INFRA ECO NETWORK EUROPE

5th IENE meeting Budapest, Hungary 14-17 April 1999

(IENE and COST 341 meeting 14-21 April 1999)

Report of the Meeting

Presentations of the participants

Swedish National Road Administration

Technical and Information Service on
National Roads, Hungary

Vägverket
Swedish National
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1. Introduction

The 5th meeting of Infra Eco Network Europe (IENE) has been organised and supported financially by the Swedish National Road Administration and Technical and Information Service on National Roads, Hungary. The meeting has taken place outside Budapest at the Budai Sport Centre between the 14th of April and the 17th of April 1999.

The 5th IENE meeting was a combined meeting between IENE and COST 341 ("Habitat fragmentation due to transport infrastructure") and brought together about 30 experts representing fourteen European countries. During two days, the open day and the excursion, about 60 Hungarian professionals in infrastructure and environment were present. The opportunity to exchange information both ways and to establish contacts among them and the IENE representatives were positively exploited.

2. Indicators

By Annette Piepers, the Netherlands and Olivia Bina, United Kingdom.

The first session of the IENE meeting was dedicated to indicators for habitat fragmentation. Annette Piepers gave an introduction and hereafter discussion took place among the IENE members.

Introduction
The first question we can ask is: What is the meaning of indicators? What can we use them for? It is important to make a distinction between different scales.

On the local scale we deal with the construction and reconstruction of concrete infrastructure projects. In Environmental Impact Assessments we try to predict the effects of these interventions on the environment. Concerning habitat fragmentation what we actually would like to predict are the real effects on the ecosystems in the neighbourhood of the new infrastructure lines, that is to say on the population size of all species that belong to these ecosystems. Because this is impossible we use indicators to literally give an indication of the real effects on the ecosystems. Examples of indicators used in Dutch Environmental Impact Assessments are the following:

- total length of intersection of specific fauna habitats or ecosystems;
- total number of intersections of migration routes of specific fauna;
- area largest part of an ecosystem or habitat remaining after intersection related to the original not intersected area.

On regional level we deal with mobility in a region. We want to compare the effect of different infrastructure plans and policy measures on the ecosystems in the concerning region. As possible indicator for habitat fragmentation the accessibility of grid cells (of e.g. one square kilometre) can be computed for specific species based on the resistance of the landscape, infrastructure having a high resistance.

On national level we deal with Strategic Environmental Impact Assessments of national plans for infrastructure construction. Indicators are also needed for the evaluation of national policy concerning environmental targets. In the Netherlands we use the length of unsolved conflict points between the highway network and the National Ecological Network related to the total length of conflict points as an indicator for habitat fragmentation. This is of course a very indirect indicator for the actual effects on ecosystems and biodiversity.

On the European level indicators are used for the spatial and ecological assessment of the Trans European Transport Network. An example of such an indicator will be presented more into detail based on the report of the European Environment Agency "Spatial and Ecological Assessment of the TEN: Demonstration of Indicators and GIS Methods" (EEA, 1998).

This report is the first output of a working group on the pilot Strategic Environmental Assessment of the Trans European Transport Network. This working group consists of representatives of DG VII, DG XI, Eurostat and the European Environmental Agency. The report demonstrates the feasibility and limitations of a European-wide assessment of the TEN and gives concrete measures on how to continue. Indicators and methods are proposed that can be developed into operational and flexible assessment tools for detecting potential conflicts between the infrastructure plans and ecological concerns.

Five different environmental themes are highlighted: biodiversity and nature conservation, water resources, coastal zones, noises and land resources. The working group considers only quantitative evaluation methods, using a Geographical Information System as an analysis tool. Only linear road, rail and water infrastructure are considered. Six different TEN network development variants are used to demonstrate how the indicators can be used: a do-nothing option (no further extensions to the existing network); a do-minimum option (the existing network is extended by the execution of fourteen specific projects); the existing network is further developed through the carrying out of all road projects; the existing network is further developed through the carrying out of all rail projects; the existing network is further developed through the carrying out of all inland waterway projects; the complete multi-modal TEN.

Within the theme of nature and biodiversity the effect of partitioning of land, that is to say habitat fragmentation, is taken into consideration. Habitat fragmentation is defined as the splitting of natural ecosystems into smaller and more isolated units thus endangering the survival of animal and plant species and communities. The decline in biodiversity after a land unit has been split into smaller fragments depends on the condition of the original unit, the size and distribution of the newly formed parts and the barrier effect of the infrastructure delineating the unit. Therefore a good indicator for measuring the partitioning effect should take both size and ecological quality into account. The size of a unit is determined graphically. The ecological quality is based on the proportion of the land unit area that is designated by international conventions and on the proportion of the land unit area that is covered by forest or semi-natural habitats. If a land unit scores above the European average on both observations, it is considered of high quality; if a land unit scores below the European average on both observations, it is considered of low quality; medium quality lies in between. For the exercise only the TEN links are included. The other existing primary and secondary road and rail infrastructure is not taken into account, Another simplifying assumption is made by ignoring original land units that are smaller than 1000km^2. This is done for scale reasons.

Two different ways for presentation are used. The first way of presentation shows a graph with the number of land units compared to their cumulative surface. The green line represents the existing situation; the red line indicates the situation after implementation of the trans-European Transport network. The red line runs below the green line. This illustrates that the same cumulative area is formed by more and thus smaller individual land units after the realisation of the TEN. This presentation does not take into account the quality of the fragmented land.

The other way of presentation shows the partitioning effect taking into account the characteristics of the land units. One map shows the existing situation and one map the situation after the development of the TEN. A third map shows the differences between both maps: The grey areas have not changed due to the execution of the TEN, whereas the brown areas have deteriorated from high quality land to poor quality land.

The evaluation of the indicator by the working group brings up the following: The indicator is easy to understand as a concept, but difficult to interpret. This is partly because it is based on many assumptions, which are difficult to agree upon, particularly at a European level. It is best used at a regional level (where smaller units could be considered in the analysis), and it should be refined to consider infrastructure other than existing TEN.

Discussion

The discussion focused on indicators for habitat fragmentation for the European scale and the national scale.

According to the participants a good indicator should take the following aspects into consideration:
- size of land units;
- quality of land units;
- location of intersection;
- vulnerability of land units;
- connectivity between land units.

At the same time a warning was given, especially for the European level: Keep it simple and pragmatic, because an indicator is meant for indicating. On the national level there appeared to be many initiatives for developing indicators: e.g. the United Kingdom, the Netherlands, Austria, Spain and Norway.

Size of land units
- For the indicator presented in the report of the European Environment Agency (EEA) it was not quite clear how the land units were determined. Opinions varied from units based on the Corine land cover data to units bordered by the TEN links.
- It was argued that the approach of the EEA calculating the number of land units and their cumulative surface (as a result of existing and TEN planned infrastructure) was a very useful one and that it should actually be adopted at national as well as at EU level. A suggestion was made that this approach could be further improved by distinguishing between scales of transport infrastructure. Particularly northern European countries argued that it would be useful to distinguish between private (usually forestry) roads, secondary roads and major roads (motorways etc.).

Quality of land units
- The functioning of ecosystems was considered an important aspect of quality. However, it would be far too difficult and complex to use for an EU level (and perhaps even national) indicator. Some argued that it is still not possible to measure function appropriately and others pointed out that this aspect of quality deals effectively with the implications of complex impacts on ecosystems and that this makes it inadequate for an indicator.
- An alternative suggestion was made to consider migration areas and core areas (which could overlap with designated areas). Such routes could be identified and analysed at a national level and possibly at the EU level if e.g. large mammals were to be chosen as indicator species. The clear advantage of the EU level approach (which should be carried out in addition to national indicators) is, that it would cover migratory routes across national borders, thus completing the picture. These "trans-European migratory corridors" were seen as an important contribution, which could ideally carried out by an international body like the EEA. The Large Carnivores Initiative of WWF was mentioned as a possible source of information on migratory routes, as well as on existing and potential areas for the maintenance and expansion of their populations. This information is already available in electronic format for the alpine areas.
- A reference was made to the data, which should be available as a result of the Pan-European Biological and Landscape Diversity Strategy, identifying core areas, corridors and areas of influence throughout Europe. It was suggested that, once this information is ready, it could be combined with land cover data to improve the information on the quality of such areas. However, it remains unclear when such information will be available in digitised form for all the Member States, let alone the rest of Europe. The Council of Europe has produced new guidelines, which are aimed to help define corridors in the context of the Pan-European Strategy. These guidelines will be send out to the IENE members in the near future.
- Spain considers density of populations as an important aspect of quality and therefore important in an attempt to calculate fragmentation and its significance.

- Norway seems to focus on corridor functions (based on the ecological network) as an important indicator of quality, rather than species. It was felt that species could be too complicated for regional and national scale analysis, although in certain specific cases species were also considered.

Size and quality

- The experts agreed that to develop an indicator which effectively combines size and quality of areas important for nature conservation was very complicated and no clear method was proposed. It was felt that the approach taken by the EEA was perhaps too limited in terms of evaluating the quality element. However, it was recognised that data constraints were a strong limiting factor at this scale.

Location of intersection

- It was indicated that the location of intersection probably is impossible to assess on the European level. At regional and perhaps even national level it could be possible to assess the location of the fragmentation with respect to the shape and size of the core areas. Such location can change dramatically the scale and significance of the potential impact.

Connectivity between land units

- The Dutch Institute for Forestry and Nature Research has developed a model for habitat fragmentation and connectivity, which will eventually be extended to cover the impacts of transport. The model functions on ecosystems level as well as on species level.
- In Catalonia (Spain) experts have calculated an index of connectivity between protected areas, which looks at: distance between protected areas, number of corridors between areas, number of barriers between areas (not limited to infrastructure). The analysis has led to a map of isolation/connectivity between important areas for conservation. Although it was felt that this example could not be carried out for the EU level, a simplified version could be considered for the national scale.

Finally the remark was made that it should be kept in mind that different types of infrastructure have different types of impacts.

Conclusions for COST 341

- An overview of indicators for habitat fragmentation used in the different countries will be included into the European state-of-the-art report.
- A description of possible indicators for the different levels (local, regional, national, European) will be given in the European handbook. According to Olivia Bina some review has been done already.

3. Database.

At the 4th IENE meeting in Brig Switzerland 1998, IENE decided to establish a database, which should be connected to the Internet side.

A model for a database, constructed by the Swedish National Road Administration, was demonstrated by Carin Rimsten during the meeting. The constructed database include the following content:

- literature
- ongoing projects (divided into research, development and construction)
- experts
- photos

It will not be possible to cover the whole range of information within habitat fragmentation and infrastructure therefore the database should focus on not widely spread information, e.g. literature and research reports, which have not been, published (grey literature).

The national coordinators will have an important task by collecting information for the database. It is very important that the database include up-to-date information.

Discussion
Construction of a database is also one of the products from the COST 341 action. The participants preferred a combined IENE/COST database. It was also decided to exclude photos from the database and that no special category for expertise is needed. The experts will be related to on-going projects and existing measures.

It was not clear what was meant by on-going projects. The following description was given: on-going projects can be divided into: research projects, applied projects, construction and development projects The data are of interest to show what is going on. English keywords should be attached in order to allow for an English search function.

Some new categories were also added:
- existing objects/measures: larger ones, new types, good examples
- statistical information, e.g. on fauna casualties: reference where to find it

The management and building up of the database will be an important and time-consuming activity, therefore it is better that COST 341 action is responsible for building up the database. IENE can take over the administration when the COST 341 action is finished.

The participants consider the national co-ordinators of IENE the most likely persons for putting the data into the database. Some remarks however, were made:
- Not all the national co-ordinators work for an institution or organisation where they have the best overview;
- a national coordinator can not always judge whether the provided data are rubbish or not (from ecological or civil-engineering point of view). A national coordinator can only judge whether the data are within the scope of habitat fragmentation due to infrastructure.

4. COST 341"Habitat fragmentation due to transport infrastructure"

In January 1998, the COST action 341 entitled "Habitat fragmentation due to transport infrastructure" was accepted by the Technical Committee for Transport of the COST program. The products of this new COST Action are: a State of the Art on habitat fragmentation at European level (June 2000), a European Handbook on Defragmentation (autumn 2002) and an on-line database (autumn 2002). The final report should be available in spring 2003.

Participating countries:
11 COST Countries: Austria, Belgium, Czech Republic, Denmark, Hungary, The Netherlands, Romania, Spain, Sweden, Switzerland and United Kingdom.

Organisation
- Management Committee (MC)
- Secretariat, chair and two vice-chairs
- Working groups

Progress of COST 341
- The draft contents of the State-of the-Art was discussed during the 1st MC meeting.
- The writing of the national State-of the-Art has been started in several countries.
- The draft contents of the Handbook have been prepared for the second MC meeting.
- Working groups for, the database, dissemination, editorial and the handbook has been established.

4.1 Council of Europe

Mrs. Maguelonne Déjeant-Pons, Princil Administrator at the Council of Europe (Environment Conservation and Management and Regional Planning Division) presents herself and the work that the Council of Europe has started on habitat fragmentation and transportation.

The Council of Europe has started an action in the sphere of transport and environment, which are very much in line with the IENE activities and the COST 341-action. It is of great importance to ensure co-ordination between the different activities.

The group of specialists, of the Council of Europe, held its first meeting in October 1998. At this meeting it was decided to focus their activities on developing a Code of Practice for the introduction of biodiversity and landscape. Consideration into transport sector will be developed in the line with the objectives of the Action Theme 2 of the Pan-European Biological and Landscape Diversity Strategy.

In its first part the Code of Practice will be set on political and social framework and propose policy options for the development of the linear transport systems. In its second part the Code of practice will provide practical examples of good and bad practice, employed by the governments with reference to the introduction of biodiversity and landscape consideration in the development of the new and maintenance of the existing linear transport systems.

The group of specialist at the Council of Europe has one or two meetings each year on environment and transport. IENE is offered to be an observer during these meetings. The Code of practice will probably come out next year (2000).

5. Future of IENE

An important role for IENE in the future will be to spread the information, which will come out of the COST 341 action. It could be advisable to organise a new international conference on habitat fragmentation and infrastructure after the COST 341 action has been finished.

The coordination centre for IENE rotates once every two years. Between 1996 and 1998 the Netherlands coordinated IENE. Sweden took over on the first of July 1998 and after the first of July 2000 another country has to take over the responsibility for the coordination.

IENE as an organisation will probably not last forever but the network will nevertheless need to continue until 2003, when the COST 341 action will be finished. In order to do so we will at least need to more coordination countries.

Next meeting, the 6th IENE meeting will be in Spain between the 6th of April until the 8th of April 2000. The meeting will again be a combined meeting between IENE and COST 341.

6. Possible new IENE members

DENMARK
Niels Tørsløv, Vejdirektoratet, Fauna and human passage problems due to infrastructure - A danish cross sectorial project to develop methods and best practice. Page 9-11.

GERMANY
Bertram Georgii, Munic Wildlife Society, Habitat fragmentation and roads in Germany- current situation and perspectives. Page 12-16.

NORWAY
Björn Iuell, Norwegian Public Roads Administration, Habitat fragmentation due to infrastructure - how far have we come in Norway? Page 17-18.

Fauna and human passage problems due to infrastructure - A Danish cross sectorial project to develop methods and best practice.

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Summary:

As a result of a national seminar on fauna passage problems due to infrastructure, a project group was formed in 1995 in order to investigate importance, character and dimensions of the problems.

The project group was established with representatives from the following organisations:

Governmental:
Road Directorate (chairman)
Danish National Railway Agency
The Natural Forest and Nature Agency
National Environmental Research Institute

Local authorities:
The Association of County Councils in Denmark
The National Association of Local Authorities in Denmark

Non governmental organisations:
The Danish Society for the Conservation of Nature
The Outdoor Council
Danish Landscape Association
Association for Animal Protection
Danish Hunters Association
Falcks Rescue and Security Company
Møller & Grønborg (landscape consultancy)

The project was established with the following *terms of reference:*
- To characterise the size and consequences of the problems
- Produce tools for priority of measures
- Assessments of effects
- Produce general and technical guidelines
- Carry out necessary research programmes
- Included: railways
- Included: human access to recreational attractions and recreational infra structure

The following reports have been produced:
- 1997 Report by Cowi : ”Roads and railways , barrierproblems”
- (not published working paper)
- 1998 Report by Danish Forest and Landscape Research Institute (FSL): ”Barrier effects of larger traffic constructions on recreational accessibility”
- 1998 Report by National Environmental Research Institute (DMU): ”Fauna passages on larger roads”

The following reports will be finished during 1999:
- *1999 Project group: Guidelines : Fauna and Human passages*
- *1999 Project group : Final report*

In addition at least part of the project is planned to perform as" National working group" in IENE/COST 341.

The main fauna problems can be identified as:
Traffic safety problems:
Compared to countries with moose or other large animals the situation is not alarming. Absence of large animals reduces the number and severness of traffic/game accidents.
Animals injured or killed by traffic:
On otter the number of killed animals is considered threatening the existence of this species. From an administrative and political point of view killed animals is mainly a very visible, unpleasant animal ethical problem.
Habitat fragmentation:
Growing awareness and new knowledge on habitat fragmentation due to infrastructure, will probably give this fauna problem the main focus in the coming guidelines.

The main "human barrier " problems can be identified as:
Barriers on the recreational infrastructure
Lack of coherence between recreational attractions
Limited access to near-urban recreation facilities
Restrictions and limitation in the planning of national and regional tour-routes

At the present stage procedures and results on building *new infrastructures* can be described:
Well established planning procedures involving ecological problems - and the public
Financing possibilities - for optimal solutions
Some technical experience in constructions
Limited knowledge on the effects!

In a similar way on *existing infrastructure:*
Poor planning procedures
Who is responsible?
Poor financing possibilities
Almost none experience in construction techniques
Effects unknown

Some important unsolved questions have been identified and will need further attention:

Assessments and compared effects on different types of passages?
Human disturbance: Quantifying the problem?
Effects of measures adapted to existing infrastructure?
Dimensions on green bridges?

Figure:

Habitat fragmentation and roads in Germany- current situation and perspectives

Bertram Georgii, Munic Wildlife Society, Linderhof 2, D-82488 Ettal

From an ecological point of view there are two very different aspects of traffic routes (roads, railway lines, waterways):

- They may have important functions as habitats and corridors, which allow animals to invade areas formerly not inhabited by such species (that's the potential positive effect).
- On the other hand, roads (more than railway lines) may be severe barriers, which are insurmountable for a lot of species, or they demand high road kill rates *(*that are the negative effect).

This review focuses on the second kind of impacts especially the degree of habitat fragmentation by traffic routes in Germany, the future road planning and recent research on how to mitigate the impacts.

The German transport infrastructure network

The current net of traffic routes of the Federal Republic of Germany comprises some 226.810 km of roads, 40.800 km of railway lines and 7.339 km of waterways (data from 1997, 1995 and 1997 respectively).

In the case of the roads, this corresponds to 173.890 km in the western and 52.670 km in the eastern federal states (Fig.1 left section). In relation to the size of the different federal states this means 0,70 km and 0,49 km roads per square kilometre in the western and the eastern part of Germany respectively (Fig.1 right section). As may be seen from the figure especially in Mecklenburg-Vorpommern, Sachsen-Anhalt, Brandenburg and Thüringen - these are all states of the former German Democratic Republic - the road density is rather low.

Taking into account the fact that the area over which significant ecological impacts (noise, pollution, human disturbances etc.) extend outward from a road covers at least a 300 m wide band on both sides of roads (RECK & KAULE 1992) an estimated 38 % (some 136.000 km^2) of the German land area is directly affected by roads.

The "Undissected Areas" approach

Looking at these statistics the degree of habitat fragmentation is expected to differ between the western and the eastern part of Germany too. To show this, since 1979 some twenty large-scale analyses had been carried out to evaluate the number of so-called *undissected low traffic areas* (unzerschnittene verkehrsarme Räume, UZV; e.g. LASSEN 1990, GRAU 1998). Most of them concerned individual federal states of Western Germany only. And all of these investigations have used indirect methods of measuring the degree of fragmentation (e.g. inquiries, literature surveys*)*. The problem is that they differ in the basic data and in the assessment scales by which they evaluate the intensity of fragmentation impact or the extension of unfragmented areas. Thus the results often are not comparable.

After the reunion of Western and Eastern Germany, the Federal Agency for Nature Conservation (Bundesamt für Naturschutz, BfN) attempted anew to evaluate all "Undissected low traffic areas > 100 km^2" (UZV-Räume > 100 km^2) using rather simple but uniform criteria for the whole of Germany. The basic aspects they regarded to have a dissecting impact were as follows:

- all roads with more than 1000 motor vehicles per 24 hours;
- all railways (single- as well as double-track ones) and
- all waters which claim more than half of an otherwise undissected area >100 km^2.

The result is shown in Fig.2. When considering railway lines, as well as all asphalted roads and motorways there is a sum total of 343 unfragmented areas > 100 km^2. Most of these areas lie in four federal states namely Bayern, Niedersachsen, Mecklenburg-Vorpommern and Brandenburg (Fig.2 left section). When relating the number of the large unfragmented patches to the total area of each federal state, those of the former German Democratic Republic show a mean density of undissected areas more than double as high as that of the western federal states (Fig.1. right section). The most outstanding states in this sense are Brandenburg and Mecklenburg-Vorpommern. The results are already present in a GIS-based but not yet published map. With this map the Federal Agency for Nature Conservation tried to develop a topical database for a sustainable protection of bio-diversity and landscape in all kinds of future road or railway planning in Germany.

The Federal Traffic Infrastructure Plan

In 1992 the FEDERAL MINISTRY OF TRANSPORT came up with the so-called *Federal Traffic Infrastructure Plan* (Bundesverkehrswegeplan, BVWP; see also FEDERAL MINISTRY OF TRANSPORT 1998). It shows the demand for motor- and highways, railway lines and waterways from an economic perspective, covering a planning period of two decades. Main objectives were the completion of the existing traffic routes and a better connection between the "old" and "new" states of Germany following its unification ("German Unity Transport Projects"). But also the opening of the borders to the East and the ambitions of the "trans-European transport network" (TEN) are important aspects for the extension of the traffic infrastructure.

Especially in the case of the states of the former German Democratic Republic this implies lots of new roads. Therefore it is to be feared that just those parts of Germany where the largest unfragmented areas concentrate as for example in Brandenburg or Mecklenburg-Vorpommern will become dissected in unforeseeable dimensions when this plan is realised. In the case of the roads alone, some 2.200 km of new motorways and 5.200 km of new highways with some 1.000 and 1.500 km respectively in the eastern part of the republic, are planned.

Although the Federal Traffic Infrastructure Plan points out that the planned road, rail and waterway projects have to be ecologically compatible, it's to be supposed that the economic objectives are the more important ones (BUNDESMINISTER FÜR VERKEHR 1993). So the ecological risk analysis is only a cursory and qualitatively descriptive assessment on a large-scale basis, and is limited to new road projects with a length of more than 10 km (HOPPENSTEDT & PREISING 1993, GÜHNEMANN ET AL. 1998). Nevertheless the ecological assessment must show that the prospected traffic routes will provide an ecologically acceptable and relatively conflict free alignment, where any remaining inconvenience may possibly be compensated. Otherwise the specific conditions for the further planning have to be altered, the extent of a project or its priority will be downgraded or - rarely - the project even will be withdrawn.

Studies on roads, habitat fragmentation and wildlife

In the last decade three noteworthy studies have been carried out in Germany concerning the impacts of habitat fragmentation or roads on wild animals and the possibilities to minimize them.

In 1994 the Federal Ministry for Education and Research started a multi-approach investigation about the importance of unfragmentated habitats with low human disturbances for a variety of species especially those which need large areas (LANDESAMT FÜR UMWELT UND NATUR MECKLENBURG-VORPOMMERN (1996). Species studied were otter *(Lutra lutra)*, badger (*Meles meles*), crane (*Grus grus*), white-tailed eagle (*Haliaeetus albicilla*), lesser spotted eagle (*Aquila pomarina*), marsh harrier (*Circus aeruginosus*) and even the river-lamprey (*Lampetra planeri*). To evaluate the impacts of habitat fragmentation essential aspects of the studies were habitat evaluation analyses, home range and activity patterns, habitat and food selection, dispersal, the impacts of human disturbances especially those deriving from roads, traffic density and animal road kills or the importance of dissectional effects on population genetics.

The studies were carried out mainly in Mecklenburg-Vorpommern and the isle of Rügen but they are still not fully analysed and therefore not yet published. For the otter for instance the results show that he is less limited by patch size than by the traffic on roads and especially roads with high traffic during dusk, night and dawn. On the other hand, the findings for the white-tailed eagle show an obvious concentration of nest sites in unfragmented and little disturbed landscape patches.

The *second* study dealt with the minimisation of the separating effects of roads by river crossings or bridge openings (KNEITZ & OERTER 1997). It was initiated by the Ministry of Transport in Bonn. The basic idea was that intersections of roads with rivers might be potential underpasses for wildlife because streams and their adjacent vegetation structures act as guiding lines and migrational corridors for many animals. During two years Kneitz and his co-workers studied a wide variety of animal species such as ground beetles, grasshoppers, dragonflies, caddisflies, stoneflies, mayflies, the macrozoobenthos as well as small mammals, game and birds at a total of 20 river crossings.

In all of the invertebrate groups species were found which used the underpasses, especially those with natural riverbeds and banks. But they also showed reduced numbers of species and individuals compared with the surroundings. This was due to the specific micro-climatic conditions, the non-local substrate, the lack of vegetation and the different vegetation structure, or even artificial embankments beneath the crossings and bridges. Furthermore, the macrozoobenthic species react above all on reduced light conditions. Most small mammals used the underpasses as habitat corridors with a species-specific intensity. The same is true for the larger game species with the exeption of narrow "box-passages". In the case of birds, behavioural changes influenced by the bridge structures, such as direction reversal or alteration of flight paths, were observed.

The *third* study was a six year investigation of the bio-ecological effectiveness of wildlife overpasses or "green bridges" over roads and railway lines (PFISTER et al. 1997; see also the contribution of V.Keller at this meeting). It was initiated by the Ministry of Transport in Bonn and the ministries of Transport, of the Environment and of Rural areas, Nutrition, Agriculture and Forests of Baden-Württemberg. The investigations were conducted by the Swiss Ornithological Institute which commissioned some further specialists to study individual groups of animals as, for example, large mammals, mice, dormice, amphibians, ground beetles, grasshoppers and even birds. The investigation comprised some just built green bridges over the new highway B31 near Lake Constance, and a comparative investigation of 12 overpasses in Germany, Holland, France and Switzerland.

At the centre of the investigations was the question as to which species of animals use green bridges, and how often. Thus with a few exeptions, the species studied used at least the wider green bridges. Small mammals and invertebrates can use overpasses effectively when species-specific habitat elements are present on the bridges, and these elements are joined to the corresponding habitats outside the road area, that is to say when the green bridges are formed as habitat corridors. Because wet habitats are difficult to establish on overpasses green bridges are hardly used by species having an affinity for water like e.g. amphibians.

Otherwise, for large mammals, the width and location of a green bridge appears to be more critical than its design or the substrate and vegetation. Green bridges less than 20 m in width were used not as frequently as wide structures. In particular, ungulates and the European hare reacted very sensitively to narrow bridges. Additionally, red deer (*Cervus elaphus*), roe deer (*Capreolus capreolus*), wild boar (*Sus scrofa*), European hare (*Lepus europaeus*), badger (*Meles meles*) as well as red fox (*Vulpes vulpes*) used the green bridges as feeding areas too.

Summarising the results of the KNEITZ and PFISTER studies, the fragmentation effects of roads and railway lines may be minimised by the described underpasses and green bridges. Therefore, perforating roads and railway lines to diminish the barrier effects makes good ecological sense. The precondition is that under- and overpasses are optimally positioned, dimensioned and designed, in other words, they have to correspond to the natural environment as much as possible.

The target species of such buildings can essentially be all species, which are significantly affected by the barrier effect of the respective road or railway line. Among these both, species which are particularly threatened in the local situation or species which have important migration routes there have priority when planning a passage. Moreover the buildings should be part of a general "permeability concept", i.e. a concept the aim of which is to connect habitats not only on a regional but also on a large-scale level.

Fig.1 Length of roads in thirteen federal states of Germany. Road length in 1000 km (left) and road kilometres per square kilometre of state area (right; database: Ministry of Transport))

Fig.2 Large unfragmented areas > 100 square kilometres in thirteen federal states of Germany. Number of areas (left) and as the percentage of each state area (right; database: Federal Agency for Nature Conservation)

Literature

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Habitat fragmentation due to infrastructure - how far have we come in Norway?

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Key figures for Norway	
Area:	approx. 324.000 km²
Population:	4.3 millions
Length:	approx. 2.500 km
Public roads:	91.350 km
National roads:	26.600 km
Pass. cars:	1.758.000

Fragmentation

Fragmentation has become an increasing problem in Norway, and the total area of "wilderness territory" has been greatly reduced over the past 100 years, especially in the southeast.

Wildlife fences

As a traffic safety measure, wildlife fences are built along roads that cross habitats or migration routes for larger mammals, in Norway such as moose, red deer, reindeer or roedeer.

Wildlife fences are a constant barrier 24 hours a day, and can over long distances in itself, or together with other kinds of regional infrastructure, have regional effects on wildlife and other long-term ecological effects.

The number of people killed or injured in collisions between cars and mammals is relatively small. And the number of animals killed is no threat to the various species as such.

Species	**Yearly quotas for hunting**	**Hunting results**	**Animals killed on the road**	**People killed**	**Accidents with severe personal injuries**	**Accidents with light personal injuries**
Moose	30 - 35.000	approx. 85%	approx. 1.200	0 - 5	4 - 14	76 - 117
Roe deer	40 - 45.000	?	approx. 2.700	0	0 - 1	4
Red deer	15 - 20.000	approx. 65%	approx. 280	0	0	3
Reindeer	8 - 9.000	approx. 45%	3 - 5	0	0 - 1	1

The use of wildlife fences should therefore be limited.

Mitigation measures, evaluation

Manmade mitigation measures such as bridges or culverts are often combined with other needs (smaller roads, paths, agricultural machines). The localisation and/or the construction of the wildlife passages can often be more "convenient" than scientifically based.

To ensure the mobility of the freshwater organisms up and down streams, riverbeds may be moved and special culverts designed.

If mitigation measures are necessary, the localisation and construction should be decided with the aim to restore the natural structures and sustain the landscape ecology.

As the traffic increases and new infrastructure is built, the need for mitigation measures should also be considered on existing roads.

Mitigation measures should always be evaluated periodically.

Planning

Natural links and migration routes, as for instance hills and canyons, must be preferred to manmade mitigation measures such as bridges, "ecoducts" or culverts.

The barrier effect can be reduced if *landscape ecology* is taken more into consideration in *planning* of new regional roads. The regional green structure should be taken care of by conserving important habitats and the links between them. The *total* barrier effects of *all* kinds of regional infrastructure or other manmade constructions should be seen from a regional wildlife-management point of view.

What have we done?

- Biologist, Dec. 1997
- "Faunapassages - what's done in Europe and what are we doing in Norway?", 1998. Describing different existing and planned faunapassages
- Environmental Action Plan for the transport sector, new focus on barriers, regional greenstructure and fragmentation, 1998
- Planning 2 research & development-projects 1999-2002, 1998
- Nordic Conference on habitat fragmentation due to infrastructure, March 1999

What do we need to know more about?

- Where are the Barriers? How do we find them?
- Can the use of wildlife fences be reduced?
- Where do roads destroy the regional green structure?
- Where should the green structure be restored?
- Is fragmentation a problem in Norway today, and where?
- How do the existing mitigation measures work?
- How do we evaluate them?
- How and where should new mitigation measures be built?

7. Open day

Friday the 16th of April 1999.

Papers presented during the open day.

1. **Irene Glitzner and Friedrich H. Völk**, Passageways through 1990 km fenced motorways in Austria: Assessment of number, distribution and quality for big game species (indicator species: red deer). Page 20-23.

2. **Andreas Zedrosser and Fritz Völk,** Large carnivores (bear, wolf, lynx) moose and trunk roads in Austria. Page 24-26

3. **Verena Keller**, The use of wildlife overpasses by mammals: results form infra-red video surveys in Switzerland, Germany, France and the Netherlands. Page 27-28.

4. **Hans Bekker,** Effectiveness of adapted culverts and bridges - methods and results. Page 29-30.

5. **Lennart Folkesson**, Environmental goals as applied to a transport corridor–A Swedish case study. Page 31-37.

Passageways through 1990 km fenced motorways in Austria: Assessment of number, distribution and quality for big game species (indicator species: red deer)

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1. INTRODUCTION

Landscape and habitat fragmentation in Austria, especially in non-Alpine areas presents an increasing problem. The motorway network in Austria is almost completed and fenced (only a few kilometers are missing). But no information is available on whether this network of barriers offers enough permeability for wildlife. Without this knowledge it is impossible to evaluate the importance of certain motorway-sections as potential migration corridors for game species. Therefore the Austrian Ministry for Economic Affairs is financing this study to evaluate the distribution and suitability of existing passageways (primarily human corridors like bridges and tunnels; bridge = underpass for game, overpass & tunnel = overpasses for game) and to evaluate the barrier effects of motorways on game species. The main purpose of the study is to find out the requirements for "green bridges" or other game specific passageways in Austria.

Red deer is a wide-ranging game species and common in every province of Austria. It shows seasonal migrations and therefore requires a lot of space. Red deer, as many other species is restricted from natural dispersal and subpopulations are more and more isolated by the expanding motorway network. Because red deer is known to be sensitive to travel through small passageways it is selected as indicator species to establish requirements for migration corridors and road crossing structures.

2. METHODS

Three levels of data collection and evaluation:
❶ Recording and evaluation of location and regional situation of existing passageways by maps and aerial photographs. Selection of passageways (bridges, tunnels, overpasses) with importance as regional and national wildlife corridors.
❷ Recording and evaluation of local environmental and structural conditions of each passageway and of migratory activity of big game species in the surrounding area.
❸ Gathering information about migratory behaviour of big game species by questionnaire; main reason: to utilize knowledge of hunters and conservationists about ungulates and large carnivores.

3. PRELIMINARY RESULTS

Present investigations show that the entire fenced road network in Austria divides the landscape into 14 habitat fragments ("polygons").
The connection of suitable habitats on both roadsides is very important for wildlife but varies greatly along Austrian motorways - due to their differing permeability. Quality of passageways mainly depends on location, width, distance to next settlements and distance to cover possibilities.

3.1. Selection procedure

The database of the Austrian Ministry for Economic Affairs contains of 3488 passageways (bridges, tunnels, overpasses) over 2 m wide existing along motorways. 1185 of the bridges & tunnels are over 30 m wide. These passageways we investigated and selected 543 passageways (46%) with wildlife ecological importance (see Tab. 1).

Tab. 1: Number of recorded, selected and assessed passageways (bridges & tunnels & overpasses) at least 2 m wide

Number of passageways (bridges & tunnels) in Austria	
width ≥ 2 m (bridges, tunnels, overpasses)	3488
width ≥ 30 m (bridges, tunnels)	1185
selected passageways (bridges, tunnels)	543
important underpasses ≥ 30 m	465
important tunnels ≥ 30 m	78

3.2. Important quality parameters of passageways

These 543 selected passageways consist of 465 underpasses (width ≥ 30m) and 78 tunnels.

Next cover

329 passageways (61%, n=543) show cover within 100 m ("very good" cover on both sides, see Tab. 2).

Tab. 2: Number of passageways and distance to next cover

next cover	**next cover**		**("exit")**	
("entrance")	< 100 m *("very good")*	100 - 500 m *("good")*	> 500 m *("bad")*	Total
< 100 m *("very good")*	329	75	39	443
100 - 500 m *("good")*	-	40	39	79
> 500 m *("bad")*	-	-	21	21
Total	329	115	99	543

Next settlements

*Fig. 1: Number of passageways (bridges & tunnels) and distance to next settlements (consisting of at least 10 buildings). * passageways < 100 m wide with a distance to settlements < 100 m are excluded through selection (see 2.1.).*
218 crossing structures are at least 500 m away from next settlements (see black column, Fig. 1).

"Very good" cover and settlements far away
Only 142 passageways (bridges & tunnels) show "very good" cover possibilities on both sides and settlements (> 10 buildings) at least 500 m away.

3.3. Hunters questionnaire: Red deer acceptance of underpasses

36% (165, n=465) of questionnaires sent to hunters were filled out and sent back to us till March 1999. We expect to get a response rate of at least 80 - 90%. First results show that about 1/3 of these 165 passageways are accepted by red deer, 7% are considered by hunters as frequently used. Most underpasses used by red deer are wider than 100 m. They show cover possibilities within 500 m.

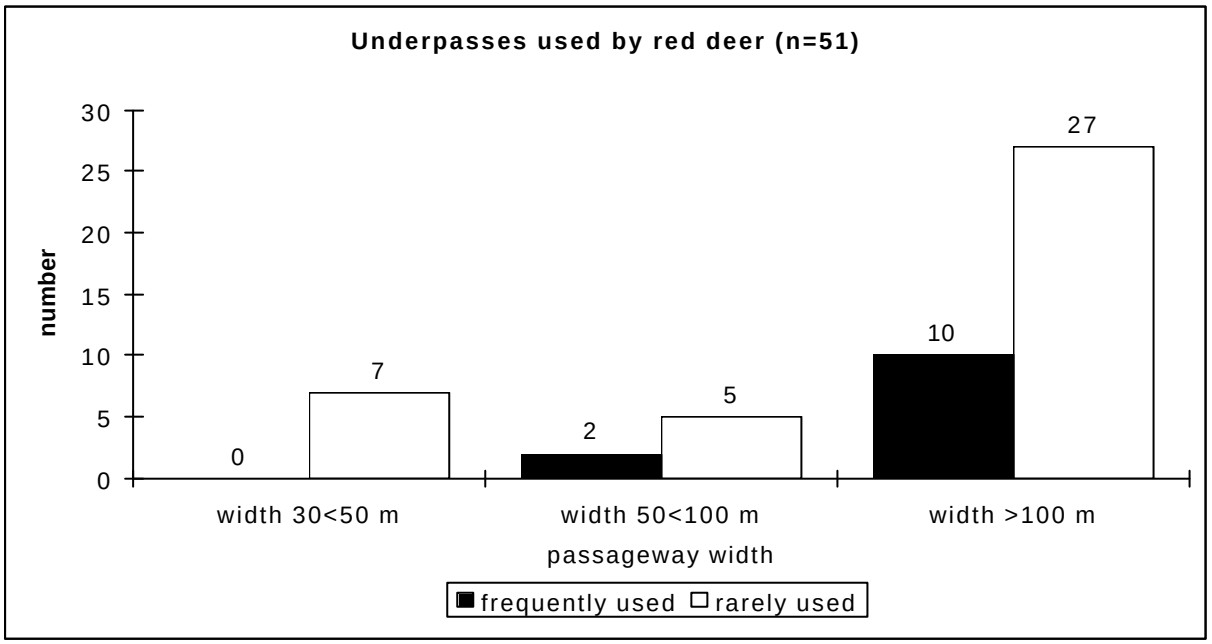

Fig. 2: Using of underpasses by red deer according to passageway width (data till March 1999)

4. DISCUSSION AND PERSPECTIVES

In Austria, the distribution of existing passageways with good effectiveness as corridors for game species signifies problems. Preliminary results indicate that fenced motorways in eastern Austria (dominated by agricultural landscape) impose dispersal barriers for game animals. Many of existing passageways may not be used by game species because they are too small, located too far away from cover possibilities and/or too close to settlements. The capital city Vienna (located in eastern Austria) is surrounded by a network of motorways, creating a strong barrier between the Alps and the Carpathian Mountains (Slovakia). It will be an absolutely necessary measure to decrease habitat fragmentation in this area.

Red deer shows shyness to small underpasses therefore the use of passageways is growing with increasing underpass-width. Cover possibility located close to the entrance and exit seems to be one of the most important parameters for passageway effectiveness. Though settlements in the surrounding area lead to decreasing acceptance a few buildings within 100 m seems to have little barrier effect on red deer if passageway-width is high and cover close.

In a mountainous area further investigations show individual red deer using even small underpasses (width 11 - 30 m) if cover is close. As known traditional migration routes determine passageway effectiveness - information from hunters indicate that even large underpasses (width > 100 m) are not accepted by red deer (since more than 20 years) if their location does not correspond with traditional migration routes. Therefore it is important to know details about historic routes before decisions will be made about the location of subsequent game passageways and - much better - before constructing and fencing motorways. The final study report will provide recommendations for the most efficient placement and construction requirements for wildlife passageways.

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Large carnivores (bear, wolf, lynx) moose and trunk roads in Austria.

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Introduction

Large mammals, especially large carnivores, are of major importance in habitat and wildlife conservation. The reason for this is due to their relative rarity, large home ranges and great mobility; especially large carnivores are known for their long distance movements. “Record holder” is a wolf in North America with a known dispersal distance of 886 km (Fritts 1983). This example shows how important planning on a large geographical scale is. This is especially true for the situation in middle Europe. A population of large carnivores can never be protected and managed by just one country, but must always be seen in connection with the adjacent countries. As a result of populations being shared, international cooperation is needed from several countries to ensure the long term survival of these species in Europe (Boitani in press, Breitenmoser et al. in press, Swenson et al. in press).

Situation of the brown bear, lynx, wolf and moose in Austria

Brown bear (*Ursus arctos*)
The brown bear was extirpated in Austria in the 19th century (Rauer & Gutleb 1997). After that migrant bears from the Dinaric Mountain Range in Yugoslavia showed up on a regular base in the southern Austrian Alps (Gutleb 1993, 1994, 1996). In 1971 a single male bear migrated from Yugoslavia into central Austria and established a home range. In this area a re-introduction program was launched by WWF-Austria. Three bears were released starting in 1989. Today Austria has a population of 25-30 bears (Rauer & Gutleb 1997). The core areas of the bear range are in central Austria around the release site and in southern Austria due to bears moving into Austria from Slovenia. The Austrian brown bear population has to be viewed as subpopulation of the Dinaric-Eastern Alpine bear population (Swenson et al. in press). For its future survival it will always depend on the connection to the source population in the former Yugoslavia. A loss of the connection to this source population because of habitat fragmentation due to major roads would be fatal for the future of the Austrian bear subpopulation.

Lynx (*Lynx lynx*)
Between 1976 and 1979 nine lynx were released in southern Austria (Festetics 1978). Although this re-introduction can not considered to be successful, single animals still exist in this area. Additionally migrating lynx move into northern and southern Austria descending from two very successful re-introduction programs in Slovenia and the Czech Republic (Huber 1995).

Wolf (*Canis lupus*)
Currently no wolf population exists in Austria. But most adjacent states adjacent host a population, thus occasionally wolves move into Austria. A study of wolf migration into Austria has been carried out (Zedrosser 1996) and clearly shows the preferred migration routes. The countries most likely to supply wolves to Austria are Slovakia via the Czech Republic and Slovenia.

Moose (*Alces alces*)
No current moose population exists in Austria. But occasionally single animals migrate from the Czech Republic into northern Austria. Two of these animals even crossed the river Danube on their movements in Austria (Steiner 1995). One of those animals was killed in a car accident on the only highway in the area.

Method

Historical data or good knowledge about the current situation and existing migration routes of bear, wolf, lynx and moose in Austria and middle Europe is available. This data was registered on a map of the existing trunk road system in Austria. Thus conflict areas could be identified where current and potential migration routes intersect with trunk roads.

Results and Discussion

11 recent and potential migration routes from possible source populations in adjacent countries of Austria could be identified. Three possible migration routes are in western Austria. Those potential routes could be used by bear, lynx and wolf. Lynx have been re-introduced to Switzerland (Breitenmoser et al. in press) and bears will be re-introduced in northern Italy (Swenson et al. in press), thus resulting in potential source populations for a migration into western Austria. Wolves naturally increased their habitat from Italy into France (Boitani in press) and even started to move into Switzerland (Breitenmoser pers. comm.). This could result in a future colonization of western Austria by wolves via France and Switzerland.

Four migration routes were identified in southern Austria. These migration routes are recently used by bears (Rauer & Gutleb 1997) and lynx (Huber 1995) and will most likely be used by wolves in the future (Zedrosser 1996). The Dinaric Mountain Range in the former Yugoslavia hosts the most important source populations for the re-colonization of the Eastern Alps by large carnivores (Breitenmoser et al. in press, Boitani in press, Swenson et al in press). Thus saving existing and providing additional migration routes is absolutely crucial for the future of large carnivores in Europe.

Four migrations routes were identified in northern Austria. Lynx. wolves and moose have used these routes very recently and are likely to do so in the future. (Huber 1995, Steiner 1995, Zedrosser 1996). The source populations are situated in both the Czech Republic and Slovakia. Especially lynx move into northern Austria descending from a successful re-introduction program in the Czech Republic (Huber 1995).

Within Austria 7 major areas were identified where trunk roads intersect with migration corridors of bear, wolf, lynx or moose. In northern Austria two crossings of a highway by moose are recorded (Steiner 1995). The area where those two crossings took place shows one of the last potential connections between two major European geographical regions, the Alps and the Carpathians. From a nature and species conservation standpoint a connection between those two geographical regions is very important. In southern and central Austria six major areas were migration routes and trunk roads intersect were identified. In two of these areas a bear and a lynx were injured respectively killed by a car when trying to cross a major road (Huber 1995, Rauer & Gutleb 1997). Of special importance are the two southernmost intersections. The migration routes in these areas connect the Eastern Alps directly with the Dinaric Mountain Range. If road-crossing for large carnivores becomes impossible in these areas, this could proof fatal for the future of large carnivores in the Eastern Alps (Swenson et al. in press, Zedrosser 1996, Rauer & Gutleb 1997).

Conclusion

Planning on a large geographical scale is crucial for the future of large carnivores in Europe. Because populations of large carnivores are usually shared by different states, national and international considerations have to be taken into account when constructing roads. To secure the connection between populations and to encourage natural expansion of existing populations international co-operation and information exchange is necessary.

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The use of wildlife overpasses by mammals: results form infra-red video surveys in Switzerland, Germany, France and the Netherlands

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Wildlife passages can be considered as a special type of wildlife corridor, linking habitats divided by traffic lines. In the last decades, biologists and planners have become increasingly aware of the necessity to create such corridors in a more and more fragmented landscape. Wildlife overpasses mainly across motorways have been constructed in several European countries, although in relation to the density of roads their total number remains small.

In many cases, wildlife passages have been constructed without knowing whether they actually fulfil their purpose. To fill this gap the Department of Transport of Baden-Württemberg (Germany) and the German Federal Department of Transport together with the Departments for the Environment and for the Rural Area (Baden-Württemberg) in 1990 gave a mandate to the Swiss Ornithological Institute to coordinate a project studying the effectiveness of wildlife overpasses or "Grünbrücken" from an ecological point of view (Pfister et al. 1997).

The aim of the project was to evaluate the effectiveness of wildlife overpasses for conservation in general and as corridors for wildlife in particular. The project should also make recommendations to planners as to under which circumstances wildlife passages are necessary and how they should be designed. The project involved specialists for different taxonomic groups, mainly from Germany.

As part of the project the use of wildlife overpasses by medium-sized and large mammals was studied using infra-red video equipment. However, the number of overpasses that could be incorporated into the study was small and allowed only preliminary conclusions on the effect of passage width and other parameters on use by mammals (Jenny et al., Georgii, both in Pfister et al. 1997). Financial support by the Swiss Agency for the Environment, Forests and Landscape allowed to repeat the surveys on the bridges already studied and to include several new overpasses which had been constructed in the mean time. The main aim of the study was to test any effects of width and location of overpasses on the frequency of use by mammals. The talk presents the overpasses studied and a summary of the main results, which will be published in Pfister et al. (in prep.).

Overall, 21 wildlife overpasses in Germany (8), Switzerland (6), France (4) and the Netherlands (3) were included in the study. Their widths (measured as width between fences) ranged from 3.4 m to 186 m. Video surveys were carried out during a total of 223 nights. For the comparison of the frequency of use only data from spring were used although seasonal differences on bridges surveyed during several seasons were small. In addition to frequency of use, the behaviour of the animals on the overpasses was analysed. The three most frequent species, roe deer *Capreolus capreolus*, fox *Vulpes vulpes* and brown hare *Lepus europaeus* occurred in all study areas, while red deer *Cervus elaphus* and wild boar *Sus scrofa* were absent from some regions, and badger *Meles meles* and (pine or stone) marten *Martes* sp. occurred irregularly.

Multiple regression analysis revealed passage width as the only significant parameter determining frequency of use. Of the three frequently occurring species present in all areas, roe deer and fox showed the strongest relationship, using broad passages with much higher frequencies. For all species apart from marten observation frequency on narrow bridges (<15 m, n = 7 bridges) was very low. Medium-sized (15-50 m; n = 9) and broad bridges (>50 m, n = 5) were used more frequently but only for roe deer there was a significant difference between the classes. On broad bridges animals showed significantly higher rates of 'normal' behaviour.
Results confirm previous recommendations of a width of at least 50-60 m for wildlife overpasses for large mammals (Schweizerische Gesellschaft für Wildtierbiologie/Société suisse de biologie de la faune 1995; Pfister et al. 1997).

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Effectiveness of adapted culverts and bridges - methods and results

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based at G.J. Brandjes & G. Veenbaas:
'Het gebruik van faunapassages langs watergangen onder rijkswegen in Nederland, een orienterend onderzoek' (DWW Delft, 1998, Ontsnipperingsreeks deel 36)

Introduction

The Road and Hydraulic Engineering Division of the Ministry of Transport, Public Works and Water Management in the Netherlands is carrying out an investigation on existing crossings of waterways under highways with special adaptations for faunal passages. The use of specific faunapassages like ecoducts and badger tunnels is well-known, but we know very little about the use of these adapted passages. Research at this type of passage was missing. We do need the knowledge especially because there is a large number of bridges and culverts in the Netherlands and elsewhere as well. Our aim is to optimize the permeability of roads for faunal purposes.

The survey is aimed to know which mammal species are using these adapted culverts and bridges, how frequently they are passing and are there species which do not use these passages although they are present in the area. Correlations between the use of the passages and their design (width, higth and length), substrate and other factors were investigated.

The research is set up for three years:
- the first year:at 22 locations: orientation and an indication about the use and a try out of the methods
- the second year: at 22 'catwalks' and 24 ongoing embankments: are these used by target species and other species
- the third year: extra adaptation at some of these catwalks (broaden till 0.7m and 1.0m) and some of these ongoing embankments (with shelter) and to compare the results with the not-extra adapted provisions

This contribution in the IENE-meeting in Budapest is based at the report of the first year and some information of the second year.

Methods

Beside the well-known sandbeds to get information from footprints and tracks two rather new methods were developed and used: infrared detectors for recording faunal passages and an 'ink-method' to get footprints on paper.

Sandbeds: The sandbeds were used on the ongoing banks of waterways under bridges. We used silver sand, which doesn't harden too quickly on drying pavement. The sandbeds were checked weekly for footprints and tracks. Afterwards the sand was equalised, filled by and rolled to smoothen the surface. The determination of the prints and tracks was done until the level of species, as possible.

Infrared detectors: Detectors were modified to be able to record movements of small animals. The data were stored in memories and read-out by a special receiver combined with a portable computer. The detectors were fixed on the underside of bridges or in culverts, just above the passage way and they recorded data and time. Mostly they were read out weekly but it was possible to do it less frequently.

On catwalks not wider than 1 m the new ink-method was used. The ink was liquid paraffin with some carbon powder at a container as ink-bed. At both sides of the container sheets of paper were fixed at the catwalk. The ink bed and the paper covered the whole width of the passageway. The papers covered over a length of 102 cm (standard length of the paper) at both sides of the ink-bed. The catwalks were checked every week for footprints and tracks. If animals had passed the sheets of paper were replaced with new ones. Tracks and prints were determined in the office and sometimes checked by another expert in footprints.

Results

Some results about the used methods
The infrared-method is a quick scan with no influence on movements. The information is about frequency and time of the movements, but determination is impossible. At some places where people passed the detector was stolen. This method is relatively cheap and little time consuming. It is possible to read out the data once in a long period

The sandbeds gave good prints, especially of larger animals. On stone-paved banks the sand dried out or blown away. It is a natural substrate of low cost. The results can not be discussed afterwards, so it is time consuming for the expert.

The ink-method gives a very good recognition of species, for large and small mammals and amphibian. It is possible to do the determination afterwards. The method is possibly influencing the use and it can be deadly for invertebrates. As improvement of the method: with a chammy it is not deadly for invertebrates.

After the first year some minor improvements of the methods were possible.

Some preliminary results of the use of the passages:
- All the investigated faunapassages were used: mammals, amphibian and birds (also invertebrates, but these were not determined or counted). At the catwalks we found 17 species and at embankments 25 species.
- The dimensions of the passage: the wider and shorter the better and we didn't found an influence of the substrate.
- Larger passages are more often used by man as well; this means that not all methods can be used.
- The passages are frequently used by all kind of mustiladea, by amphibians and by cats, mice and rats.

Environmental goals as applied to a transport corridor - A Swedish case study

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Summary:
This presentation aims at demonstrating a contribution to methodology development in strategic environmental assessment (SEA) in connection with the planning of transport infrastructure. The study concerns the use of environmental goals in SEA of a multi-modal transport corridor in southern Sweden.

Based on existing environmental goals on the national and the regional level, environmental goals were set up for the transport link between Göteborg and Jönköping. The goals were tested against eight given development alternatives. These consisted of combinations of doing nothing, upgrading the existing road, building a new highway (two levels of standard) and building a railway. The compatibility of each of the eight alternatives with the environmental goals was analysed using a simple trend analysis based on the question "To what extent does the development alternative contribute to the fulfilment of the environmental goal?" The next step was the identification of extra-ordinary environmental measures that would be required in order to make each of the eight alternatives more compatible with the environmental goals. The final step was the identification of those points of environmental conflict that would still remain once the extra-ordinary environmental measures had been taken.

The results show that all alternatives which provide infrastructure in new alignments largely conflict with several of the proposed environmental goals. The most important conflicts concern infringements upon cultural, historical and ecological connections and structures in the landscape as well as the barrier effect and physical dominance of the infrastructure in the landscape and residential environment. The alternatives that include the construction of a new highway in the corridor entail greater dependence on fossil energy. Establishing a railway would enhance overall traffic safety. As regards environmental goals related to acidification, eutrophication and global warming, the development alternatives that include the railway are in line with the environmental goals of the link, whereas the other alternatives are in conflict with the goals. The zero alternative and the minimal-upgrading alternative neither contribute to nor detract from the goals for the natural and cultural environment. Both alternatives conflict against emission goals, however.

In conclusion, a railway development with or without minimal upgrading of the existing road are judged to be the only alternatives which together give a positive contribution to the environmental adaptation of the Göteborg–Jönköping link. None of the alternatives studied, however, can be regarded entirely compatible with the environmental goals for the link.

The main contribution of this study to the development of methodology of SEA is the setting up of environmental goals for a multi-modal transport link and the demonstration of the consequences of their application.

This study has been used as a case study in the EU Commission's work on the SEA of the Trans-European transport network. The study, commissioned by the Swedish National Road Administration, forms part of a report that has been published in Swedish and in English[1].

[1] Gothenburg–Jönköping Transport Corridor. Environmental Impact of Strategic Choices. Demonstration of Methods. – Swedish National Road Administration, Publikation 1998:62E. Borlänge, Sweden.

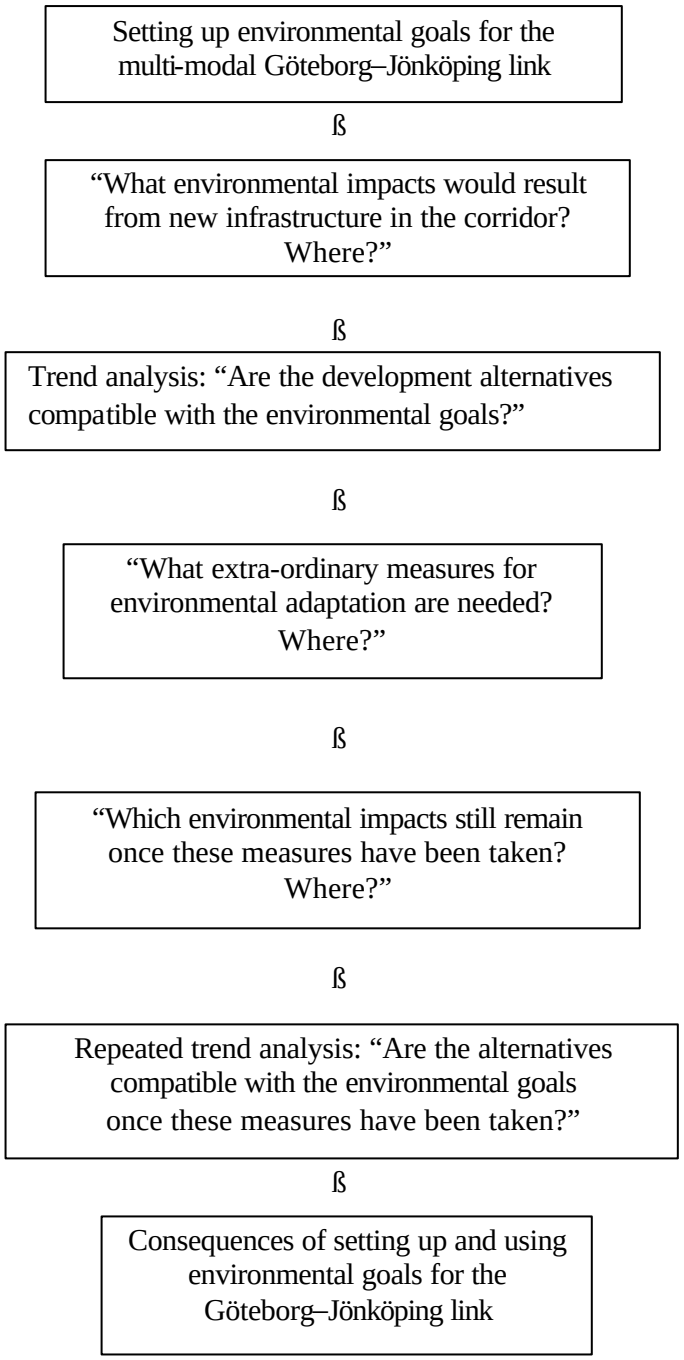

Figure 1. Principal approach.

Table 1. The development alternatives for the multi-modal transport link between Göteborg and Jönköping, S Sweden.

Alternative (road+rail)	National Road 40	Railway
0 + 0 (reference)	Do nothing (today's standard of existing road)	Do nothing [1)]
0 + rail line	Do nothing	New railway Gbg - Jkp
Mini + 0	Minor local upgrading	Do nothing
Mini + rail line	Minor local upgrading	New railway Gbg - Jkp
4L + 0	Upgrading of existing road to 4-lane highway	Do nothing
4L + rail line	Upgrading of existing road to 4-lane highway	New railway Gbg - Jkp
MW + 0	Motorway (partly in new alignment)	Do nothing
MW + rail line	Motorway (partly in new alignment)	New railway Gbg - Jkp

[1)] A railway exists between Göteborg and Borås, halfway to Jönköping

Table 2. Suggested environmental goals for the transport link Göteborg–Jönköping.

The link shall -
- constitute part of the environmentally sustainable transport system
- support the local transport and settlement system of today
- harmonise with the landscape and strengthen its cultural and historical values
- fit into landscape patterns and contribute to defragmentation
- promote landscape-ecological functions and life of endangered species
- promote biodiversity of the region
- contribute to reduction in the pollution of water and wetlands
- avoid damaging valuable lakes, watercourses and wetlands
- contribute to reduction in urban noise and air pollution
- enhance traffic safety
- promote social safety, comfort and well-being
- improve local accessibility and preconditions for local recreation
- help to make the transport system and energy use more efficient
- help to meet targets concerning climate change
- help to meet targets concerning acidification and eutrophication
- help to reduce the local and regional load of air pollutants

Table 3. Trend analysis of the contribution of the development alternatives to the fulfilment of the environmental goals (in Table 2) set up for the Göteborg- Jönköping link. Question: *"To what extent can the development alternatives be expected to contribute to the environmental goals?"* The analysis concerns the **situation not involving extra-ordinary measures for environmental adaptation**. The analysis concerns a conceivable future (c. 2010) situation in relation to the current situation. Development alternatives presented in Table 1.

The relative developmental contribution of the alternatives to the environmental goals:

---	very large negative contribution
--	large negative contribution
-	small negative contribution
(-)	very small negative contribution
0	no or insignificant contribution
+	small positive contribution
++	large positive contribution
+++	very large positive contribution

Environmental goals of the link:	0 +0	0 +rail	Mini+0	Mini+rail	4L +0	4L +rail	MW +0	MW +rail
form part of the sustainable transport system	**0**	++	**0**	++	- -	-	- - -	- -
support the transport system of today	**0**	- - -	+	- -	++	- -	- - -	- - -
harmonise with the landscape	**0**	- - -	**0**	- - -	- -	- - -	- - -	- - -
landscape patterns and defragmentation	**0**	- - -	**0**	- - -	**(-)**	- - -	- - -	- - -
promote landscape-ecological functions	**(-)**	- -	**0**	- -	- -	- - -	- - -	- - -
promote biodiversity of the region	**(-)**	- -	**0**	- -	- -	- - -	- - -	- - -
reduce pollution of water and wetlands	**(-)**	**(-)**	**(-)**	**(-)**	-	-	-	-
valuable lakes, watercourses and wetlands	**0**	- -	**0**	- -	-	- - -	- -	- - -
reduce urban noise and air pollution	- -	- - -	- / +	- - **/0**	- / **0**	- - / -	- **/0**	- - / -
enhance traffic safety	- -	- -	+	+	++	++	+++	+++
promote social safety, comfort and well-being	-	- -	+	- -	- / **0**	- - -	- / +	- - -
improve local accessibility and recreation	-	-	**(-)**	-	-	- -	- / **0**	- -
efficient transport system and energy use	-	**0** / +	**0**	**0** / +	- - -	- - -	- - -	- - -
meet targets for climate change	**(-)**	+	**(-)**	+	- - -	- - -	- - -	- - -
meet targets for acidification and eutrophication	-	+	-	+	- - -	- - -	- - -	- - -
meet targets for load of air pollutants	-	+	-	+	- - -	- - -	- - -	- - -

Table 4. Examples of suggested extra-ordinary measures for environmental adaptation of the Göteborg- Jönköping link.

- avoid large undisturbed areas
- good accessibility of present towns to new infrastructure
- keep present local network
- attractive public transport
- infrastructure dimensions and design adapted to scale of the landscape
- infrastructure complying with cultural and historic structures
- passages for people, fauna and water
- active measures promoting wildlife movement as well as traffic safety
- environmentally sound maintenance of freeway
- environmentally prioritised through-roads
- measures promoting safety, comfort and well-being in dwelling areas

Table 5. Trend analysis of the contribution of the development alternatives to the fulfilment of the environmental goals (in Table 2) set up for the Göteborg- Jönköping link. Question: *"To what extent can the development alternatives be expected to contribute to the environmental goals?"* The analysis concerns the **situation after extra-ordinary measures for environmental adaptation have been taken** in accordance with Table 4. The analysis concerns a conceivable future (c. 2010) situation in relation to the current situation. The shading indicates cells where the situation has changed from Table 3.

Environmental goals of the link:	0 +0	0 +rail	Mini +0	Mini+rail	4L +0	4L +rail	MW +0	MW +rail
form part of the sustainable transport system	**0**	++	**0**	++	- -	-	- - -	- -
support the transport system of today	**0**	- - -	+	- -	++	- -	- - -	- - -
harmonise with the landscape	**0**	- - -	**0**	- - -	- -	- - -	- - -	- - -
landscape patterns and defragmentation	**0**	- - -	**0**	- - -	**(-)**	- - -	- - -	- - -
promote landscape-ecological functions	**(-)**	- -	**0**	- -	- -	- - -	- - -	- - -
promote biodiversity of the region	**(-)**	- -	**0**	- -	-	- - -	- - -	- - -
reduce pollution of water and wetlands	**(-)**	**(-)**	**(-)**	**(-)**	**0**	**0**	**0**	**0**
valuable lakes, watercourses and wetlands	**0**	-	**0**	-	- / **0**	- -	-	- -
reduce urban noise and air pollution	- -	- -	- / +	- / +	- / +	- - / -	- / +	- - / -
enhance traffic safety	- -	- -	+	+	++	++	+++	+++
promote social safety, comfort and well-being	-	-	+	-	- / +	- -	- / +	- -
improve local accessibility and recreation	-	- / **0**	**(-)**	- / **0**	- / **0**	-	- / **0**	- -
efficient transport system and energy use	-	**0** / +	**0**	**0** / +	- - -	- - -	- - -	- - -
meet targets for climate change	**(-)**	+	**(-)**	+	- - -	- - -	- - -	- - -
meet targets for acidification and eutrophication	-	+	-	+	- - -	- - -	- - -	- - -
meet targets for load of air pollutants	-	+	-	+	- - -	- - -	- - -	- - -

Conclusions:

- All seven development alternatives conflict with most of the environmental goals set up for the Göteborg–Jönköping link
- Infrastructure in new alignments will not be compatible with the environmental goals
- Development of a new highway will conflict with goals concerning acidification, eutrophication and climate change
- Motorway or 4-lane highway will increase the dependence on fossil energy
- New railway will promote traffic safety
- Only a railway development with or without local minor upgrading of the existing road will give a positive contribution to the ecological adaptation of the link

Main contributions of the study:

- Identification of major environmental conflicts
- Establishment of environmental goals for the Göteborg–Jönköping link
- Test of compatibility of the seven development alternatives with the goals
- Need for special adaptation measures
- Consequences of setting up and using environmental goals

Figure 2. Examples of extra-ordinary measures for environmental adaptation of infrastructure in the Göteborg–Jönköping corridor.

Figure 3. Examples of remaining conflicts with the environmental goals for the link once the extra-ordinary measures for environmental adaptation have been taken.

8. Field trip

Saturday the 17th of April.

The third day of the IENE meeting was dedicated to a field trip to the planned section of the M0 ring road north of Budapest and a visit to the Duna-Ipoly National Park. In the late afternoon there was also time for a short visit to the citadel of Visegrád. The field trip gathered about 80 peoples, the IENE participants and Hungarian experts.

The first ring road around Budapest was constructed in 1942. The ring road of today has a much wider circle around Budapest, as the town has grown.

The ring road should function as a:

- connecting road
- take away traffic from Budapest city centre.
- create links between Budapest and the surroundings.

The plans for creating Duna-Ipoly National Park was started in 1991, in order to protect the Danube river and it tributaries. The uniqueness of the Duna-Ipoly National Park comes from the interaction among three different landscape forms, lowland, river valleys and mountains.

9. Contributions from IENE member countries

Summary of the IENE and COST 341 activities in different countries

Habitat fragmentation due to transportation infrastructure in Austria. Current research, problems, guidelines, and publications - a short overview.

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1. Splitting of competence and responsibility

For governmental authorities in Austria, it is difficult to realize their general responsibility for habitat fragmentation caused by transportation infrastructure, because competences of ministries are quite splitted (different competences for streets, railways, waterways, and environment). Concerning COST 341, no joint financing could be found for preparing the national report. It is easier to succeed with special demands in single projects (even with high money requirements) than to obtain a (small) common budget of federal and provincial institutions.

2. Recent initiatives

Recently, the ministry for economic affairs took the initiative and is financing two studies to assess the current situation concerning wildlife and trunk roads in Austria (e.g. KYEK 1998, VÖLK and GLITZNER 1998; short information about large carnivores and ungulates will be presented). An Austrian working group has developed a guideline "game protection" (Forschungsgesellschaft für das Verkehrs- und Strassenwesen, 1997). Besides some data about fences and reflectors, it determined basic standards for wildlife passageways (non-compulsory recommendations). Actually another working group is developing a guideline concerning roads and protection of amphibians.

3. Environmental Impact Assessment

Environmental Impact Assessment is obligatory in Austria since 1994, but only for greater projects (details see VÖLK 1998, report of IENE meeting Brig/CH). Information about this procedure is available e.g. in UMWELTBUNDESAMT (Guideline 1994 and Checklist 1998).

4. Forests as "wildlife corridors"

The Austrian Federal Ministry for Economic Affairs recently defined the "Design of the road network in the Danube-European region with special reference to Austria's role as a business location" to adapt the Austrian road network to a Pan-European solution (BUNDESMINISTERIUM FÜR WIRTSCHAFT-LICHE ANGELEGENHEITEN, BUNDESSTRASSENVERWALTUNG 1999). So we know that the highest proportion of road planning probably will be in eastern Austria.

In this region, there are large areas without greater forests. But we have only little knowledge about traditional and potential migration routes of big game between these forest-"islands". More and better data about wildlife corridors are necessary. As a first step of analysis, we produced a map surrounding the forests with a buffer zone of 500 m (see map, yellow zone). If the distances between forests are higher than one kilometre (showing already white zones), we argue that "connectivity" for many big game species is not very good, even if there are no additional barriers, e.g. by settlements, railways and streets. Based on this map, we will select and analyse corridors with shortest distances between forests to identify actual and potential game corridors. Aim of this study is to preserve and - if necessary - to restore potential migration corridors in and through Austria.

Some reports and maps about game distribution (ungulates) and migration routes (large carnivores) enable us to determine still existing main corridors for big game (ONDERSCHEKA et al. 1993, GRUBER 1994, STEINER 1995, HOLZMANN 1995, PFEIFER/ASTE 1996, ZEDROSSER 1996, RAUER/GUTLEB 1997). Andreas ZEDROSSER subsequently will give an overview about large carnivores and Irene GLITZNER will present preliminary results about red deer. Interpretation of these data and information allow us to localize the most important areas, where barriers due to transportation infrastructure has to stay "permeable" (see VÖLK/GLITZNER 1998 and our poster-presentations at this meeting). Outside of the alpine region forested migration corridors became already rare. Especially for north-south migrations (e.g. between bavarian/czech/ slovakian forests and the Austrian alpine region), cover possibilities for big game when crossing the extended Austrian farmlands is very poor (see map: white areas). And we will try to prioritize, where linkages between forests have to be restored or improved (by afforestations, hedges, wind breaks, etc.; see map) for ensuring also big game mobility.

One of the most delicate questions is: What will be enough permeability of barriers for larger terrestrial game species? How many passageways are necessary between isolated game habitat islands? If there would remain only one connection for such game between separated subpopulations (e.g. a wide bridge situated in a forest, or at least with good cover possibilities on both sides) - is that enough, or do we need more? Suggestions concerning these targets are very welcome!

5. Reports, publications, guidelines in Austria

ARBEITSGEMEINSCHAFT BRAUNB? R LIFE (Hrsg.), 1997: Managementplan für Braunbären in Österreich. Wildbiologische Gesellschaft München e.V. 157 pp.

BUNDESMINISTERIUM FÜR UMWELT, JUGEND UND FAMILIE, 1994: UVE-Leitfaden. Eine Information zur Umweltverträglichkeitserklärung. Wien.

BUNDESMINISTERIUM FÜR WIRTSCHAFTLICHE ANGELEGENHEITEN, BUNDESSTRASSENVERWALTUNG (ed.), 1999: GSD - Die Gestaltung des Strassennetzes im Donaueuropäischen Raum unter besonderer Beachtung des Wirtschaftsstandortes Österreich. 34 pp.

CORSI, F., SINIBALDI, I., BOITANI, L., 1998: Large carnivores conservation areas in Europe: a summary of the Final Report. Istituto Ecologia Applicata and WWF. Roma. 28pp + maps.

FORSCHUNGSGESELLSCHAFT FÜR DAS VERKEHRS- UND STRASSENWESEN (Hrsg.), 1997: Richtlinie Strassenplanung RVS 3.01 - Umweltschutz, Wildschutz. 9 pp.

GLITZNER, I., GROSSAUER, F., RAMSKOGLER, K., 1998: Wildbiologische Begutachtung B 78 Obdacher Strasse Abschnitt Zeltweg - Weisskirchen. Auftrag der Steiermärkischen Landesregierung Fachabteilung 2 a. 42 pp.

GRUBER, F., 1994: Die Veränderung von Rotwild- und Gamswildverbreitung und der Abschusstendenzen von 1983 - 1993. Forstschutz aktuell Nr. 15 (September 1994), FBVA-Wien: 6 - 9.

HOLZMANN, H., 1995: Leithagebirge - Donauauen - Karpathen. St. Hubertus, Heft 4: 12 - 14.

KYEK, M., 1998a: Prioritätenreihung der Amphibienwanderstrecken an Bundesstrassen, Schnellstrassen und Autobahnen: Endbericht. Bericht im Auftrag des Bundesministeriums für wirtschaftliche Angelegenheiten: 105 pp. + Datenband.

KYEK, M., 1998b: Amphibienschutz an Strassen - Empfehlungen für den Strassenbau unter besonderer Berücksichtigung des Neubaus von Strassen. Bericht im Auftrag des Bundesministeriums für wirtschaftliche Angelegenheiten. 32 pp.

ONDERSCHEKA, K., REIMOSER, F., VÖLK, F., 1993: Wildäkologische Raumplanung für das Land Salzburg und Richtlinien für das Schalenwildmanagement. Grundlagenstudie im Auftrag der Salzburger Landesregierung. Forschungsinstitut für Wildtierkunde und ökologie der VeterinŠrmedizinischen Universität Wien. 277 pp + annex.

PFEIFER, M., ASTE, C., 1996: Zerschnittene Lebensräume. Barrierewirkung von Autobahnen und Schnellstrassen für Wildtiere, Leitart Rotwild. Politikum. Josef Krainer Haus Schriften 16 (70): 63 -68.

POZAREK, W., 1996: Umweltverträglichkeitsprüfung in Österreich. Vorgangsweise und Methodik am Beispiel Hochleistungsstrecke. Forschungsarbeiten aus dem Eisenbahnwesen, Band 8. Bundesministerium für äffentliche Wirtschaft und Verkehr. Wien. 75 pp.

RAUER, G., GUTLEB, B., 1997: Der Braunbär in Österreich. Umweltbundesamt Wien. Monographien, Band 88. Wien. 64 pp.

STEINER, E., 1995: Die Rückkehr des Elches (*Alces alces* L.) nach Österreich - Chronologie der Ereignisse. Stapfia 37: 255-267.

UMWELTBUNDESAMT (ed.), 1994: UVE-Leitfaden. Eine Information zur Umweltverträglichkeitserklärung für Projektwerber, Planer und die interessierte Öffentlichkeit. Bundesministerium für Umwelt, Jugend und Familie. Wien. 85 pp.

UMWELTBUNDESAMT (ed.), 1998: CHECKLISTE für Umweltverträglichkeitserklärungen. Berichte Nr. BE 127. Bundesministerium für Umwelt, Jugend und Familie. Wien. 17 pp.

VÖLK, F., 1998: Infrastructure and game: The Austrian situation. In: INFRA ECO NETWORK EUROPE (1998): 4th IENE meeting, Brig, Switzerland (22 - 26 April 1998). Report of the meeting. Presentations of the participants. Ministry of Transport, Public Works and Water Management, Directorate-General for Public Works and Water Management, Road and Hydraulic Engineering Division, The Netherlands: 61-63.

VÖLK, F., GLITZNER, I., 1998: Kostenreduktion bei Grünbrücken durch rationellen Einsatz. 1. Zwischenbericht. Auftrag des Österreichischen Bundesministeriums für wirtschaftliche Angelegenheiten. 31 pp.

VÖLK, F., GLITZNER, I., 1998 (in press): Assessment of barrier effects on red deer due to motorways in Austria. First steps at assessing the permeability of 1990 km fenced motorways. In: Routes et Faune Sauvage. 3 èmes rencontres (30 septembre - 2 octobre 1998), Strasbourg. (1 p. Résumé and 3 pp. notice)

VÖLK, F., GLITZNER, I., ZEILER, H., REISS-ENZ, V., 1998: Wildwechsel trotz gezäunter Autobahnen. Österreichs Weidwerk, Heft 1: 14 - 16.

ZEDROSSER, A., 1996: Der Wolf *(Canis lupus)* in Österreich. Historische Entwicklung und Zukunftsaussichten. Forschungsinstitut WWF Österreich. Studie 25. Wien. 38 pp.

Map of Austria

Poster

Habitat fragmentation and infrastructure in Flanders (Belgium): state of the art 1998-99

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1. Geographical orientation

Belgium is a federal state and matters such as infrastructure and environment are the competence of the three different regions (see map below). The policy as well as the legislation concerning infrastructure and environment is different between the three regions.

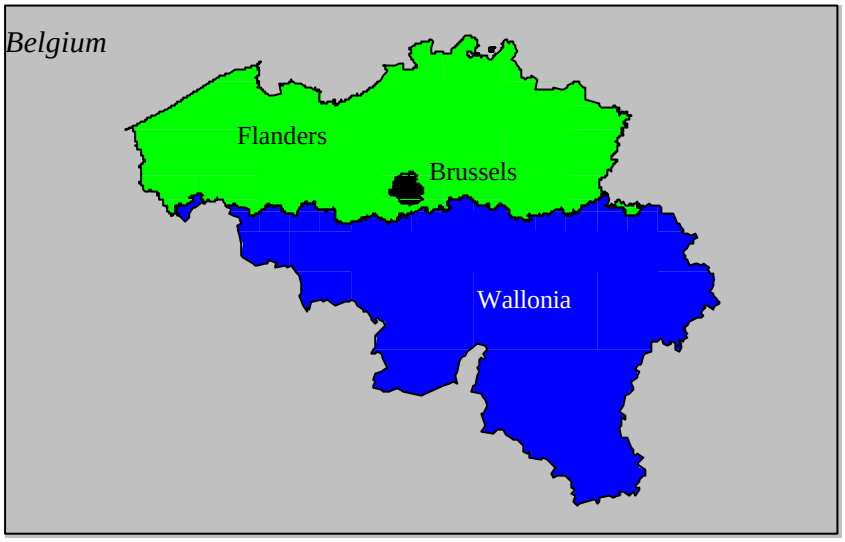

Figure 1: The federal state Belgium, with the three regions Flanders, Brussels and Wallonia.

For this moment the delegation for the IENE (and also COST 341) is represented only by the Flemish part of Belgium, there is no representative for Brussels and Wallonia. In the near future it is the purpose to look for representatives of those 2 regions, to make it possible to give an overview for Belgium concerning the habitat fragmentation due to infrastructure (COST 341).

The aim of this document is to give a global overview about the situation of habitat fragmentation (research, actions, defragmentation projects,…) in Flanders. The next topics will be discussed:

- Current state of fragmentation
- Legislative framework (policy)
- On-going research
- Involved institutions/organisations

Current state of fragmentation

Since 1996 a report of environment is made by the Flemish Government. The first report of environment was published in 1996 (MIRA1) with a regular periodicity of 3 years. Next to this 'state of the environment'-reports, a thematic report is published every year. One of the chapters in MIRA deals with fragmentation. The scope of fragmentation in MIRA is approached rather broad and focuses on landscape characteristics (structure, pattern, open space,…). Habitat fragmentation is not yet included in this study.

In the yearly thematic reports of MIRA, the definition of macro and micro indicators was the main aim for the chapter concerning fragmentation. For defining those indicators 2 strategies were used:

Macro strategy
Basic data that are used are satellite images. Defining these macro indicators is relevant for monitoring of fragmentation of the country on regional level. Three macro indicators for fragmentation are distinguished: Open space, green space and agrarian space. Also the identification of functional and/or morphological causes are described, namely urbanisation, infrastructure and destination planning.

Micro strategy
The determination of micro indicators is done by sampling. Important to know is that those micro indicators must be able to give a description of spatial differences of fragmentation in Flanders. Another important aspect of the micro indicators is that they must be transparent quantitative indicators where consistency and relevance can be determined using detailed terrain information. The most important indicators for Flanders are: Intersection by infrastructure, fragmentation and boarder effects.

Until now, fragmentation is only described in terms of landscape structure, not specifically on e.g. habitat fragmentation. In future reports of MIRA, habitat fragmentation will be discussed. A preliminary approach is further discussed.

Flanders has a very dense road infrastructure and strong urbanisation. Open space is very spare and the new Master land use plan deals with a/o a sustainable conservation of open space in Flanders. Most important users ('social sectors') of open space are agriculture, nature conservation and recreation. As shown in Figure 2, road infrastructure has an important pressure on open space, next to urbanisation. In the next years, specific research should be dedicated to the impact of this dense infrastructure on open space and its 'users' (such as nature conservation or habitat fragmentation). As already mentioned in earlier reports for IENE, research and measures concerning habitat fragmentation are sparse in Flanders, but recently some initiatives are encouraging (see further).

2. Legislative framework (policy)

Next to the MIRA-reports, which are an inventory of the state of the environment of Flanders, there is environmental policy planning, the so-called MINA-plan that covers the period 1998 – 2002. Different themes (more or less the same as in MIRA) are distinguished in this plan and fragmentation is one of them. For each theme several actions are proposed. There is also a financial support for each described action, some of the are binding.

The objectives in this plan for the theme fragmentation are:
- Limitation of future fragmentation due to infrastructure and urbanisation
- Decrease of actual fragmentation by defragmentation projects
- Mitigation measures and compensation

To reach the aims for this theme 5 different topics are distinguished:
- Attitude change (awareness) of politicians, decision-makers, general public
- Precautionary policy
- Defragmentation projects
- Strengthening of the existing ecological infrastructure
- Scientific research concerning fragmentation

Attitude change of politicians, decision-makers and general public

The basic criteria for this topic are:
- Filling up urbanised areas
- Bundling new infrastructure with existing infrastructure

- Fitting in buildings and infrastructure in the landscape
- Using all possibilities for solving fragmentation

Precautionary policy

Instruments and a frame of reference are needed for the evaluation of potential effects of fragmentation. Environmental/town and country planning (ARHOM, Ministry of the Flemish community) is one of the instruments which has an essential role in the precautionary policy. Within the planning three elements are very important:

- Development of a spatial master plan for Flanders
- Conservation (development of open space)
- Concentration of living and working

If one wants to use the instruments of spatial planning for the precaution of fragmentation, guidelines are necessary. Next to spatial planning, other instruments could establish a precautionary policy:

- Fragmentation should be included in the procedure for a construction permit :
- Fragmentation should be integrated in the guidelines for environmental impact assessment.

Another important instrument of precautionary policy is strategic environmental assessment (SEA). Although SEA has not yet a legal basis in Flanders, some pilot studies have been carried out. During 1997 and 1998, two preliminary road corridor assessments were assessed using vulnerability maps, a/o habitat fragmentation. The methodology of the vulnerability approach is described in the report of the 3rd IENE meeting in Vladimir.
During 1999, the Flemish government will publish a Mobility Master Plan for Flanders, based upon the Spatial Master Plan. As a pilot study, an informal SEA (on the level of Flanders as a region) will guide this mobility plan, and will be executed by different universities and institutes in Flanders.

Strengthening of the existing ecological infrastructure

For having a successful strengthening of the existing ecological infrastructure two basic elements are important:

- Stimulation of co-operation between private organisations (concerning nature conservation and nature management) and government
- Go along with local projects or initiatives

Strengthening of the infrastructure by the government can be done by landuse planning. This instrument offers the possibility to develop a multifunctional (multi-sectoral) vision for an area.

An inventory of the elements of the landscape and the development of a vision about those elements are important to become a coherent and functioning ecological infrastructure. In 1999 the ecological network of Flanders should be defined (geographically), and should becoming part of the Spatial Master Plan (on a legal base).

Scientific research concerning fragmentation

The knowledge about habitat fragmentation in Flanders is very limited. Few data is available about references and standards or conditions concerning fragmentation. There is a need for supplemental research and monitoring on habitat fragmentation and vulnerable species (a/o Red lists) in Flanders. The results of this monitoring will form the frame for developing vulnerability maps and other nature policy instruments.

Results of the MINA-plan concerning habitat fragmentation

1. The above mentioned actions in the MINA-plan have already led to some results with significant importance to habitat fragmentation. Four years ago, a special unit 'Ecological Engineering' was set up within the Flemish Environmental Administration (within the General Environment and Nature Policy Division). The tasks of this unit are to work out nature-friendly solutions for the construction, design and management of road infrastructure (motor/railway/waterway) and to develop guidelines for ecological engineering. At this moment, this unit is staffed with five civil servants. This unit has published two important handbooks concerning nature-friendly techniques of road design and habitat defragmentation measures (as well as for watercourses as roads). These handbooks will be translated in English and French and will therefore be useful for IENE and COST341. Next to this, a small unit within the road administration is ordered to assist the design and management of road infrastructure concerning ecology and nature conservation (since 1998, three headed staff: biologist, landscape architect and administrator). This looks minimal, but it is a start. Both units have worked out and manage defragmentation projects in the period of 1998-1999 (on-going or planned projects), summarised in Table 1.

Table 1:

Target group	location	Project characteristics	status
Badger	Agricultural re-allotment projects (Kolmant)	3 badger tunnels and guiding fences	E
	Road N79 (St. Truiden-Tongeren	2 badger tunnels, 1 tunnel adaptation and guiding fences	
		20 km guiding fences and tunnel adaptations	E
	Motorway E313	8 km guiding fences and tunnel adaptations	IE
	Railway Tongeren-Luik-Visée-Lontzen	fauna exit ladders along 15 km	IE
	Albert channel		IE
Deer	Channel Kwaadmechelen-Dessel	fauna exit ladders	E
	Bisection of the Nature reserve De Teut by E314	Tunnel adaptation (3x5m) and guiding fences	IE
	Bisection of Nature reserve Genk-Kwaadmechelen E314	Ecoduct and tunnel adaptations and new ecotunnels, guiding fences	P
	E19 motorway Antwerp-Breda and High Speed Train - Peerdsbos (forest area)	Tunnel adaptations and new ecotunnels	P
Fish	River Scheldt (Bovenschelde)	Special fish passages (fish ladders)	IE
Amphibians	Local authority Enamebos (Oudenaarde) Genk (Houthalen-Helchteren) Tervuren (Zoniënwoud) St. Pietersleeuw Bilzen Regional authority N223 (Tielt-Wingene) N437 (Kruishoutem)	Special tunnels for amphibians (see Figure 3)	E

Status: P: planned; IE: in execution; E: executed

As illustrated in Table 1, quite some investigations concerns guiding fences along as well as motorways as railways (special attention was put in the 'badger region' of Flanders). The badger population is estimated to about 250-300 individuals and each year more the 30 dead badgers are registered as traffic casualties. Next, an ecoduct project is planned to defragmentate the large and important heathland ecosystem (5000 ha of heathland and pine forest) that is bisected by the E314 (Genk-Kwaadmechelen). Preliminary feasibility studies are already carried out and proposed several tunnel adaptations (of existing tunnels), new
Table 1: Defragmentation projects in Flanders (executed, in execution or planned in 1999).
ecotunnels (about 6) and two ecoducts (50-75 m wide and 65 m long) to be effective and along a total distance of 12 km (which will be fenced). The estimated cost of this project is about 500.000 EURO.

Fauna exit ladders are another effective measure for different mammal species, particularly badgers and deers. Figure 3 illustrates the used fauna exit ladders on the Albert channel.

1. A formal regulation concerning strategic environmental assessment is expected this or next year, following the European Commission's Proposal on the assessment of the effects of certain plans and programmes on the environment (COM(96), 511 final).

2. Applied scientific research concerning habitat fragmentation is stimulated by a 'Flemish Impuls Program of Nature Development' and by some individual projects funding by the Minister of Public Works (Infrastructure); The most important projects are further discussed.

4. On-going scientific research concerning habitat fragmentation

At this moment, the following scientific research programs are going on concerning habitat fragmentation and related topics:

Flemish Impulse Program Nature Development

Two research projects granted by the Flemish government concern the impact of habitat fragmentation:

a) Development and assessment of ecosystem vulnerability maps concerning biotope loss and barrier impact (3 years) for Flanders, Participant: Institute of Nature Conservation

Methodology-content
- working with available baseline data
- spatial vulnerability = sensitivity of cartographic object + valuation (nature conservation)
- 2 basic ecological data layers :
  - species distribution (1x1 km) (see figure)
  - biotope information (biological valuation map, see further - 1/25000)
- vulnerability map gives spatial overview of the bottlenecks
- vulnerability analysis evaluates the potential environmental impact of different location alternatives within one transport modus

a) *Evaluation of the corridor function of landscape elements using connectivity models*

Participants: University of Antwerp, University of Leuven, Institute of Nature Conservation

Objectives
- quantification of the relationships between mobility of several animal species and relevant structural landscape features;
- construction of a predictive connectivity model including sensitivity analysis;

- testing the resulting models for their applicability by analysing actual scenarios for landscape planning.

Effects of habitat fragmentation on animal population dynamics: University of Antwerp, Department of Biology

Several research projects concerning bird species, squirrels, Butterflies, Roe (deer) and habitat fragmentation are on-going.

Specific policy supporting research projects

a) Fish passages on the river Scheldt

In a decision made in 1996 by the governments of the Benelux, free migration of fish species in all hydrographical basins is guaranteed by 1 January 2010. Therefore the required space for constructing a fish passage is provided together with the renewal of the barrages on the Bovenschelde at Asper (see Figure 4), Oudenaarde and Kerkhove. On the basis of literature, it appears that only V-shaped weir and a bypass channel generate flow conditions in the fish passage that allow fish to migrate. However literature provides not enough knowledge about the location of the entrance of the fish passage in relation to the turbulent zone of the weir outflow. A hydraulic model was constructed (1/10) of the new weirs and the downstream part of the weir channel. By the Institute of Forestry and Game Management, fish of four different species were put in this scale model and their behaviour war surveyed during weeks.

b) Localisation of fauna-barrier impact due to the existing motorways (see below) as basic information for defragmentation projects in Flanders

During 1998 and the beginning of 1999, the Institute of Nature Conservation and University of Antwerp have elaborated special 'habitat fragmentation maps' due to transport infrastructure, by order of the ministry of public works. In a first phase, indication maps of potential habitat fragmentation were derived from existing ecological baseline information on a regional level (Flanders). Integrated biological information is brought together to define 'large cartographic units with important ecological value and relations'. Those areas are overlaid with major road maps to designate potential bottlenecks concerning habitat fragmentation. These preliminary maps are starting documents (indicator maps) for further research as well as to define priorities for further policy actions and initiatives (a/o defragmentation projects). An example of such applications of these maps is the intention of a defragmentation project of the E40 coast highway, especially concerning the intersections of ecologically valuable watercourses.

Next to these indicator maps (worked out for the whole of Flanders), specific habitat maps are obtained by translating the biotope typology from the Biological valuation map and the Ecological river typology map to habitat suitability maps for specific animals or animal groups. Together with the existing knowledge about the distribution of animal species, bottlenecks about (potential) fauna barrier can be located.

Methodology

- Definition of relevant mammalians and amphibians (habitat characteristics, home range);
- Translation of ecological information to habitat characteristics;
- Inventory of distribution of the selected species;
- Localisation of the barrier bottlenecks by confrontation of the distribution and habitat maps with the existing motorways;
- Setting up priorities for defragmentation projects.

These projects resulted in two different indication maps for (potential) habitat fragmentation:
- fragmentation on habitat level (splitting large ecosystems);
- potential barrier impact maps to specific animal species - populations.

Directory of institutions/organisations involved

- Institute of Nature Conservation
- Institute of Forest and Game Management
- University of Antwerp, Leuven, Gent and Brussels
- Administration of environment, nature, land and water management (Ministry of the Flemish Government)
- Road administration (Ministry of the Flemish Government)

Existing activities, ongoing and planned projects concerning habitat fragmentation in Czech republic

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1. Legislative framework

Environmental Impact Assessment, Strategic Environmental Assessment
For planned transport infrastructure, the Law 244/92 Coll. is valid. The annex of this law introduce construction parameters where is duty to introduce EIA process. In the field of transport, all constructions and fundamental re-constructions of highways, roads, rails, airports and waterways must pass through the EIA procedure.

Brief characteristic of EIA procedure:

1. 1. EIA documentation
- basic data
- data on inputs (consumption of water, land use, energy)
- data on outputs (point, square and line pollution sources, emissions from stationary and mobile sources)
- description of varieties
- environment description (geology, geomorphology, geography, hydrogeology, ground and surface water, flora and fauna)
- supposed impacts description
- proposal of measures, monitoring, final point of view

2. EIA review, which evaluates
- completeness of data, presented in documentation
- correctness of all impacts assessment
- review of maps etc.

1.3. Public discussion - in public discussion following partners and invited, after submitting written expression:
- investor (Directory of Roads and Highways), authors of documentation and review
- civil initiatives (more than 500 persons) that have one deputy at discussions
- interested communities (towns, villages) through its authorities

1.4. Final conclusion of competent authority
- Ministry of Environment
- District authorities

Biological valuation according to Law No. 114/92, out of EIA and SEA processes

Authority of nature protection can order biological valuation also in the case when any construction does not have size and parameters for EIA procedure. The content is similar to EIA documentation:
- varieties description
- environment description
- supposed impacts description
- proposal of measures, monitoring, final point of view.

At present the novel of the Lav No. 244/92 Coll. on environmental impact assessment involving the assessment of intentions (EIA), conceptions (SEA) a transboundary assessment (ESPOO).

2. Role of interested institutions in connection with habitat fragmentation and infrastructure

Ministry of Transport

- management of transport sector,
- transport infrastructure planning
- creating and editing laws concerning transport sector
- EU legal harmonisation in the field of transport
- transformation of Czech railways
- financing of construction and maintenance of transport networks
- financing and management of transport research

Ministry of Environment

- management of environment sector,
- creating and editing laws concerning environment
- EU legal harmonisation in the field of environment
- financing of environmental programs, projects and research

Transport Research Centre

- research habitat fragmentation problematic
- co-ordination of Czech activities in this field
- co-operation with "biologic" organisations: Agency of Nature and Landscape Protection, Department of Environmental Chemistry and Eco-toxicology

Department of Environmental Chemistry and Eco-toxicology, Faculty of Science, Masaryk University

- research habitat fragmentation problematic diversity and activity of choice communities in terrestrial ecosystems stressed by heterogeneous environmental mixtures of persistent organic pollutants (POPs) and heavy metals

Directory of Highways and Roads

- investor responsible for the construction of approved transport road network (quality and finance
- responsible for maintenance of present road network (in the frame of financial possibilities)
- investor of fauna passages construction or reconstruction

Czech Railways

- investor responsible for the modernisation of rail corridors: which should make more attractive rail transport in the opposite of road transport (more travel comfort, increased speed to 160 km/hour)
- should be investor of fauna passages construction

Agency of Nature Protection

- co-operator at solving the projects concerning habitat fragmentation, especially in the field of existing highway passages analysis from the view of slot analysis, etc.

3. Existing corridors and fauna passages

To 1992 year no fauna passages are constructed in my country. From 1992 year the bio-corridors are constructed from time to time on the base of district authority decision. Every district authority has a department of environment that proposes places (laps) and dimensions of fauna corridors. The quality of proposals depends on the quality of EIA documentation.

It is possible to say that current highways that are still not constructed completely are enough passes usable for small and middle fauna. I introduce the overview of corridors in 1 newly constructed motorway and 1 planned motorway.

3.1. Newly constructed motorway "Olomouc - Lipnik n. Becvou"
3.2. Planned motorway D8 Prague - Dèín. The direction of this motorway is across significant protected landscape area "Ceské Stedohoí".

4. The overview of Czech related existing projects and results

Two projects are going on in my country.

1. "Impact of habitat fragmentation caused by transport infrastructure on the biodiversity"

First part is the identification of conflict points. Now we are collecting the data, because of conflict points identification. Maps of networks, forests, protected elements, watercourses and area systems of ecological stability are the first data. Other significant document is Atlas of the mammals in the Czech Republic, where the occurrence of selected mammals including rare species is described. Further we ensure, through hunting statistic, numbers of all monitored species in firstly identified crossing between infrastructure and protected elements. Unfortunately the maps are still not available because of software problems that should be solute in the nearest future. Foremost we are aimed to main Czech highway Brno - Prague (D1). The points of intersection are determined with a help of maps; road killed fauna statistic and hunting statistic.

These points will be further assessed from the view of transport intensity, concerned emissions and noise and also of possibility of highway bridges utilisation as fauna passages (existed highways). Other procedure depends on the possibility to use current corridors or the necessity to construct new passages.

2. Evaluation of Passage Possibilities for Big Mammals in the Motorway Net of the Czech Republic

At first stage all D1 highway is evaluated and other main roads D2, D3

Assessment Methodology of highway bridges utilisation as fauna passages"

A: Recognition of all contemporary bridges and corridors

The system of 3 categories was set:

1. Objects pervious for animals size to fox, badger and otter
2. Objects pervious for animals size to red deer
3. Objects pervious for animals size to elk, deer, lynx, etc..

Every category was divided to 3 sub-categories: passed fully, partly and hardly.

B: Used criteria:

1. Bridge size: width and height
2. Under-bridge character
3. Surrounding landscape character, *connection with wildlife areas (out-urban areas are often surrounded by city* estate)

4. Current usage by animals: this is very complicate to monitor. From 169 objects, which are mentioned in database survey, in one half the usage was assessed by slot study. This study will be exacted after receiving detailed hunting statistic.

C: Comparison with over-regional bio-corridors of ecological stability area systems (USES system)

The D1 intersects 11 over-regional bio-corridors, but 9 of them is quite non-passable, 1 partly and 1 fully passable. Over - regional bio-corridors in present time can not serve as migration routes for big mammals. The results are the maps of fauna passage with identification of problem and non-problem segments of D1.

Conclusion: I would like to draw you the attention for the problem, which is according to my opinion not sufficiently considered. At the highway construction in the Czech Republic highways were constructed parallel and nearby original roads. Original roads, however, are constantly used, by motorised road transport. The consequence is present state: parallel direction of new highway and old road. The barrier effect is significantly increased. That is why, the part of our research will be the study of "double road" and proposal of measures: for example to restrict the traffic in parallel, old roads and to promote its usage for non-motorised transport (cycling).

Existing database: available is a database of 169 objects on highway D1 and 39 objects on D2. Every objects is described by following data:

1. Evidence number
2. Communication
3. Lap (km)
4. Habitat
5. Height
6. Width
7. Depth
8. Description of object
9. Outline
10. Under-bridge description
11. Vegetation
12. Watercourse, if any:
13. Width
14. Shore character
15. Pass assessment
16. Proposal of measures
17. Note
18. Date and responsible person

These data will be further added by traffic intensity (passenger and freight road transport), and emission and noise characteristic.

Tabell Objects

INPUT FROM THE 3rd MEETING «ROADS AND WILDLIFE, 30 Sept to 2 Oct 1998 - Council of Europe - Strasbourg - France

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State-of-the-art

The erosion of biodiversity, due mainly too human activities, has given rise to a mobilization of scientific research, because the habitat fragmentation process is considered as a possible cause of the extinction crisis looming ahead.

Habitat fragmentation results in:
- a reduction in areas available for use by organisms,
- an increase in the distances between their habitats,
- the disappearance of landscape elements conducive to dispersion (corridors),
- the existence of barriers such as roads and canals.

Fragmentation results in a cascade of impacts on local populations: loss of specific biodiversity, population deficit, extinction risk in the absence of rescue effects normally generated by migratory movements.

Conservation biology seeks to study these phenomena and the implementation of restoration, management and rehabilitation strategies.

There are several spatially-dispersed population systems:
- populations similar in size with the same extinction probabilities (Levins 1969),
- a source population sustaining satellite populations liable to extinction (Boorman and Levitt's "core-satellite" model, 1973,
- the archipelago model between sub-populations of the same size,
- metapopulations in desequilibrium through a lack of colonization,
- hybrid systems associating several of the previous models,
- source/sink systems.

These systems do not have the same biological meaning. A better knowledge of the way they work will provide an answer to some basic questions:
- What is the minimum area required for a metapopulation persisting?
- What are the effects necessary for the survival of a metapopulation (MVP concept - Minimum Viable Population)?
- What are the effects necessary to maintain genetic variability?
- What species - grouped into metapopulations - offer the greatest resistance (or susceptibility) to different degrees of fragmentation?
- For the same surface area, is a single large habitat better than several small habitats (SLOSS problematics - Single Large Or Several Small)?

Models are being introduced, which will soon enable the future of species and communities to be predicted with reference to different space pattern scenarios (c.f. G. Pain) and there is no lack of practical space redevelopment solutions (G. Désiré and Ph. Clergeau on corridors, C. Cibien on barriers, G. Pain on landscape ecology, C. Verheyden on biodiversity and the ecological functioning of green motorway ancillaries).

Debate on SLOSS and MVP, the construction of a sound theory on metapopulations and debate on sustainable development must not be a pretext for inaction (precautionary principle).

It is now an accepted fact that a study of the functioning of ecological systems integrates two basic parameters: habitat heterogeneity and temporal dynamics (space-time). Thus over the past ten years, the concept of landscape ecology has gradually become an essential consideration in the study on management, conservation and restoration of spaces and species.

At the landscape level, corridors, their characteristics (width, spatial connexity) and biological processes (barrier effects, source habitat, sink, etc.) are more interesting than concepts of status or heritage value. These parameters[2] are increasingly being successfully studied in impact studies and are assuming as much importance as habitat density or quality.

In road projects, this discipline justifies development choices or guides protection measures in cases where the lack of an emblematic species shows the limits of the conventional heritage approach. This promising new approach is being successfully used on projects such as the A84 "Estuaries" motorway, the A4 ecological restoration of the Saverne Pass, the RN 83 Colmar-Sélestat link. It implies the use of an overall planning logic over the longer term (sustainable development) and forms a natural part of the entire road project consultation procedure, which is consistent with the principles of continuity and progressivity.

In these analysis systems, the viability of animal populations depends on the extent of the favourable habitats and their spatial and temporal organization, without losing sight of the fact that the home range of an individual includes functional areas of different types:

- feeding grounds (ungulate food patches, hunting grounds)
- breeding grounds
- growing areas (ponds for amphibians)
- wintering grounds

Movements (seasonal or daily migrations) enable zoological groups to reach favourable functional areas but these groups do not all necessarily use the same movement strategies. Amphibians migrate in order to:

- look for wintering sites ⎫ Adults
- look for breeding sites ⎭
- migrate towards growing habitats ⎫ Juveniles
- colonize new sites ⎭

Amphibians usually group themselves into metapopulations and form small clusters of breeding stock dispersed in expanses of water. The small numbers are offset by immigration movements (which support a momentary population depression) or dispersion-habitat recolonization movements. This system may be disturbed by infrastructure-generated fragmentation as regards the biological cycle (need to maintain habitats that are favourable in terms of quality and surface area) and the way it works (need to maintain migration and dispersion possibilities). The infrastructure may prevent movement (barrier) and act as a population sink for species in movement when a heavily trafficked road results in high mortality.

Research has shown that movements of tailed amphibians are guided both by the magnetic field and by chemical stimulants (olfactory guidance). This orientation system requires a straight pathway and shows that connexity can only be ensured or restored by a corridor of hedges or ditches, as is the case with mammals or insects[3]. In order to develop remedial measures for the imposed disruption in connexity between habitats, the ethological characteristics of amphibians must be taken into account.

The consequences of their orientation methods require the following measures:
- The most efficient connection between the pond and the terrestrial habitat must be the shortest straight path
- Large toad tunnels are inefficient (too long)
- To enable them to get their bearings by olfactory stimulation, large diameters or cross-sections must be the objective.

[2] Dynamics of metapopulations, network theory, corridor movements, biological transition areas (connexity)
[3] Amphibians use hedges as a habitat and not as a corridor

The special ethology of batrachians challenges the universal character of the corridor and works in favour of other connexity models such as the permeable habitat sector.

The fragmentation of populations may also have a genetic impact. Reductions in numbers of a population cause a reduction in the diversity of its constituent genotypes. When the new populations derive from a small number of individuals[4], genetic diversity is very limited. Populations lose local adaptive traits and may even have to overcome a general deficiency in the quality of individuals. The recent development of genome analysis methods opens up new prospects in this field of investigation, particularly with the work of Hartl who indicates that in the Vosges, there is a genetic differentiation of the distinct population of deer separated by the A4 motorway. Genomic recombinations due to the practice of selective screening are exacerbated here by the motorway barrier. The consequences of habitat fragmentation are complex and may have contradictory effects on the genetic structure of populations. For instance, the metapopulation system is conducive to genetic variability and guarantees polymorphism. But conversely, if the introduction of a genotype formed by a specific selection system is dispersed in a different environment, it may result in local maladjustment.

Measures in favour of wildlife - a practical assessment

In France, the procedures of March 1996 are the result of 20 years' experience of road project impact studies (enriched with input from European directives and ecological observatories). State commitments are a mark of the will to carry through the measures contemplated in the impact studies. The monitoring and assessment procedure should improve know-how (experience feedback). But the result as regards wildlife is ill-defined and the environmental studies are slow and lack ambition and precision. Avoidance strategies are not priority considerations in cost-benefit analyses. Fragmentation effects do not take into account induced effects (destruction during land consolidation). Reduction measures mainly target ungulates with a high sociological value (hunting) but whose populations are not threatened. Second is the group of amphibians and there is also a recent tendency for ad hoc (but not generalized) measures in favour of some groups (bats) or species (hedgehogs, tortoises, owls, otters). Some changes are becoming apparent but logic requires development input to be primarily targeted at abundant populations whereas it is precisely the poorly represented matapopulations that are most at risk of extinction. In this logic, considerable efforts are being made in favour of large wildlife (census updating of passages in 1990) with facilities of unequal value but some interesting achievements (c.f. further ahead).

The Ministry of the Environment, by implementing service schemes, the Act on land use planning and sustainable development and the Natura 2000 network, is seeking to modify excessively sectoral approaches by giving priority to more general debate in which the territory and natural spaces are assets for economic development.

Through the collective service scheme for natural and rural spaces, the State is defining its guidelines and adjusting its own policies based on principles laid down by the scientific community:
- principle of ecological continuity
- principle of conservation of major geographic units free from perturbations (having an economic value for health, recreation, etc.)
- principle of multifunctionality of spaces and territories
- precautionary principle providing economic management of space
- principle of sustainable development which imposes a long term vision and monitoring instruments (trend indicators).

The Natura 2000 networks (European initiative) integrate these same factors of habitat continuity and population exchanges. Recent trends are gaining ground. Their success will depend on many parameters: a

[4] Francklin suggests empirically that 59 should the minimum number of individuals necessary to maintain genetic variability and that 50 should be the sufficient in number to restore genetic variability lost by drift.

social and political will to solve problems, know-how, motivation of the people in charge of implementing them. In this field, France is lagging behind compared with Dutch or Swiss practices developed during the seminar.

Role of green motorway ancillaries.

For a long time, steps have been taken at intervals to improve the ecological value of ancillaries. ASF* and CNRS** have made a three-year ecological appraisal of the functioning of ancillaries by comparing them with the transited landscapes on three sites belonging to three different biogeographic fields. The study concerns invertebrates and land vertebrates (reptiles, amphibians, birds, mammals).

The main results are as follows:
- Diversity is greater in green ancillaries than in the transited environments (for the same surface area, there are more animal species in the green ancillaries than elsewhere except for birds),

- populations in the two compartments are never the same: 68% of the species are found in both compartments,

- seasonal variations in abundance are generally synchronous in the two compartments but rarely have the same amplitude (the rights-of-way are more stable),

- there are exchanges between the different compartments.

This original research is to be paralleled with studies conducted by the National Hunting Agency on free movement areas of deer throughout the country. 1005 free movement areas have been recorded. The identified tracks show that country-wide, 6% of the tracks can no longer be used by the deer. Deer movements are threatened in 185 areas (1/8th of the areas concerned). Over the short term, exchanges will be difficult in 27 further areas (mostly because of motorways).
This national approach to fragmentation - on this scale - is a first (with the study of calm areas). It should lead to concrete proposals for conservation measures and the restoration of deer movement areas, and then it will be extended to other species (landscape defragmentation programme).

The sociologists' view

The status of the wild animal is worthy of mention. The same animal can be considered harmful and then be classified as a "protected species" (temporal variability of legal status). The status of the wild animal may also vary according to the society (deer are wild game in France, reindeer are animals domesticated by the Lapps). And what about the "wildness" of the animals that are to be "guided" towards the specific, reserved passages, along an appropriate route, lured by feeding and "attractive plant" arrangements, and sometimes unknowingly filmed. A sociologist will wonder whether we are forming a "new wild animal" generated by a long technical development. From the ethological angle, does an animal that has learned to use the passage stay the same? Doesn't the passage change the very nature of the animal, which becomes the product of incentive teaching (and what can be said of a deer that balks at using the passage?). Human sciences are examining the change in nature of the wild animal, the possibility of manipulating its behaviour....

* Autoroutes du Sud de la France (South-of-France motorway company)
** Centre National de la Recherche Scientifique (National scientific research centre)

Specific facilities

✓ Axial highways disturb the territories of **bats**, whether for returning to their summering or wintering areas or for moving nearer a hunting ground. The most tangible dangers are the segmentation of territories, mortality, disturbance (jobsite, maintenance of works hosting bat roosting sites).
Collisions chiefly occur in September and October. The Cher *Département* (county) has 16 species of bats, 11 of which are concerned by road mortalities but in varying degrees accounting for 15% of the total county-wide road toll.
Compared with other species, not many steps have been taken to provide amenities for bats and those that have, are too recent to assess their efficiency. However the following measures are recommended:
- avoid fragmenting plant corridors (hedges); restore some or all of them (bats rely on plant structures to travel),
- make green ancillaries less attractive to insects (bats are strictly insectivorous),
- avoid lighting, give preference to sodium lamps and position them as high as possible. Bats use waterways as transit routes and hunting grounds. Encourage them to pass under bridges rather than over them (risk of collisions with vehicles) by cutting back riverine vegetation,
- bats will readily use underpasses to cross motorways or green bridges (tree-covered overpasses),
- high plant structures right at the roadside induce bats to climb high enough to avoid collisions.

✓ **Terrapins** and **tortoises** do not escape fragmentation effects and collisions (particularly when they are looking for laying or dispersion grounds).
Various solutions are proposed in USA and Australia to reduce mortality and restore crossings. The sole French experience (A57) concerns the Hermann's tortoise and consists in the following operations:
- install a buried fine-mesh fence
- capture and move the tortoises found within the right-of-way (some 300), mark them and put them back into their natural surroundings
- install two "tortoise tunnels" to reconnect the territory segments.
All in all, few animals are run over (efficiency of the fencing) but few animals use the tunnels. Access to the passages is very difficult and too long for their small cross-section, with the result that tortoises will only use a covered underpass that reconnects a public way.

✓ The **otter** often travels long distances along waterways. The home range of an adult may be several tens of kilometres long; the young wander far and wide and take a long time to find a free territory; the recolonizing movements begun in several regions of France are causing otters to colonize new sectors, thereby incurring mortality risks when the animals have to leave the run of the river to cross the road.
New steps are being taken to restore the free movement of otters (the Atlantic seaboard, the Massif Central). Whatever their design, facilities for otters are regularly used to preserve the animals from risks and extend their distribution areas. Such facilities are relatively cheap but need to be well-adapted to the habits of the species.

✓ **Amphibians**. To curb the death rate of frogs, the *Department 68 (Haut Rhin)* has been pursuing two complementary lines of action since 1970:
- setting up temporary protective nets on 18 sites
- building toad tunnels - this département was the first to install this type of structure in 1983 in a difficult mountain area. Today there are three such structures in the département and the scheme is well advanced, making the *Haut Rhin* the best equipped département.
At regular points (3 sections) some roads are temporarily closed to traffic.
All these measures saved the lives of 48,000 individuals in 1998. This success is the result of volunteer work. These operations to protect amphibians are helping to raise public awareness of the need to respect natural wetlands.

IENE – Hungarian activity

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Co-ordination centre of IENE activities and COST 341: Technical and Informational Services on National Roads.
Supervisor: Ministry of Environment, Authority for Nature Conservation.
Financial background provided by Road Fund (Provision for Road Maintenance and Development).
05.1998. Hungarian declaration to join the COST 341 action by Technical and Informational Services on National Roads.
09.1998. Hungary signed the Memorandum of Understanding of "Habitat fragmentation due to linear infrastructure"
09.1998. Official start of COST 341. 09 –10. 1998. Working groups are created

Several institutions, universities are involved: such as Institute for Nature reservation, Institution of Environment, Research Institute for Soil Science, Institute of Ecology and Botany, University of Sopron, National Parks, consultant companies, individual researches.

The working groups have adapted the table of content of the State of the Art Report.

The topics of discussions in the working groups:
- characteristic Hungarian habitats
- selection of infrastructure networks
- mapping of fragmentation
- data collection

Case studies stimulated by IENE-COST 341:

- Effect of roads on the vegetation and animals in the Hortobágy alkali grassland (Dr. Tibor Tóth Research Institute for Soil Science)
- Colonisation surveys of higher plants along a 14 km long section on the shoulder of a two years old motorway M0 (Mr. Ferenc Németh)
- National database on game–traffic accidents (Ms. Orsolya Pallag Institution of Environment)
- Migration routes and possible technical solutions on old roads, National survey — methodology and preliminary results (Dr. Miklós Puky Institute of Ecology and Botany, Hungarian Academy of Sciences and Mr. Zsolt Vogel D&V Ltd.)
- The effects of traffic on birds in Hungary (Dr. Sándor Faragó University of Sopron)
- Forest ecosystems, biodiversity of Hungarian forest (Dénes Bartha University of Sopron)
- Evaluation of existing game bridges
- Landscape fragmentation (Dr Attila Csemez, University of Horticulture and Food Technology)

IENE 5th meeting 14-21. 04. 1999. Hungary, Budapest

- Open day and excursion with international and Hungarian experts
- Cost 341 Management Committee meeting
- Working groups meetings

Summary:
Activity of National Report on Habitat fragmentation in Cost 341 action, and case studies have increased the awareness to deal with and to solve the problem. For that reason more than 100 participants came together on the open day and excursion of the IENE meeting and expressed interest.

On-going activities of I.E.N.E. Italy

Prof. S. Malcevschi - EIA Commission Ministry f Environment
Dott. ssa M. Belvisi - ANPA
Dott.ssa S. Ceppi - University of Pavia

During last year I.E.N.E. Italy has carried out several activities mainly focused on:

- Construction on data-base and evaluation of first results
- Realisation of an Handbook about "linear infrastructures and habitat fragmentation"
- Initiatives on ecological network
- Dissemination of information about IENE initiative through a page on a scientific review (the last four issues) "ACER (specialised review on natural rehabilitation
- Construction of Web site IENE dedicated.

Construction of data-base

Italy is collecting all the available data about the habitat fragmentation in order to produce a database that will contain useful information and referees on this matter. Until now we are handing out questionnaires in all the meetings and the conferences connected with this that have given in this fieldwork, and we are processing all the data. In the following a summary of this results are presented.

During this first step of the enquiry following results came out: 61% of operators are involved in the public sector and 43% work in the private sector (see. Fig. 1)

Most of operators used to work on locals and regional projects, less on European projects. The National level, which includes for example highways and high-speed railways, involved 20 % of the peoples (see Fig. 2).

Fields of principals interests (see Fig. 3) more relevant for all operators are:

a) filter ecosystems along infrastructure
b) hedges along filter ecosystem
c) hedges and row of plants
d) viaducts and ecoducts for fauna

Study and research and project managing, together, are principal field of activities.
Less interest is dedicated to implementing programmes and project realisation.
We can outlines

- Habitat fragmentation study in the latium area and in the Mediterranean area for amphibian and reptiles " (Marco Bologna, Università degli studi "Roma Tre");
- Planning of interventions of restoration of landscape for a new high speed railway Milano-Bologna and planning of environmental and acustic mitigation measures for linear infrastructure (Barbara Vizzini, Aquater spa);
- Report of European community project Ecos Ouverture su "Cintura verde metropolitana"(Battisti Corrado, Provincia di Roma)
- Ministry of Industry and tourism project –"Tourism valorization project of Po river (province of Lodi"(Giovanna Fontana, Landscape Studio Association)

Principal reports produced consider planning formulation (32%) thematic maps (21%) or divulgations articles (see fig. 4)

About on-going production (see fig. 5) we can find handbook and guidelines (16%) and scientific publication, planning formulation (38%) %) e thematic maps (19%).

Handbook about "linear infrastructures and habitat fragmentation"

I.E.N.E. Italy, in co-operation with the Italian Environmental Ministry – Environmental Impact Assessment Service (Ministero dell'Ambiente – Servizio Valutazione di Impatto Ambientale) is realising a handbook about "Infrastructures and habitat fragmentation".
The steering committee is working in order to involve experts in this fieldwork, NGO's, and to collect the most interesting experiences in big and small areas with the co-operation of local administrators. This handbook will be available before the end of 1999, and will be spread to all the organisations, public administration and private subjects involved in the habitat fragmentation. It will be a handbook useful for planners and for technicians that will meet the problem of the realisation of infrastructures with the need of the fauna movements.

The handbook will contains the following topics:

LINEAR INFRASTRUCTURES AND HABITAT FRAGMENTATION

1. THE PROBLEM OF HABITAT FRAGMENTATION
1.1 Species, habitat, environmental components
1.2 Habitat, ecosystem, landscape, territory
1.3 Habitat fragmentation
1.4 Habitat fragmentation and human population
2. LINEAR INFRASTRUCTURES
2.1 Linear infrastructures
2.2 The impacts of linear infrastructures on ecological continuity
2.3 Traditional kinds of fauna passages
3. TECHNICAL SOLUTION FOR FAUNA PASSAGE
3.1 The hoofed mammals
3.2 Other mammals
3.2 The birds
3.3 The reptiles
3.4 The amphibians
3.5 The fishes and the water ecosystem
3.6 Terrestrial Invertebrates
3.7 The plants
4. ECOLOGICAL CROSSING AND SURROUNDING ENVIRONMENT
4.1 The Ecological networks
4.2 Targets of land use
4.3 Ecological networks and infrastructural networks
4.4 Technical integrated solutions
5.PRACTICABILITY ASPECTS
5.1 The management of ecological permeability
5.2 The costs
5.3 The monitoring
6.CONCLUSIONS
Enclosures: Case of study

ANPA initiatives on ecological networks
Programme presented on Brig meeting last year was structured into lines of activity founded essentially on the involvement of local organisation like Environmental Agencies in order to observe eleven study cases, located all around the national territory. Results deriving from these studies started in the 1998, represent a starting point for definition of methodological proposal actually practicable.

Four programmes are scheduled for next two years:

First, starting at present, provides for a joined study among ANPA, regional and provincial environmental Agencies and other subjects for planning methodologies of monitoring of the ecological networks. The second, to start in this year intends to carry out a study of feasibility whose aim to coatutuite a prototype of

informative system specifically conceived as a support of the planning choices which consider the safeguard of ecosystemical and landscape values. The third, planned for a next year, has as its purpose to achieve a first definition of protocols for the interventions of renaturation and restoration of natural structures and landscape. The last programme will be the conclusive transposition into guidelines of the whole work carried out during the execution of the plan. The purpose is to create a first official reference for improving ecologically the instrument of territory's management.

Figure 1-5, 2 pages.

News from the Netherlands

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National report COST 341

Till now four meetings have been held with representatives of the Road and Hydraulic Engineering Division, NS Railinfrastructure, the Ministry of Agriculture, Nature Management and Fisheries, Institute for Forestry and Nature Research, Staring Centre for Integrated Land, Soil and Water Research and Wageningen Agricultural University for the purpose of the national report of COST 341. Based on the checklist for the contents of the European State of the Art report, an overview of contributions of the concerned institutions has been made. In the beginning of May the actual writing will start. A final draft of the report with the state of the art concerning habitat fragmentation in the Netherlands will be ready by the end of October 1999.

On-going and finished research

The field study of the project road lighting and nature has entered the second phase. After determining the starting situation, 24 lampposts were placed in a nature conservation area in order to measure the breeding success of the black-tailed godwit *Limosa limosa* under illuminated circumstances. This way the influence of the lighting of the nearby highway is investigated.

Foto

After six years the project on hedgehogs has been concluded with a workshop. There were three hundred participants that listened to presentations, watched an audio-visual and could attend posters and stands about the hedgehog. It became clear that in the Netherlands about 2 hedgehogs per kilometre are killed on roads. There are indications that the density of hedgehogs in the vicinity of roads is about 30 percent lower than in similar areas without roads. The papers will be compiled into a special number of the scientific magazine Lutra (in English).

Since 1975, the Ministry of Transport, Public Works and Water Management in the Netherlands has been building fauna passages crossing under or over highways and also adapting viaducts, bridges and culverts for joint use by fauna. The use of specific fauna passages like ecoducts and badger and amphibian tunnels is relatively well-known, but with respect to adapted passages, until 1997 we knew very little about which species use them, and their frequency of use. To fill in this gap in 1997 a survey was carried out throughout the Netherlands on passageways along waterways crossing under highways, since many culverts and bridges were adapted in the nineties. One well-known and two rather new investigation methods were used. In 1998, an experimental study started to find out the optimal width of a passageway under a bridge. First at twenty sites (consisting of at most four passageways) movements of animals were recorded with adapted infrared detectors. After some weeks more detailed information of 22 passageways was obtained from footprints and tracks, left in sandbeds and on paper, fixed on both sides of an 'ink' bed on the passageway. In the second study foot print data were collected from 22 wooden passageways and 19 so-called extended banks. The target group of the footprint survey were mammals, though we collected tracks of amphibians as well. The tested investigation methods worked well, provided the (larger) underpasses were not heavily used by humans. All investigated passageways were used, but the broader they were, the more frequently they were used and the more species were found. Amphibians did not show this relationship between width and use of passageways. Extended banks seem to be most attractive: most species were found there. The experimental study will be continued in 1999.

Foto

A student has started research on the influence of habitat fragmentation due to infrastructure on human livability. He will investigate the consequences of change in landscape characteristics, a.o. biodiversity, on the use and perception of the landscape (probably forest, heathland and meadow). Another student has started research on the avoidance of habitat fragmentation in the Netherlands. She will assess the policy of the “no-unless” principle: no interventions in areas with a specific nature conservation status are allowed to take place, unless this is inevitable as a result of an important social interest. For that purpose she will examine a number of new road and rail projects on which the decision has taken place.

Mitigation

In December last year the fourth ecoduct in the Netherlands was opened. The ecoduct is situated over a highway that dissects the largest nature reserve of the Netherlands literally in two. On the edges of the ecoduct walls are constructed in order to reduce the disturbance by the traffic. The walls are planted with trees and shrubs. In the middle part a more open vegetation is planned. This way possibilities for passage are created for both fauna species of forests and fauna species of heath land and drifting sand area. At the southern side of the ecoduct a drinking pool is situated that is filled with water from the ecoduct. In order to increase the quietness in the vicinity of the ecoduct the accessibility of several forest trails has been reduced by planting them with trees.

Compensation

'Compensation' in environmental management terms refers to the balancing of negative impacts of development against societal functions, and is becoming an increasingly accepted phenomenon, cf. payments to agricultural producers for losses in income by wildlife damage or agrarian reform, plantation of woods to fix CO_2 emissions, and measures to offset environmental damage to wetlands. The *ecological* compensation principle was introduced in the Netherlands in 1993 by national initiative for use in the context of large-scale development projects. The principle has two objectives. Firstly, it aims to enhance the input of nature conservation interests in decision-making on large-scale infrastructure projects and similar developments. It explicitly confronts a project initiator with the ecological impacts of the various options for a development project, the measures required to counter these impacts, and the overall project costs. Secondly, the compensation principle is designed to bring about a 'no-net-loss' situation for nature when a given development project is implemented. It follows other national policies in this area, e.g., those in force in the USA, Canada and European countries like Germany, the United Kingdom, Sweden and Switzerland.

Until 1993 application of compensation measures was optional in the Netherlands. With the publication of the National Structure Plan for Rural Areas, the compensation principle came into force, however. In cases where the national government acts as the initiator of development projects its application is based on 'self-commitment'. Actual implementation of the compensation measures is not rooted in national legislation. Up to now, such measures have been implemented by means of a non-regulatory approach, i.e., by way of agreements between affected parties.

Since 1993, Dutch initiators are faced with the consequences of the national policy. In EIAs associated with large-scale developments the consequences of the compensation principle for the problem-solving alternatives are indicated. A very few projects that have been permitted, are implementing a compensation plan.

The Dutch government is evaluating the implementation of the compensation principle. On the basis of the results of this evaluation, the government will decide in the near future whether or not to provide the principle with a legal instrument.

Report from IENE Russia and IENE-PIARC C-14

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Summary IENE Russia

We have two all-Russia conferences on environmental problems of the Highways. Both represent the most regions of Russian Federation. On both special IENE report was presented. The Poster and flyers were distributed. It is important that in all-Russia professional magazine "Avtomobil'nie Dorogi" issues my articles were published with information about IENE activity.

The processes of "ecologisation" for the most of the road specialists still understood as problem of physical and chemical environment. The biotic problems are not "included" usually in the circle of problems that are discussed. Slowly but surely IENE principles and practice attract more and more interest and belief.

In the January 1999 in Russian Federal Highway Administration (RFHA) established "Department of Environmental Problems". The real Russian name is long and means the department of Methodology of Environmental problems solving. The Head of this department Yuri Trofimenko- -full doctor of Technical Science and recent Vice-Rector of Moscow University of Auto-Roads.

We have two meetings and he was clearly positive to cooperate and pay full attention to multidisciplinary approach, make better contacts with other IENE experts and groups. I was informed on the plans of RFHA to organise in Moscow 16-19 November 1999 International Conference "Environmentally Friendly Roads in XXI century". Last week I was invited to work out the program as the program Committee member. My proposals were welcomed by the vice-minister of the RFHA Mr. O. Skvortzov. Understanding that Conference planning is very late and it make difficult to organise all things in proper way I propose to write personal invitations to our IENE, COST-341, PIARC leaders and members. In addition I pointed that the World Bank loan for Russian highways reconstruction (400 billions $) have not sufficient EIA and absolutely needs principle revising and new parts as biota, level of fragmentation etc. Also was proposed to organise open hearing of the WB project in Russia with IENE, COST341, PIARC C-14 experts. I hope that if new government (on last week we get new government again) will not turn all plans, I will send information to IENE President about official coming issue.

Our book " Automobil Roads in Ecological Systems" (240 pages, 90 tables, etc.) should be finally printed specially to the 5 June as Environmental Day.

The "Impulse-M" that IENE members remember while visiting Fauna passage on the Moscow Ring Road is continuing it activity and reports that passes was used by different animals including beavers.

International projects in Russia.

World Bank project "Second highway rehabilitation and maintenance project".

My attempts to contact with WB institution stuff in Moscow was informative enough to continue establishing contacts and making certain proposal to WB mission (the mid March) that visited Moscow. Sorry to say but there were any response not from Mr. Caary Saary (WB environmental sector for highway project), not from the environmental specialist of WB mission for Chita-Khabarovsk as well as European part of Russia. My conversation with the Head of DORINVEST Mr. V. Matuchin was twice and showed that all problems of EIA are on the shoulders of WB experts. The same results we get inviting environmental expert WB Mr. Scott Hanna to participate on international IENE meeting in Vladimir (1997).

At the same time my laboratory go on working as National coordinators of the IENE and represent Federal Highway Service in World Road Association (PIARC). Our activity covers a family of the problems: ecosystem ecosystems carrying capacity to absorb carbon dioxide ("carbon credit"), risk assessment and reducing it by technical and planning means. Important to mention that now possible to apply economical evaluation of the natural protected areas as part of the regional economy.

PIARC C-14 (committee N 14) activity.

I participate in two PIARC C-14 meetings. In both (Helsinki-May, 98) and Washington- October 1998) I make presentation of IENE goals, structure, activity and COST341 project.

C-14 was chaired by Mr. Kurt Suter. The C-14 activity is mainly sharing experience, vision and new projects. C-14 is not organisation that gives advice, money or makes judgement. It is all about professional atmosphere of better roads for better environment. It makes great contrast to IENE fertility role and great mixture of practical sharing, planning and acting.

My reports and materials that were displayed were accepted as some "fresh approach" and I get general welcome to IENE. In the Washington C-14 meeting the two hours follow-up workshop was organised in the Department of Environment (Ministry of Transportation US) on which was presented "VIA-VITA" simulation game presented successfully. Was mentioned by the head of Department Mr. Eugene Cleackly that this kind of training is very productive and turned toward human interests.

For our future activity I have conversation in Budapest with Mrs Inga-Maj Eriksson and we make a plan of several steps of presenting IENE interests in C-14.

IENE - Progress report Sweden

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Short summary

The IENE network is being built up in Sweden. One step was the organisation of a meeting on 11 December 1998 in Stockholm to present IENE and COST 341 to invited scientists and representatives of institutions of interest. The meeting primarily aimed at finding sources of information to be used in the national background report for "European State-of-the-Art Report on Habitat Fragmentation due to Infrastructure".

Information on both IENE and COST 341 has also been disseminated by the two national IENE coordinators L Folkeson and A Seiler participating in two seminars. One was a Swedish meeting organised by the Swedish National Road Administration (SNRA) on 25—26 November 1998: "Ecological effects of roads and railways". The other was a Nordic meeting organised by the Norwegian Public Roads Administration (Bjørn Iuell) on 2—3 March 1999: "Roads, road traffic and habitat fragmentation". These meetings rendered further contacts and information of value to the work with the Swedish national report.

Intentions exist for the continuation of Nordic seminars on the topic—the next one could suggestedly be held in Sweden in 2000.

The importance of IENE in the Nordic countries will benefit greatly from Denmark and Norway soon joining IENE.

A national web page is in preparation to collate and distribute information about on-going and recently finished studies on infrastructure and wildlife conflicts. The web page will be published by the SNRA and linked to the IENE home page.

The SNRA is currently preparing a series of handbooks on wildlife passages that shall guide road planners and landscape architects when planning mitigation measures.

The national IENE coordination activity, into which the participation in COST 341 is integrated, is financed jointly by the SNRA and the Swedish National Rail Administration.

On-going projects in Switzerland

Peter Oggier, University of Bern, Zoological Institute, Baltzerstrasse 3, CH-3012 Bern, E-mail: oggier@zos.unibe.ch

1."Modeling of the landscape dynamics and its habitat function for wildlife. A tool for land-use planning based on fauna needs. Case study : the European hare *(Lepus europaeus)* in Switzerland".

Responsible: Corinne Gilliéron. Beginning: November 1998

Thesis research project at the Laboratory of Ecosystem Management (GECOS) of the Swiss Institute of Technology - Lausanne (EPFL), in collaboration with the Swiss Ornithological Institute of Sempach.

We will develop a model that simulates the spatio-temporal changes of the habitat function of the agricultural landscape on the swiss Plateau for the European hare *(Lepus europaeus)*. The goal of this research project is to propose a decision aid tool for landscape management, which allows to evaluate the effects of human intervention on this ecosystem, like new transportation infrastructure, urban development, social development, rural land improvement projects, changes in agricultural policies or practices. Why the European hare? First because the hare's population has dramatically decreased in Europe and second because it is a good indicator of the quality of an agricultural landscape.

The research will be accomplished in three steps:

- Analysis of the habitat function of the landscape for the European hare on three experimental sites on the swiss Plateau. The landscape will be described as the hare would see it. This will be done on basis of aerial black and white photographs and with help of field verifications and GIS.

- Development of a model that simulates the dynamics of this landscape. Temporal series of photographs from 1950 to now will be described and analysed as in the first step and also with help of topographic maps. The results of these analyses, stored on a GIS, will be used as base for the development of the model. It is foreseen to use an already existing model of landscape dynamics based on the Cellular Automata techniques (CA). As they were developed in other conditions, for other landscapes, scales and time periods, they will need to be adapted. We are now testing three of them which were developed in France, Canada and the USA. What is a Cellular Automata? A CA is a discrete system (in time, space and state), using simple evolution rules to reproduce complex behaviour. In practice, a regular grid is overlaid on the landscape and each cell changes its state at each time step, following transition rules that include human driving forces, natural evolution and neighbourhood effects.

- Development of a decision aid tool for landscape management. The predictive aspect of the model will be developed by applying the model to practical cases and different management scenarios. The last step will be to offer a user friendly interface.

2. A concept that takes the whole fauna into consideration at the time of the planning and the exploitation of transportation networks.

S. Schneider, Groupe d'étude Faune-Trafic, (LAVOC-ECONAT-ECOTEC-INSECTA-S. Müller)

The transport network will constitute soon a coherent and complete whole. Displacements of fauna take place in corridors also forming a network that enters in conflict in many places with the first one. The technical means, for lack of the financial means, allow today to take measures that limit the inherent risks to the superposition of networks, and this without trouble for people and the wild animals. A better knowledge of the way of life and needs of fauna should allow to optimize the cost of constructions like

wildlife passage or fences. Before building a passage, it is necessary to choose a suitable site and then to verify its long-term efficiency.

During the survey of a new infrastructure of transport, difficulties often appear essentially because of a lack of understanding between the engineer and the biologist. Mistakes in the conception of the mitigation measures lead to disruptions of the natural environment. Exaggerated environment requirements may imperil the pursuit of the survey and the realization of transport routes qualified of indispensable.

Sometimes, after some years, wildlife passages are not used by fauna any more, either due to modifications of the fitting out, or by a lack of follow-up and maintenance. The objectives of this survey are to establish a concept that takes the whole fauna into consideration at the time of the planning and the exploitation of transportation networks.

3. Switzerland's wildlife corridors

Contact: Dr. Otto Holzgang, Swiss Ornithological Institute, CH ñ 6204 Sempach, Switzerland. Phone: ++41 41 462 97 00, Fax: ++41 41 462 97 10, email: holzgang@orninst.ch

Roads, railway lines and settlements fragment habitats of wild animals. In addition, many traditional migration trails between habitats have been interrupted by the construction of fenced highways, forcing the animals to use small and sometimes artificially determined corridors for their movements. The aim of this study was to localise existing or interrupted natural axes of dispersal and migration, to detect wildlife corridors and bottlenecks, and to suggest measures to improve todayís situation.

We used the following three sources of information: (a) Temporal and spatial analyses of hunting statistics mark the distribution of wild animals. (b) The cantonal wildlife services and/or hunters were interviewed on the area of distribution and movements of roe deer, chamois, wild boar, red deer and alpine ibex, following a specific questionnaire. (c) A Geographic Information System (GIS) was used to model the permeability of the landscape. Because many wild animals use forests for their movements, the model was based mainly on forests and buffer zones, but information on protected areas was also included.

Our study led to a map giving an overview of the natural axes of dispersal and migration between habitats in Switzerland. Wildlife corridors were localised and their condition was described. They were classified by their importance into corridors of national or regional importance. The number of localised corridors of national importance totals 303, of which 84 (28%) are still intact, 179 (59%) are slightly to heavily disturbed, and 40 (13%) are interrupted. 68 corridors of national importance need purpose-built constructions as for example green bridges or wildlife passages. The situation is not satisfactory at all: at four locations, constructions are already in use, at three locations under construction and at six locations planned.

To increase in future the landscape's permeability for wildlife, further efforts are required: The localised corridors and movement axes have to be taken into account in land use planning. Purpose-built constructions have to be demanded at heavily disturbed or interrupted corridor locations. Because the constructions are expensive, measures have to be realised stepwise according to a plan taking costs, success, priority a.s.o. into account. Although we used data of large mammals for this study, small mammals and even invertebrates will also profit on long terms by open corridors.

4. External Costs of Traffic in the Wildlife and Landscape Ecology Sector

Contact: Guido Masé, ÖKOSKOP AG, Allmend 1, P.O. Box 102, CH-4460 Gelterkinden, Switzerland. Phone: ++41 61 985 44 60, Fax: ++41 61 985 44 28, email: oekoskop@oekoskop

Traffic causes damage in landscape, ecosystem functioning and biodiversity. The disruption of ecological functions affects not only nature itself but also the basis of human life and economy, e.g. water quality, natural resources and biological pest control. These costs are usually not recognized and certainly not paid for by various users of traffic systems. So far, some studies concerning the costs of the impact on humans and human health have been conducted. To fill a gap, a preliminary study (1998) and now a major study (in progress) are trying to establish an estimate of the minimal costs that traffic causes in the wildlife and landscape ecology sectors.

First a framework has been developed to categorize the effects of traffic. The categories are as follows: air, climate, water, soil, wildlife and landscape, noise and light. Subcategories include effects of infrastructure, buildings and maintenance and operation of traffic itself, direct and indirect. These effects have been established and weighed with the help of literature and experts. The relevant effects for which a good database and calculation models exist, have been selected as a basis for the main study. They should cover 60% to 80% of the dimension of all the efects of traffic.

The Swiss landscape of around 1950 forms the comparative standard of a seminatural landscape with very limited influence from traffic infrasturcture (setting aside effects of globally trading goods and organisms). Against this, the changes brought by traffic systems (especially roads and railway lines) up to 1998 will be measured. The next step will be to establish the proper method to calculate these changes for differnt areas of Switzerland (Plateau, Jura,Alps) and for varied landuse (forested, cultivated and urban areas). This requires a pilot study. Random samples will help to establish the extent of this change. The measures will be habitat loss, loss of habitat quality and fragmentation of habitats. This will allow formulation of mitigating and compensating measures like underpasses and restoration of agricultural land away from large traffic systems to seminatural ecosystems. Foreseeably, the main method of calculating the costs of traffic will be to establish the costs of these measures in the areas tested and apply them to the whole of Switzerland with regard to the different characteristics of areas. The major study will be completed in the year 2000. We are very interested in contacts regarding this issue.

IENE activities and on-going projects concerning habitat fragmentation in the UK

Dr Penelope Angold, University of Birmingham, B15 2TT Birmingham, E-mail: p.g.angold@bham.ac.uk

Iene in relation to COST:

As part of the COST action, and to maximise the benefit of COST for the UK, the Highways Agency is part funding and co-supervising a studentship for Ms Jackie Underhill, who is based at the University of Birmingham for three years from September 1998. Ms Underhill is undertaking reviews of literature and current practice regarding habitat fragmentation and linear transport infrastructure. She is also carrying out primary research to increase our understanding of the barrier effect for small mammals of different classes of roads in the UK; and also the potential of the road verge as a biological corridor.

Overview of research methods: (in following tables)

Research has focussed on an investigation of the methods currently available for assessing the fragmentation and barrier impact of linear tranpsort infrastructure, and on a comparison of the reliability and types of information which may be obtained using these methods. Three main objectives were determined:

1. To investigate the extent to which road verges can function as a wildlife corridor.
2. To investigate the extent to which roads act as barriers to species movements.
3. To evaluate the use of ecopassages under or over roads.

A comparison of the methods available for addressing these objectives is given in the tables attached to this report.

Current research related to IENE and COST 341 in the UK

A three year research programme has been started in the form of a pilot study to illuminate the above three questions using an adaptation of an existing methodology which was chosen as a relatively cheap and simple way of obtaining large quantities of data:

A Method To Assess The Extent Of Road Avoidance By Wildlife On Road Verges In Deciduous Woodland Habitat, In The Uk.

By: Jackie E. Underhill and Dr. Penny G Angold
School of Geography and Environmental Sciences, University of Birmingham, Edgbaston, Birmingham, B15 2TT, UK.

And

Anthony Sangwine, Len Wyatt and Robin Cure
The Highways Agency, St. Christopher's House, Southwark Street, London. SE1 0TE.

The intensity and growth of the road network in the UK during the last 20 years has reduced much of the British landscape to small fragments of often sub-optimal wildlife habitat. Whilst some autecological studies have been undertaken in Britain, there has been comparatively little research on the effects of roads on the assemblage of different mammal species commonly found on roadsides. We are trialling a method to assess the permeability of roads for an array of British mammals. The method also assesses the effectiveness of measures designed to mitigate the effects of fragmentation arising from linear transport infrastructures.

Study methods which use traps and which are routinely used for single species investigations are unsuitable when dealing with species which range in size from 48mm (shrews) to 1000mm (fallow deer). Footprints and tracks left in sand beds however, enable all mammals to be studied, whatever their size. The data collected provide a relatively easy and inexpensive means of assessing the extent to which various species are affected by different classes of roads and different traffic densities.

Footprint data can also provide information about roadside features and sandbeds have been used in the past to verify the use of faunal passages by target species. To assess the effectiveness of faunal passageways at a population level however it is necessary to know:

1. whether such tunnels provide the sole means by which a species crosses a road;
2. whether animals present on the road verge fail to cross despite the means to do so safely.

Carefully positioned sand traps are being used in field trials of an experimental technique designed to assess these factors. Initial results suggest that the following factors are important for the success of the technique:

1. The sand bed must be sufficiently wide (in excess of 1m) to prevent the larger mammals from jumping over itIt may take some time for animals to become habituated to the new substrate.
2. The underlying substrate must be sufficiently rough to prevent slippage of wet sand and sufficiently robust to prevent the growth of vegetation through it. (old carpet is ideal).
3. Weather conditions are critical - the sand must be lightly moist to hold small prints.
4. Sandbeds work only in dry weather and must be visited frequently (optimum daily in UK climate).

Annex 1 List of Participants.

Annex 2 The organisation of IENE.