to be supported by several European partners and financing (Life program for example). The poster will present this project. During the COST Meeting in November, we will know if the project is accepted.
Ecological impact assessment of motorways on the biodiversity of National Park “Russian North” (Vologda Region)

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Keywords.: Motorways, ecosystems, impact, biodiversity

Poster session

Abstract:

The estimation of ecological damage to ecosystems from motorways is connected with number of complications, such as:

1. lack of scientific base for estimation of ecological effect of motorways on ecosystems and biota;
2. weakly developed methods of economical estimation of biodiversity loss;
3. absence of social practice of compensation of ecological damage to protected areas (as “payment for nature use” from motorways owners and drivers).

Besides, the effect of motorways on protected areas has complex character that includes a great variety of factors characterized by different times of their effect (immediate or deferred), and different steadiness of the impact.

In summer 2001, we conducted a complex research of motorways influence on faunal biodiversity (birds, butterflies and dragonflies), spatial structure and stability of south taiga forest ecosystems in National Park “Russian North” (Vologda region). The area of NP is 166 400 hectares).

We studied species number and composition around 19 active and 7 abandoned motorways, and also population structure and densities, and spatial patchiness of vegetation. These data were compared with those obtained in intact ecosystems far from motorways to estimate changes because of motorways.

We divided studied species onto several groups:

1. 1) Climax species that inhabit undisturbed ecosystems, either forests or meadows, marshes etc. These species avoid fragmented habitats, and their number is proportional to the patch area of suitable habitat.
2. 2) Pioneer species that readily inhabit fragmented landscapes and are tolerant to human activity.
3. There are primary and secondary effects of motorways on fauna of the NP.

Primary effects were a) population decrease of climax species: several species of birds and butterflies, and b) population increase of pioneer species. The effect is most significant within immediate vicinity of roads (150-200 m), but it is noticeable up to 3.6-5.1 km distance from the nearest motorway. We suggested two indices characterizing species expulsion from and attraction to motorways, based on distance in which the effect of motorways is significant.

The certain intensity of influence increases risk of local extinction of n climax species and risk of population decrease of m climax species. The same influence stimulates colonization of the affected zone by p pioneer species and population increase of q pioneer species. Our results show that, independently of traffic intensity, everywhere p < n and q < m. This rule defines direction of fauna transformation because of motorways and suggests the reduction of biodiversity during this process.
As a result, natural avifaunal complexes of Taiga zone rapidly lose most of the specific climax species and become similar to depleted fauna of recreational forests of Moscow region.

**Secondary effects** of motorways are following: a) slowing down of the natural successions and b) decrease of the probability of climax ecosystems recover. Therefore, the ‘another side of the coin’ of economical profit of motorways exploitation in protected areas is ecological ‘fare’ – degradation of remains of natural South Taiga ecosystems, landscapes and unique species.

Our research in “Russian North” National Park determined which negative consequences of motorway influence on biodiversity and ecological systems stability are most probable at different levels of the influence, at what times they may follow, and what damages may be caused.

Among the damages, there are following:

a. Damage from vulnerable species loss;
b. Damage from the alteration of natural fauna to the fauna of man-made landscapes that follows to value decrease of the protected area;
c. Damage from deferred (secondary) effects of motorways.

Total damage to the area of the National Park was estimated as **4.14-5.84 million** US dollars while annual income of the Park in 1992-2000 was about **22-30 thousand dollars**, including own funds.

**Landscape connectivity models as a tool to evaluate the effects of linear infrastructure on species dispersal. A case study in Doñana (SW Spain).**

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**Keywords:** Landscape, connectivity, resistance, road, barrier effect, dispersal, mammals

**Poster session**

**Abstract**

The effects of linear infrastructure on species dispersal and landscape permeability can be evaluated with landscape connectivity models. Barrier effects of linear infrastructure are considered in the context of the whole landscape. Connectivity models simulate species dispersal across the landscape, show connection areas between selected sources and targets, and quantify dispersal costs under different conditions and management scenarios.

Species have different dispersal capacity across different types of landscape elements (forest, grassland, road, etc.). In other words, different landscape elements have different resistance to species movement. Connectivity models calculate cost-distance values for each point of the landscape considering the distance to the source and the resistance of the landscape elements between the source and the point. To assign resistance values to landscape elements is necessary to integrate bibliographic data and expert knowledge about the species.

In this case study, connectivity models are used to analyze the effects of a problematic road in Doñana Natural Area, SW Spain. Doñana holds international importance as a nature conservation area, with many endangered species including mammals as the Iberian Lynx (Lynx pardina). Fragmentation and roads are one of the most important management problems in Doñana. Roads have many negative effects on species and habitats, and they are the main cause of death of Iberian Lynx in the area.
Landscape connectivity models as a tool to evaluate the effects of linear infrastructure on species dispersal. A case study in Doñana (SW Spain).

Doñana includes different legal protection status such as Scientific Reserve, National Park and Natural Park. The studied road is a segment of 11 km length at the north of Doñana, crossing Coto del Rey’s woodland from east to west. This is an important area protected as Natural Park, which seems to be the natural connection between the core area of Doñana and other nature protected areas at the north (Sierra Morena, Guadiamar River Basin).

This road is likely to have impacts on ecological processes at a regional scale - barrier effects on species movements between Doñana and Sierra Morena, and at a local scale - barrier effects on species movements between habitat patches in Doñana. Connectivity models can be applied at different spatial scales.

At a regional scale, north-south connectivity between Sierra Morena and Doñana is studied for the case of forest mammals as a group, including different species such as European Badger (Meles meles), Genet (Genetta genetta), Egyptian Mongoose (Herpestes ichneumon), and Iberian Lynx (Lynx pardina). The use of connectivity models shows the importance of Coto del Rey’s forest patches. The connection between Sierra Morena and Doñana through this area has lower cost-distance values than the connection through the riparian forests of Guadiamar River. The importance of Coto del Rey’s forest patches is confirmed by available field data on the distribution of these species.

At a local scale, connectivity between different forest patches in the north of Doñana (Coto del Rey) is studied for two species separately, European Badger (Meles meles) and Iberian Lynx (Lynx pardina). Source and target patches are selected at both sides of the road, at north and south of the forest area of Coto del Rey. The effects of the road on landscape connectivity are studied considering different scenarios in relation to the hypothetic application of different management measures: closed road, open road, and road with fauna passages. Results show differences between Badger and Lynx, but in both cases the distribution of rivers and streams in the area seems to be the key factor for the selection of dispersal routes. Several streams with preserved riparian vegetation cross the area from north to south; bridges over these streams should be carefully designed.

Defragmentation of HST and Highway E19

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Poster session:

Abstract:

As I said in my other speech, most of the Flemish roads are already built. Our natural landscape is a patchwork of small areas. To avoid further fragmentation the alignment for the new high speed trains is built alongside other railroads, or highways. The line from Brussels to Amsterdam is initially following the existing railway till Antwerp. Between Antwerp and the border with the Netherlands the high speed line is built alongside the E19. This results in a very solid barrier in the landscape. It is not only a view barrier but also a physical barrier for wildlife.

State of the infrastructure

4. It was required in the EIA (MER) to built the two infrastructures as close as possible to each other to reduce loss of space. To avoid accidents with vans, security measures are built in the strip between the two.
5. At the location of ‘Peerdsbos’ (city-woods): a tunnel over ground level has to reduce the noise. For security reasons the distance to the trees normally has to be bigger in order to avoid trees from falling on the tracks.
6. More to the north the railway is built in a U-shaped concrete structure.
7. The second half of the line is separated from the highway with a high mound.
All this results in a very solid fragmentation of the landscape in the north of Antwerp. In order to defragmentate the highway, several measures where proposed in a specific defragmentation-study. Based on this results we proposed a list of measures to be built on the combined infrastructures. All this measures were compelled in the building permit for the high speed railway.

29 eco tunnels and 5 eco culverts are built, together with one eco duct and one combined bridge, (a cycle way and a green verge).

The difference with other projects is that this one is not built in an area of outstanding natural value. In our urbanized country we have also to pay attention to other sites. To travel between two territories, animals make use of small landscape elements such as tree rows, hedges, brooks, river banks, etc. Therefore small agricultural landscapes are also important for wildlife.

Improvement of mitigation measures on a existing road crossing a wetland area proposed for the inclusion on Nature 2000 Network (Catalonia, NE Spain)

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Keywords. : Mitigation measure, Nature 2000 Network, wetland

Poster session

Abstract:

The Aiguamolls de l'Empordà Natural Park is a wetland area of Catalonia (north-eastern Spain) proposed for the Nature 2000 Network as a Site of Community Importance. On year 2000, a local road crossing this Natural Park (and a Natural Reserve), with some 25,000 vehicles per day, was converted into a motorway. The motorway was fenced and, for the first time in Catalonia, specific wildlife passages were built in order to minimize fauna impact, especially for amphibians, carnivores (polecat, Mustela putorius, and otter, Lutra lutra) and ungulates (wild boar, Sus scrofa, and fallow deer, Dama dama).

During spring and autumn of 2001 a study was carried out, on the 2.2 km stretch crossing the Natural Park, to assess the effectiveness of fauna passages, to identify black spots of fauna casualties and to make some proposals to enhance the use of these structures by fauna and to improve other mitigation measures. 17 fauna passages and adapted drainages were checked for a week in each season by using a marble powder substrate to register animal tracks and infra-red photographic cameras. Identification of black spots was made by collecting all the vertebrate carcasses found on the road during one month each season. The fauna passages were intensively used by almost the whole terrestrial animal groups in the area. There were identified 15 wildlife species, plus some birds that also cross these structures. Polecat was identified in one structure (with a diameter of 0,8 m), otter in three adapted drains and wild boar in the two wider structures (10 and 11 m width each one). Fallow deer don’t use these structures (probably due to height that it is 2 m as a maximum).

Over the road, there were found 117 carcasses of a minimum of 29 vertebrate species. The most affected group were birds (53% of total mortality). Some of the species identified are catalogued as species of Special Interest in Spain: tree frog (Hyla meridionalis), ladder snake (Elaphe scalaris), purple gallinule (Porphyrio porphyrio), Savi’s warbler (Locustella luscinioides) or Great reed warbler (Acrocephalus arundinaceus). There were found also some birds that had died after collision with glass acoustic screens installed to reduce nuisance to nesting birds, despite the use of adhesive bird of prey silhouettes which, it was hoped, would frighten the birds away. This measure was proved to be completely inefficient.
Improvement of mitigation measures on a existing road crossing a wetland area proposed for the inclusion on Nature 2000 Network (Catalonia, NE Spain)

Some of the proposals made to enhance use of passages and to reduce fauna casualties include:
- Installation of an opaque barrier, close to the perimeter fencing, to prevent amphibians and reptiles crossing over and to guide them to the passages.
- Lengthening the lateral platforms, that provide a dry zone in case of flooding, on four adapted drainages, that were not built on the ancient structure when upgrading the road. Also it is proposed to construct ramps that must facilitate the access of animals to these platforms.
- Planting of vegetal screens to force birds to fly higher.
- Adhesion of vertical strips on the transparent acoustic screens, to make they visible to birds and to avoid their collision.

Assessment of applied measures effectiveness, when the road is already in use, is a fundamental element to improve future design of measures and also to correct detected deficiencies and to reduce the impact of the road on the fauna.

Incorporation of linear barriers and corridors in landscape connectivity models at different scales. A case study in Madrid (Central Spain).

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Keywords: Landscape, connectivity, resistance, road, barrier, corridor, dispersal, hedgerow

Poster session

Abstract:

The effects of linear infrastructure on species dispersal and landscape permeability can be evaluated with landscape connectivity models. Barrier effects of linear infrastructure are considered in the context of the whole landscape. Landscape connectivity models provide cost-distance maps representing the effort or difficulty for a species to reach each point of the map from the source points. Minimum cost routes between source points can be calculated from these maps, with direct applications on the design of ecological corridors and networks.

Landscape linear elements play an important role in landscape quality and connectivity, functioning as barriers and as corridors. However, these elements are not commonly included at the scales used for land planning and nature conservation. To incorporate the functions of linear corridors, such as rivers and hedgerows, studies at different scales of spatial extent and resolution can be performed.

In this case, landscape connectivity models are used to simulate the movements of forest species within the woodlands of Manzanares River Basin (Madrid, Spain). Among the endangered and protected species in Madrid, forest species are the most numerous group, including insects, reptilians, birds and mammals. Although each species has its own requirements and dispersal abilities, a 'model' forest species can be considered to assign the parameters of the connectivity model.

Two core areas are defined in Manzanares River Basin Regional Park, one at the north, in the mountains of La Pedriza (Sierra de Guadarrama), and the other one in the south, in the sandy areas of El Pardo (adjacent to Madrid City). The area between these core areas can be considered as a wide ecological corridor, providing protection for the dispersal and seasonal migration of species.

Habitat fragmentation due to infrastructure is one of the main problems for nature conservation in the Region of Madrid. The main barrier existing in the corridor of Manzanares River Basin is probably an important road that crosses the area from east to west, disturbing the natural connections between the forest patches at the north and the south of the area.
Incorporation of linear barriers and corridors in landscape connectivity models at different scales. A case study in Madrid (Central Spain).

Resistance values must be assigned to each type of landscape element to run a connectivity model. These values are given according to literature on forest species and expert criteria, and represent the cost of moving through one pixel of the class. In this case, a resistance value of 100 is assigned to the road.

Landscape linear elements are incorporated at two spatial scales. Rivers and streams are mapped from aerial photographs at scale 1:18,000 in a 10 x 10 km square (UTM 30TVL20), located between the core areas of Manzanares River Basin Regional Park, and crossed by the studied road. A resistance value of 1 is assigned to rivers and streams. Results show the important role of these elements as corridors, with least cost-distance routes along them.

Hedgerows are incorporated at a more detailed scale, from 1:6,500 aerial photographs in a 2 x 2 km square, located in the centre of the previous 10 x 10 km area and also crossed by the road. Results show the importance of the hedgerows between fields or adjacent to the road, determining the routes and road-crossing points.

Landscape connectivity do not only depend on species and resistance values, but also on the spatial scale used and the types of landscape elements mapped. The use of detailed scales is necessary to include the functions of landscape linear elements, which can be a key factor in the selection of minimum cost routes.

Landscape connectivity models have direct applications on the design of ecological corridors and networks. In this context, consideration of the important role of linear corridors can contribute to the valuation and conservation of these elements.

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Key words: biological and landscape diversity, motorway infrastructure, environmental impact study, inventory-making, phytocenosis, autochthonous vegetation

Abstract

By interpolating motorway infrastructure into the natural environment of a specific landscaping and ecological diversity, the harmful impact of the motorway upon the ecosystem fragmentation is reduced by landscape formation. Ambitious plans are under way in Croatia for the construction of a motorway - 1470 km of motorway infrastructure is planned to be constructed by 2010 (459 km constructed by 2001). The state surface area has been divided into 16 landscaping units. Specification of the Zagreb - Split Motorway route was faced with very high designing standards with regards to the ecosystem protection as a whole and as individual valuable habitats, i.e. biocenosis, since the route edges are contiguous with the protected parts of nature (Nature Park Velebit, National Park Krka, protected valley of the river Gacka). Environmental impact studies that have applied the highest possible level of interdisciplinary approach specified the optimal route corridors. Already in the phytocenosis inventory-making stage, the landscape formation has a key role in the protection of the ecosystem regions, since the basic principle applied is designing by using regionally autochthonous species.
The ecological network a new challenge for defragmentation in land use planning

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Keywords: ecological network, mitigation, land use, GIS, 3D visualisation

Poster session

Abstract

The ecological network is an adaptation of the network concept for land use planning. The ecological network improve the biodiversity and advances the movements of animals at city green areas. Ecological network consists of core areas and ecological corridors. The core areas are wide, unite forest areas and forest parks. The ecological corridors are narrow fragmented but still unite vegetation and forest chains. The community structure is quite loose in the Finnish towns and it is usual that long or large forest areas situate in the middle of housing and industry.

The goal was to define the ecological network in cities at the means of GIS (ArcMap 8.1) and 3D visualisation. The eleven Finnish cities and one German city participated the research. The digital master plan of the city was the basic study material. We got also data about the conservation areas, animal data from administrations and from the citizen enquiry. The interaction between animal movements and land use forms was evaluated by six experts. The amount of animal species was 16 in the groups of general wild animals: for example vegetarians: hare, squirrel, predators: fox, badger, stoat, water related: otter, mink and others: hedgehog, bats. The barrier effect of land use for animal movement was described as the barrier value, which was the mean of all animal species. The barrier value for each land use form was made a reference for the land use polygon and the model was produced in 3D visualisation.

As the result we got a three dimensional map about the ecological network in respect the land use. The block house areas and industrial areas make a high barriers for animal movements, forests and parks make low barriers and single house areas something there between. The road especially fenced highways make high barriers and streets with low traffic density only low barrier effect. At the city of Helsinki there was a clear finger structure, which facilitates the movements of animals to almost to the city centre. In contrary at the neighbour city Espoo, the community structure is very scattered and big forest areas are isolated by roads and buildings.

Now it is possible to make master plan according to the ecological context concerning also biodiversity and the sound community structure with the means of the ecological network.
Methods to monitor the use of fauna passageways

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Keywords: fauna passageways, monitoring, mammals, amphibians, roads

Poster session

Abstract

Many different types of fauna passageways have been constructed in The Netherlands, and many more will be constructed. The Road and Hydraulic Engineering Division of the Dutch Ministry of Transport, Public Works and Water Management commissions investigations to assess the use and effectiveness of these fauna passageways with a view to improving both existing and planned passageways.

In order to monitor the use of different types of fauna passageway existing monitoring methods were improved and new ones developed. In or on smaller fauna passageways like badger pipes and walking strips underneath bridges, the so-called ink method works well. Fixed on a board, inking-pad and sheets can be placed about 1.5 or 2 metres in a small fauna pipe, giving better insight in crossing animals than a sandbed does, which is put at the entrance of a pipe.

If more information about the behaviour of crossing animals is needed, or if track methods cannot be used, an automatic video recording system could be applied. The Road and Hydraulic Engineering Division commissioned the development and tests of an automatic fauna monitor. A small infrared video camera is connected with a recorder at some distance, hidden in bushes or something similar. The recorder is controlled by several passive infrared motion detectors. Power is supplied by two exchangeable sets of batteries, each set comprising three maintenance-free 70 Ah batteries switched in parallel. This unit can operate about one week without changing batteries or video film. Operating time however depends on the number of crossing animals and length of recording time per record. Concerning recording time about 2 minutes appears to satisfy. Tested at seven fauna passageways, the system appeared to be a suitable method for obtaining information about the use of fauna passageways by mammals. At smaller passageways like walking strips under bridges and fauna pipes the fauna monitor covers all crossing animals. At much wider passageways like ecoducts only the use by larger animals (like wild boar and roe deer) will be covered completely.

The research report on these tests is accompanied by a CD-ROM with 66 video fragments of fauna passageways and crossing animals.

(I intend to offer interested people the opportunity to watch video fragments of animals passing over the fauna passageways by putting a laptop with CD-ROM somewhere on a suitable place.)
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