Habitat Fragmentation due to Transportation Infrastructure

ESTONIA

Draft

State of the Art Report

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Introduction

The republic of Estonia is situating at the eastern coast of the Baltic sea having common borderline with Finland in north, Sweden in west, Latvia in south and Russia in east. Total area of Estonia according the State Statistical Office is 45 227 km^2 (incl. area of inland waterbodies 2833 km^2) and resident population at 1. January 2000 was 1 439 197 inhabitants (1 015 369 in 47 towns – 411 594 in Tallinn and 100 577 in Tartu). There are 1521 islands and several rivers in Estonia. Administrative division shows 15 counties, 47 towns and 207 municipalities (Statistical Office of Estonia, 1999-2000).

Estonia has notable diversity of natural and semi-natural habitats that are still remained at the quality which is sufficient for their protection. Also, quite a number of species inhabit in these diverse habitats. At the same time there is a big risk for quick destruction and fragmentation of these habitats and due to that also species diversity, because of enlargement of the infrastructure in the conditions of quickly developing economy. Therefore strong need for environmentally friendly planning of the infrastructure as well as taking of mitigation measures for habitat fragmentation due to transportation infrastructure has risen into agenda.

Biogeographical description

Estonia is traversed by an important European biogeographical borderline, which divides the area into two phytogeographical provinces. The northern and western parts of the country on the Ordovician - Silurian limestone bedrock with numerous alvars, calciphilous fens, rich-in-species wooded meadows, broad-leaved forests and calciphilous species dominating in plant communities belong to the Mid-European province. The eastern part of the republic, where acid soils on the Devonian sandstone bedrock promote the development of acidophilous plant communities and pine is the main forest-forming species, belongs to the East-European province (Külvik, 1996).

Zoogeographically, Estonia is a transitional region between the western and eastern Palaearctic zones, with western Palearctic species in a small majority. The development of Estonia's fauna has been influenced throughout the ages by the Baltic Sea and the abundance of inland waters.

Compared to other regions with similar areas situated to the north of the 57th northern parallel, the diversity of Estonian flora and fauna is one of the richest in the world. The reasons for it are geographically conditioned diversity of Estonian climatic conditions; the existence of both islands and continent; the influence of sea and large number of inland waters; diversity of soils, simultaneous incidence of Silurian (to a lesser extent Ordovician and Devonian) limestone and Devonian sandstone as bases for the formation of soils, and the resulting incidence of neutral, lime-rich and lime-poor soils; extension of a large number of species distribution area borders to the territory of Estonia; large proportion of natural landscapes in Estonia; retention of traditionally extensive methods of land use until the middle of this century and in many areas until the latest decades, and the respective relatively extensive retention of semi-natural habitats (heritage habitats) and relatively unimportant role of alien tree species in forestry (Kull, 1999).

Landscape features

Estonian present situation in the junction of various natural spheres and historic processes causes quite high diversity in our country. Having been covered with continental glaciers during the last Ice Age, it still differs from the neighbouring Nordic countries in base rock, soil and relief. Estonia situates in a transitional zone of maritime and continental climate and in a contact border of North taiga and European deciduous forests. Quite young and developing postglacial relief favours distinctions in surface forms and water regimes. That results in large diversity of habitats, enriched by a long and devious coastline. Estonia is famous for its lakes, islands, beautiful forests and mires.

Estonian agricultural landscape can also be characterized by high diversity. Traditional land use has created traditional landscapes, which exist along with the cosequences of large-scale agriculture during the Soviet era. It is influenced by the processes of restructuring land property and agricultural production since Estonian independence.

Changes take also place in fields that can directly be connected with human activity. Constantly broadening highways and harbour districts contrast with disappearing village lanes and railway system. The flourishing times of building panel houses since 1950's gives way to the building of private houses and reconstruction of the so-called decay quarters. The village building is constantly diminishing, at the same time earlier abandoned farmhouses are reconstructed in naturally beautiful places and new cottages and summer houses are being built near waterbodies (Kull, 1999).

Habitats

Estonia is well-forested country. There is 21 431 km^2 forested land in Estonia, which is 47,4 % of total land area of country. Only during the last 50 years has the area of forest stands more than doubled and the growing stock has increased 2.4 times. This is due to the natural afforestation of agricultural lands, drained wetlands and guarries but, first of all, to the large-scale forest sowing and planting. In the post-war years, the area of sown and planted forests was almost twice as large as the yearly clearfelled area.

Pine forests dominate in the northern, north-western and south-eastern parts of Estonia. Birch is well represented throughout the country. Spruce is encountered mostly in central Estonia, while the tree species of mixed broad-leaved forests occur mainly in western Estonia and on the islands of the West-Estonian Archipelago.

Estonia belongs to the temperate hardwood-coniferous forest zone. 22 site-types and 71 forest types have been distinguished within the territory. The most important types include dry pine forests on sandy soils, temperate spruce forests, hardwood-spruce mixed forests, transitional (mesotrophic) swampy forests, dry heath pine forests, bog (oligotrophic) pine forests, fen (eutrophic) birch forests, rich-in-species swampy black alder forests, floodplain forests and alvar forests (Külvik, 1996).

In these largely natural forests are living approximately 29 000 roe deers *(Capreolus capreolus)*, 7700 moose *(Alces alces)*, 10 300 wild boars *(Sus scrofa)*, 1200 lynxes *(Felis lynx)*, 600 brown bears *(Ursus arctos)* and 300 wolves *(Canis lupus)*. Large game animals are concentrated mainly at the mid-Estonian forests, having internal migration passages from NE-Estonia to SW-Estonia and also from mid-Estonia to NW-Estonian forest and bog areas. Also, distribution scheme of large carnivores is showing strong concentration in continental forested areas. Despite these distribution facts still no any other measures than traffic marks showing possible ungulates appearance on roads were taken.

Grasslands, meadows and natural or seminatural pastures are some of the vegetation types most characteristic of Estonia. Meadow communities, often rich in species, are beautiful patterns in our landscape, adding to the few colours of our northern nature. Especially bright are wooded meadows with their dense herb layer rich in orchids and single old oaks, ash-trees, lime-trees, etc. About 690 species, some of them very rare, have been recorded in the Estonian meadow flora (Külvik, 1996).

After World War II, during the collectivization period, when different agricultural measures were introduced, large areas of natural meadows were changed. Some meadows were cultivated into grasslands, some were afforested, large areas became overgrown with brushwood. This has been a loss to our flora. A number of presently common species will probably become rare or die out in the future. 83 species are in danger of extinction already. Some plant communities (e.g. the *Melampyrum nemorosum - Scorzonera humilis* association in which 163 species were recorded on 100 m^2 in 1951) are in danger of extinction, they have only remained within a few nature reserves. Alvar-meadows, communities typical of Scandinavia, are mostly treeless and meadow-like in Estonia, with a very interesting mosaic flora and vegetation of a continental character, which are sometimes called pseudosteppes. In the last decades they have been overgrowing with pine and juniper because sheep which used to keep them in a steady condition earlier are not grazed in most of these areas any more.

Mires cover approximately 22 % of Estonia's land area. Fens (eutrophic mires) make up 57%, transitional (mesotrophic) mires 12%, and bogs (oligotrophic mires) 31% of the total area under mires (Table 7). Estonian mires are deep-layered, hundreds of bogs have peat layers thicker than 5 m (the deepest peat layer reaches down to a depth of 16.7 m). In the last decades, over 700,000 ha of water-logged meadows, fens and mires have been drained. As the agricultural use of these areas has often not proved successful, part of this land is presently covered with young forests and shrubs of low value. The fauna and flora have been damaged, a remarkable part of bogs important as freshwater reserves has been destroyed (Külvik, 1996).

About 25 % of Estonian plant species are habitants of mires. Most of Sphagnum species occur in peatbogs, but only about 5 % of Angiosperms can be met there.

Mires are important growing sites of cranberries, red whortleberries and cloudberries, the reserves of which are considerable. The cranberry (*Vaccinium oxycoccus*) is used in cultivar breeding. Some 760 different samples of the Estonian cranberry have been planted into a collection in the Nigula Nature Reserve.

Owing to the abundance of mires, and the activity of inhabitants during the years under Soviet power, large wetland areas have fortunately been maintained. Currently, mires occupy 1.009 million hectares of Estonia's land area. 94 mires or 54 % of ecologically healthy mires (174,300 ha by area) are wholly or partially protected in Estonia.

Species

The indigenous flora of Estonia includes 1441 species (incl. hybridogenic species) of vascular plants. The number also covers taxa with unclear existence in present Estonian flora (herbarium evidence proves earlier existence, but no fresh findings), and micro-species. Usually, the species of the genera *Taraxacum, Hieracium* and *Pilosella* are considered as microspecies, but we have no objective grounds for such discrimination. Existence of another 130 taxa has been published in literature, on which no proof has been found, and these thus taxa have not been included (Kukk, 1999).

If we add the 97 subspecies to the 1441 indigenous species (i.e. the species are found as two or more subspecies in Estonian indigenous flora), the total number of taxa increases to 1538. The number of indigenous pteridophytes is 50, the number for gymnosperms is 4 and angiosperms 1387. These indigenous species belong to 113 families and 443 genera. A general picture of the number of species in the families is given in Table 3. The largest family is *Taraxacum* with 165 species, followed by *Hieracium* with 81 and *Carex* with 69 species.

There are 82 naturalized species belonging to 30 families known in Estonia (see also Chapter 4.6). The majority of naturalized species (51) are cultivated species run wild; 26 species have arrived in Estonia as casual aliens, and five species are cultivated species run wild and aliens.

The total number of species and subspecies migrated or cultured and run wild (including naturalized) is 718, and 10 of the alien species are represented by two subspecies. However, 17 of our indigenous species are also represented by one or more alien subspecies. The number of alien taxa is 373 and there are 409 taxa run wild, while 54 taxa occur both as casual aliens and cultivated plants run wild. The adventive taxa belong to 84 families, of which 24 are represented by migrated species and subspecies only (cf. the number of families consisting of indigenous taxa only is 52).

Of the 251 species of higher plants having the habitat boundary within Estonia, 71 species (*Cladium mariscus*, *Heliochrysum arenarium*, *Berula erecta,* etc.) have reached the northern, 50 species (*Juncus subnodulosus, Litorella uniflora,etc.*) the eastern, 32 species (*Cornus suecica, Cochlearia danica, etc.*) the southeastern, 9 species (*Botrychium lanceolatum, Carex glareosa, etc.*) the southern, 14 species (*Carex brunnescens, C. globularis, etc.*) the southwestern, 16 species (*Chamaedaphne calyculata, etc.*) the western, and 59 species (*Arenaria procera, Trisetum sibiricum, etc.*) the northwestern distribution limit (Külvik, 1996).

During the course of a century, many vascular plants, lichens and bryophytes have become extinct or very rare in the Estonian flora. Seventeen species of plants, including *Alisma lanceolatum, Blechnum spicanti, Botrychium lanceolatum, B.simplex, Carex rhynchophysa, Cochlearia officinalis, Crassula aquatica, Dactylorhiza sambucina* (reintroduced), *Eleocharis ovata, Erica tetralix, Galium schultesii, Geranium columbinum, Hypericum humifusum, Juncus anceps, Melica ciliata, Orchis coriophora, Scrophularia auriculata* have died out.

87 native and over 500 introduced tree and bush species are recorded in the dendroflora of Estonia. The main tree species in forests are pine (*Pinus silvestris*) - in 41% of forests, birch (*Betula pendula* and *B. pubescens*) - in 28%, spruce (*Picea abies*) - in 23%, speckled alder (*Alnus incana*) - in 4%, aspen (*Populus tremula*) - in 2%, black alder (*Alnus glutinosa*) - in 1%, broad-leaved trees (oak, ash, linden, elm) in 1% of fine deciduous forests, each (Külvik, 1996).

The list of the Estonian **vertebrates** consists of 488 species, including the vertebrates which are naturally spread in Estonia and 8 wildbreeding introduced species.

There are 11 species of **amphibians** *(Amphibia)* recorded in Estonia; however, the occurrence of the marsh frog (*Rana ridibunda)* is not certain. Some species, like the grass frog (*Rana temporaria)*, the moor frog (*R. arvalis)*, the common toad *(Bufo bufo)*, the smooth newt (*Triturus vulgaris*) are relatively wide-spread, while others, e.g. the crested newt (*Triturus cristatus)*, the common spadefoot *(Pelobates fuscus)*, the natterjack (*Bufo calamita)*, the green toad (*Bufo viridis*), the edible frog (*Rana esculenta)*, the pool frog (*R. lessonae*) are more or less rare or sporadic. According to EU Habitat Directive *Bufo viridis, Bufo calamita, Pelobates fuscus and Rana arvalis* belong to annex IV and *Rana temporaria, Rana ridibunda* to annex V. In Estonia under the protection are all of them (Külvik, 1996).

Reptiles *(Reptilia)* are represented by 5 species, including the widely distributed viviparous lizard *(Lacerta vivipara)*, the adder (*Vipera berus)*, and the grass snake *(Natrix natrix*). The listed reptiles as well as the slow-worm *(Anquis fragilis)* and the still rarer sand lizzard (*Lacerta agilis)* have been included in the list of protected species in Estonia.

Of the 332 **bird** species, 222 are breeding in Estonia (206 regularly). In addition to those, dozens of species have been recorded as transit migrants and/or winter visitors, e.g. the Bewick's swan (*Cygnus columbianus)*, the long-tailed duck *(Clangula hyemalis)*, the redpoll (*Carduelis flammea)*, the common scoter *(Melanitta nigra)* and several others. Many species, like the great nipe (*Gallinago media*), the willow grouse (*Lagopus lagopus)*, the roller (*Coracias garrulus)* have declined in numbers, and therefore 222 species have been taken under national protection or included in the Estonian Red Data Book. On the other hand, some species whose abundance is decreasing in Western Europe have increased in numbers in Estonia, e.g. the white stork (*Ciconia ciconia*) and the corncrace (*Crex crex*) which are interesting objects of study for many Nordic and Western ornithologists visiting Estonia. The populations of several gull and passerine species are increasing while they often become urban inhabitants. The Estonian bird fauna is protected and thoroughly studied in the national parks (Vilsandi, Photo 11), state nature reserves (Matsalu), and bird sanctuaries. Bird hunting has been considerably reduced during this century. At present, ducks, dowes, coods, geese and some waders are the main game birds in Estonia.

64 species of **mammals** have been recorded in Estonia. 5 species have been introduced: the raccoon dog (*Nyctereutes procyonoides*), the American mink *(Mustela vison)*, the muskrat (*Ondatra zibethicus)*, the red deer (*Cervus elaphus)*, the sikka deer (*Cervus nippon*). The European beaver (*Castor fiber)* disappeared in the middle of the 19th century. The species was reintroduced and since the 1950s a vital population exists again in Estonia. 29 species of mammals enjoy state protection. The rarest and most endangered of them are the European mink (*Mustela lutreola)*, the flying squirrel (*Pteromys volans*) and the gleridans (*Gleridae*).

There are 17 species of game animals, the moose (*Alces alces)*, the wild boar *(Sus scrofa)* and the roe deer *(Capreolus capreolus)* being of the highest commercial interest. As a result of reasonable hunting policy and moderate forest management, rich populations of animals, strictly protected elsewhere in Europe, have developed in Estonia during the last 60 years. These species, like the wolf (*Canis lupus)*, the lynx (*Felis lynx)*, and the brown bear *(Ursus arctos*) , have been included in the list of game animals (Külvik, 1996).

Transportation infrastructure

Road network in Estonia according the data of State Road Agency is 44 182 km long, having 16 430 km public roads and only 8366 km with a pavement. It makes total mean road density to be 0,977 km/km^2 and mean density of paved roads 0,185 km/km^2. Mean density of public roads is 0,363 km/km^2. Number of cars in Estonia is 537 877, which makes 372 cars per 1000 inhabitants. Intensity of traffic on bigger public roads varies from 720-15790 cars per section in 24 hours that makes mean of 8255 cars. Anyhow there is mostly intensity between 3000-6000 cars per section outside of Tallinn area.

Main trends in the development of transport in Estonia

During last 10 years motorization has been very fast in Estonia (see the chart). What concerns passenger transport, public transport has largely been replaced by private cars. While in 1990, inside Tallinn 90% trips were made by public transport, then in 1997, the corresponding figure was 40%. Passenger conveyance on trains has decreased by 75% during 7 years. Fortunately railway has managed to keep its position in the transportation of goods – over 80% of transit traffic is done by railway.

The number of cars per 1000 inhabitants is equal to Europe’s average.

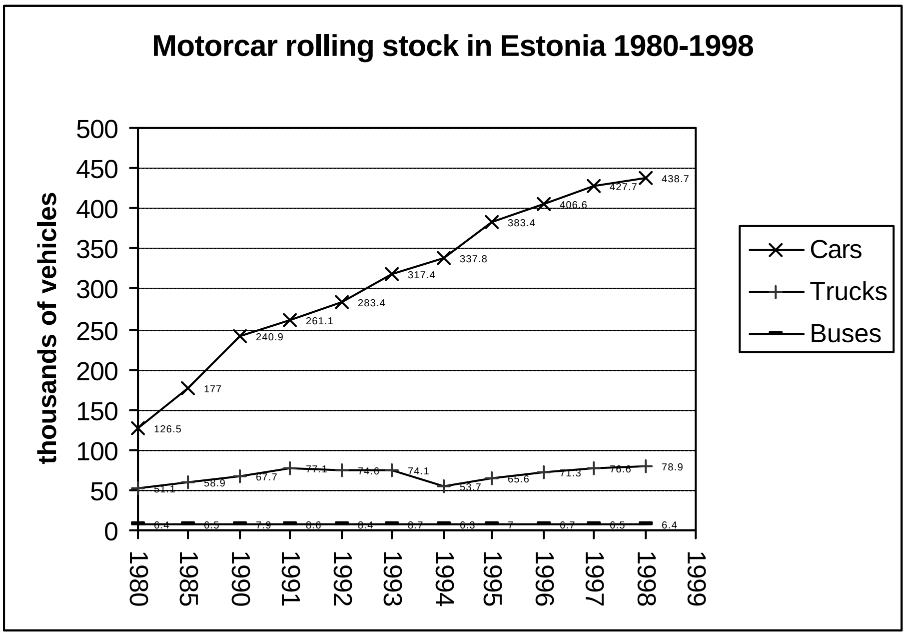

Fig. . **Motorcar rolling stock in Estonia 1980-1998** (Source: Transport. Communications 1997, Statistics board, 1998, Car Register)

If we analyze state transport assignments in real value, we can see that assignments for the maintenance of roads have increased 1.5 times while the revenue out of fuel excise and vehicle taxes have increased 5 times. At the same time the subsidies for public transport have decreased three times within five years. We can see that nothing much has been done to reduce external costs caused by the growth of traffic although the taxation of car users has grown considerably. No alternatives, such as public transport or environmentally friendly transport means.

The biggest transport-related problems are the growth trend of cars, developing car-centered infrastructure as a priority and the growth of demands for traffic services. Although the impact of transport on natural diversity is now comparatively small, it can, due to the short-sighted policy of transport and land use be much more serious in the future.

Another potential hazard for the environment is the development of transit trade as majority of the transit goods on the East-West direction belong to the group of risky freight (crude oil products) and the growth of haulage industry requires road construction.

Selected indicators in transport sector which touch upon natural diversity

In order to understand how big is the pressure of transport sector on natural diversity and to evaluate the changes, the following factors should be observed:

* area of lands and their density per 1000 km which are under transport infrastructures

Total land area under transportation infrastructures in Estonia is ca 800 km^2, which makes almost 2% of total land area in Estonia. Mean density of public road network by the data of State Road Agency is 363 km per 1000 km^2 (0,363 km/km^2) and for whole road network 1094 km per 1000 km^2 (1,094 km/km^2).

* total passenger and freight amount and distribution by means of transport

By the data of State Statistical Office the conveyance of passengers by public transport has been decreased two times from 1990-1998 (1990 – more than 400 milj. passangers per year; 1998 – less than 200 milj. passangers per year), which indicates clear rise in usage of passanger cars and also in traffic density.

* traffic density on highways

There are no any real highway type roads in Estonia at the moment. Anyway there are sections of roads with almost highway type around capital Tallinn, having traffic density close to 15000 cars per day. Also at 1999 there was more than 300 km of road sections where allowed highest traffic speed was more than 100 km/h. According to estonian legislation there is need for road to meet standards of highway, when traffic density exceeds 8000 cars per day. There are ca 40 km of such road sections at the moment (only around Tallinn).

* crossing of transport corridors with heavy traffic (over 2000 vehicles a day) and the migration corridors of animals and birds.

Preliminary estimation of author is that there are ca 200 possible conflict locations with migration corridors of animals and bigger roads in Estonia (ca 50 of these conflict points occure on roadsections with traffic density over 2000 vehicles per day).

* number of animals and birds perished in traffic

No any official statistics about animal collisions is available in Estonia. By the data gathered from previous researches and from traffic accident statistics (contain only these accidents where there was any financial loss or human ingury) mean amount of collisions with animals on Estonian roads may be roughly estimated at least 500-1000 events per year. By author estimation there are not more than 10 serious collisions with large animals (moose, roe deer) per year, which cause damage to cars or human ingury. At the same time information about collisions with animals smaller than wild boar is mainly absent, because no any recording system for them is set up yet. By the data gathered during the research made by Mardiste at 1985-1990 (mean traffic density and passanger car number was about half of amount it is at the moment) about half of animal collisions is happening with roe deer (population number was ca 40 000 ten years ago and is ca 30 000 now), about one third with moose (population number was ca 12 000 ten years ago and is ca 7000 now) and about one seventh with wild boar (population number was ca 14 000 ten years ago and is ca 10 000 now). As this data is not containing very much information about smaller animals and also amphibians the real picture might be much different.

* rate of plant and health damages caused by transport

Research on that topic is totally absent in Estonia. There are some ideas to start with road verge analysis for setup of natural vegetation there, instead of introducing cultivated plant species.

* size of territories which are not fragmented by transport infrastructures, how many territories of 10, 50, 100 km² which are not fragmented

Research on that topic is currently launced. By preliminary rough estimation there are no any patches larger than 100 km² not fragmented in Estonia; ca 5 patches with area between 50-100 km² which are not fragmented and ca 20 patches with area between 10-50 km² and not fragmented.

* vitality of plant and animal populations in the vicinity of transport corridors

No any research on that topic is done yet and also not planned in near future.

* traffic and speed limitations

Highest speed limit in Estonia is 110 km/h. Although it is set up only at quite some sections of road network. Usual speed limit outside of towns is 90 km/h and in towns 55 km/h. Anyhow there are some problems with drivers to keep these limitations as penalty for crossing speed limit by 10 km/h or less is not so big, therefore one might expect quite much cars driving usually with speed of 100 km/h and on some sections even 120 km/h.

* ecoducts, ecotunnels, noise screens, protection zones

There are no any ecoduct or ecotunnel built in Estonia currently, but there are planned to build some of them for new section of Tallinn-Tartu road in near future. Some noise screens are set up for those houses that are close to road sections with highest traffic density.

* education and science programs, campaigns for sustainable transport

There are special information campaigns organized by State Road Agency concerning driving culture. Specially on keeping speed limit on the allowed range, not driving drunk, usage of life belts, but not considering animals on the roads yet (this is planned).

The basis for transport management is not to satisfy the transportation needs of people and goods, but to guarantee the effective access to homes, schools, service and business establishments, places of employment and social interaction, and other necessities for life. In Estonia the transport sector and institutional structure should develop in such a way that it satisfies the everyday needs of people with the lowest possible travel and goods transportation, and consuming the least amount of natural resources.

To decrease the impact on biological diversity, **the whole scope of the transportation sector should be considered ---** from the production and development of fuel, vehicles, and infrastructure, and the related consumption of resources, to the global effects of transportation pollution.

Anticipation and prevention of the negative effects of transport

In solving the problems of transport, attention is paid to the causes for the increase in traffic and other problems. Solutions to problems dealing with the influence of transport on biological diversity are sought also outside of the transport and environmental protection sectors. Existing and unavoidable effects are dealt with and alleviated.

Employment of integrated transport policy – coordination and analysis among the types of transport, and integrated implementation of human settlement and transport planning and environmental protection.

Employment of the principles of "polluter pays" and "user pays." All the external costs, including the impact on biological diversity, must be reflected in the cost of transport service.

Preferential development of environmentally sustainable transportation types and improving the level of transport service. Promotion of use of clean and economical vehicles and fuel with the help of new tax policy and standards.

Scientific and educational work will be used to help explain the effects of transport on biological diversity and offer environmentally sustainable solutions to transport problems.

Development of cooperation with neighboring countries, Baltic Sea countries, and the European Union with the strategies and action plans.

Main objectives are:

1. Sustainable development of transports institutional system –by using spatial planning the need for the transportation of people and goods is minimized, and effects of transport on biological diversity is reduced. The amount of land under transport infrastructure is not increased significantly. The land space presently under existing transportation infrastructure is redistributed to more effective transportation means in terms of land use (rail transport, public transport, bicycle and walking).

2. In the internal distribution of transport environmentally sustainable types of transportation and movement such as public transportation, light transport, railway and ship are predominant. For the carrying out of daily activities people are not dependent on the ownership or use of a private car. The indirect giving preference of private car use over public transportation is ceased.

3. In the planning, development and coordinating of projects in the transportation system, damaging effects on the environment are considered and precluded. the existing and unavoidable harmful effects of the transportation system are alleviated by development of ecological network.

Overview of fragmentation

Any linear infrastructure, either man-made (roads, forest tracks, electricity transmission lines, ditches etc.) or natural ones (rivers, coastline etc.) have doubtlessly a negative (rarely positive) impact on the biological diversity in the nature. Let us have a closer look at some of the impact types.

Barrier effect

A linear infrastructure diffuses biotopes of different species and creates obstructions in free migration for individuals, as well inside of a population as between the different parts of a biotope or a population. Such impact has its positive and negative features. Firstly, if barrier effect occurs too often, it splits the population up into smaller and smaller parts and through the prevention of its natural reproduction, finally the population perishes. We cannot talk about free development of the diversity of species if we prevent a species to migrate freely. Through creating barriers we cut some territories off from the possibility to "accommodate" certain species. In wider sense, the prevention of migration inside a population may bring along the emergence of a totally new species, but only on condition that the barrier has been permanently set up between sufficiently large parts of the population during a sufficiently long period, provided the parts of population have not been dispersed in some other manner.

In Estonia we can mention barrier effect only in connection with larger highways (Tallinn-Tartu, Tallinn-Narva, Tallinn-Pärnu etc.). Smaller roads can also form a barrier, but only for the organisms whose spreading is already obstructed by some natural barrier. At the same time the sensitivity of these organisms (several species of invertebrates) to major changes in the environment is usually higher than in the case of larger organisms. The diversity of species among these groups of organisms is considerably bigger.

Barrier effect will have an even bigger impact when along the new roads under construction (Tallinn-Tartu-Luhamaa) fences against animals will be put up at the most hazardous sections of the road.

Perishing of animals and birds in traffic accidents

The clearest destructive impact of linear infrastructures on wildlife species is perishing of animals when trying to overcome the barrier. This happens to species with the most active migration whose periods of migratory activity coincide with the peaks in traffic. Species which perform massive invasions are also endangered; the worst thing is that the most active migratory part of these populations consists of younger animals. Another cause for perishing is the gathering of animals who seek warmth at night on roads warmed up by the sun in the daytime.

The density of traffic in Estonia, as compared to the corresponding numbers for other European countries, is comparatively low, reaching to 10 000 – 15 000 vehicles a day in the busiest sections of Tallinn-Tartu road, but the density is growing from year to year. We do not have regular statistics about the number of animals who perish on the roads, in electricity transmission lines or ditches. There are no statistics whatsoever about the cases of massive perishing of smaller organisms. Neither is there any analysis of the possible reasons of such cases.

Disturbance

An area with a width of approximately one kilometer from each side of a road is considered to be the range of direct influence. The biggest range of influence is in the case of motorways to bird populations. Bigger animals usually keep a distance of 100-200 meters from the roads unless their instincts appear to be stronger than their fear during their activity periods. The factors of direct disturbance are noise, lighting at night, chemical compounds spilt on the roads and littering the road sides.

Invasion of new species

The construction of every new linear structure brings along the appearance of new limiting areas, new ecotones and thus the appearance of new biotopes. These new niches are first inhabited by invading species (ruderal plants, rodents, pests) which have arrived by transport. We could call it a positive impact on the biological diversity as the number of species grows. But usually these invading species, with their extreme vitality become strong competitors to the endemic species and in the end simply extract them.

Destruction of biotopes

Construction of linear infrastructures always means crossing biotopes and dividing them into smaller sections. Such fragmentation can often be hazardous to the diversity of natural species and biotopes. Therefore all linear infrastructures should be possibly planned and designed so that they will follow the structures and borders of already existing natural biotopes. Smaller and more sensitive biotopes should not be cut off from their base biotope (for this reason it is not wise to construct a road between a forest and a swamp when on the other side of the swamp there is a field). In any case the main rule is that an already existing semi-natural biotope is always more resistant to the results of fragmentation than a neighboring natural biotope.

Administrative and legislative framework

Strategies and action plans

1. Estonian Environmental Strategy
2. Estonian Environmental Action Plan
3. Estonian Transportation Development Plan
4. Estonian Biodiversity Strategy and Action Plan

Financial planning in Estonian Biodiversity Action Plan (BDAP)

Table 1. COST OF BDAP AND LABOUR CONSUMPTION IN 1999-2005

SECTOR	TOTAL COST		LABOUR CONSUMPTION	
	1000 EEK	%	years	%
…				
11. TRANSPORT	***109265***	***4,4***	***32,1***	***1,7***
…				
BDAP TOTAL	**2508640**	100,0	1936,05	100,0

Table 3. BDAP NEED FOR FINANCING IN YEARS 2000-2005

SECTOR	NEED FOR FINANCING (1000 eek)	%
11. TRANSPORT	**98265**	4,3
BDAP TOTAL	**2260130**	100,0

Table 5. TOTAL ACROSS YEARS

Sector	Need for financing in years 2000-2005 (1000 EEK)						
		across years					
	2000-2005	2000	2001	2002	2003	2004	2005
11. TRANSPORT	**98265**	12595	18565	16945	16720	16720	16720
TOTAL	**2260130**	**374165**	**394485**	**378790**	**374110**	**369865**	**368715**

State level legislation

Act on Roads has been approved at… but it does not contain anything about mitigation measures for habitat fragmentation etc.

International requirements

There are no any international convention or directive stating directly need for mitigate habitat fragmentation due to transportation infrastructure approved in Estonia.

Administration

Institutional framework

IENE national coordinator:	Mr Jaak Liivaleht, Road Administration.
IENE national sub-coordinator:	Mr Hannes Palang, Institute of Geography, University of Tartu.
IENE national sub-coordinator:	Mr Lauri Klein, Estonian Environment Information Centre.
Other concerned institutions:	Ms Mari Jüssi (task manager of the transportation working group of Estonian Green Movement), Stockholm Environmental Institute –Tallinn Office.
	Mr Mati Karelson (preparation of signing Memorandum of Understanding for COST 341 action), Department of Chemistry, University of Tartu.

Current activities

1. Cooperation

   Between Road Administration, Environment Information Centre and Institute of Geography there is under construction information network setup for better and operative exchange of knowledge and advice for planning and reconstruction transportation infrastructure. Also there is under compilation phase national working group of advisers on transportation infrastructure influences to environment.

2. Projects

   There is designed project, that needs launching by Ministry of Environment and will probably be financed by Duch Embassy in Helsinki. Project name, aim and foreseen outputs are as follows:

Project name: *WILDLIFE PASSAGES PLANNING ON ESTONIAN ROAD NETWORK (WILDESTROAD)*

Aim: To establish a digital set of cross points of road and ecological network for proper set up of precise underpass locations and their optimal construction types and start with planning precise wildlife passages on roads Tallinn-Tartu and Tallinn-Narva.

Outputs: 1. Digital map with possible conflict areas of wildlife and bigger roads;
2. Detailed plan of underpasses locations and construction types on new section of road T2 between Tallinn and Tartu;
3. First draft of environmentally friendly road planning and building manual for road planners and constructors use.

3. Participation at Conferences

Conference name	Information/Presentation title	Participant name
ICOWET III in Missoula, USA at 13-16 Sept.1999	http://www.dot.state.fl.us/emo/sched/ICOWET_III.htm Usage of GIS in Wildlife Passage Planning in Estonia	Lauri Klein
4th MC meeting of COST 341 action in Sitges, Spain at 4-5 April 2000	http://cost341.instnat.be/documents-frame.htm	Lauri Klein
6th IENE meeting in Sitges, Spain at 5-7 April 2000	http://iene.vv.se	Lauri Klein

On-going and planned research and case studies

Road T2 (Tallinn-Tartu) – (Annex

WILDESTROAD

Methods

For background layer CORINE Land Cover database will be used. CORINE Land Cover project in Estonia was compiled at 1996-1998. During the project Estonian digital database was completed on the basis of common European methodology. The aim of the project was natural resource mapping, done by using remote sensing. Land cover essentially concerns the nature of features (forest, crop, water body, bare rock etc.). Working scale was 1:100 000; data from Landsat MSS/TM sensors were used; the satellite data by means of photo interpretation of false-colour images was analysed; unit area was clearly characterised; the size of the smallest unit mapped was 20 ha and land cover nomenclature was hierarchically structured in three levels into 44 land cover classes. CORINE Land Cover project was part of European Union CORINE program, which was implemented in EU member states in 1985-1990. Since 1991, the CORINE databases are preserved and processed by European Environment Agency. The CORINE databases in Central and Eastern-European countries, incl. Estonia, were completed in 1995-1998 with the support of EU Phare program (Meiner, 1999)

On the background of land cover working layers of road network, river network, nature conservation areas, protected parks and specially road T2 will be created with programme ARC/INFO and afterwards analysed with ARCView. Possible ecological network will be initiated as line connecting nature conservation areas through main forested areas were possible or through most natural habitats. Cross sections of that rough econet line and main roads will be detected as possible conflict points between human created infrastructure and wildlife trails. Locations of these conflict points will be estimated on main roads by kilometres. Comparison of these locations with animal accident statistics (taken from insurance companies and road police data) will be done. Also intensity of traffic on these possible conflict points will be taken into account.

New section of national road T2 will be digitized basing on a road corridor scheme on paper created by State Road Agency. Separately 500 and 100 wide buffer zones will be initiated for both T2 and its new section. For new section of road T2 that crosses two counties, hunters from both counties will be questioned to point possible underpass places for large vertebrates, taking into account main trails of animals. Comparison between information got from hunters and taken from GIS analysis will be done and possible underpass locations marked on a separate digital layer. Also prioritisation of these underpass locations will be done.

At the second stage of a study special field-works are planned to carry on in the study area: to check cross points of wildlife passages and new road corridor and mark their location with GPS on field, comparing these after with possible ones set up by using GIS analysis. Also, most optimal construction types of underpasses must be chosen for every location.

Outputs:

- Digital map with possible conflict areas of wildlife and bigger roads;
- Detailed plan of underpasses locations and construction types on new section of road T2 between Tallinn and Tartu;
- First draft of environmentally friendly road planning and building manual for state road agency use.

Inputs:

- Project team consists:
    - ? team-leader, also expert of game animals (12 month work);
    - ? expert of small animals (6 month work);
    - ? expert of plants and communities (6 month work);
    - ? expert of GIS and digital mapping (6 month work).
- Technical assistance about road building by State Road Agency.

Duration:

12 month (1.01.2000-31.12.2000)

Conclusions and recommendations

The traffic accidents caused by big mammals are quite rare in Estonia. These kinds of accidents very often cause material damages and the traffic insurance will pay car`s repaire only after the registration of the accidents. It`s possible to get this statistic material from police department and insurance firms. But we don`t knew how many amphibians and small mammals like hares, hedgehoges, foxes etc. were killed by cars. Every year we can find great number of dead amphibians on the roads. The amphibians are particularly unprotected animals for many reasons: *they have two migration periods - in spring they move towards the breeding ponds and in autumn they move back to their hibernation places. They often have to cross roads. When it takes place only few cars can kill them in masses. *they are active in twilight and in darkness, so it`s difficulty to notice them. *they move quite slowly and probability to be killed by vehicles is very high. *the nights are very often cold in Estonia in spring (the temperature is near the freezing point) and amphibians are almost motionless. In these nights we can see many stiff toads and frogs on the roads. They aren`t able to protect themselves from vehicles. Three main roads of Estonia will be reconstructed. In cooperation with local environmental protection agencies (governmental and public structures) and road-masters we have to find out the places where the conflicts between amphibians (and of course the other animals too) and vehicles are and decide how to protect them from traffic (underpasses, overpasses, tunnels etc.) before the construction work starts. It`s nessessary to find out the conflict places on the roads which will be not reconstructed and built different road crossing constructions too. These kind of investigations and works take a lot of time and it`s possible to help for example amphibians with other methods before (to collect them and take over the road etc.). Some (few) steps have been taken to protect amphibians in Estonia: *the speed limit has been lowered in the migration areas on the migration period *the warning traffic signs have been put on the road side.

References

Külvik, M. 1996. Status of biological resources. In ”Estonian Environment. Past Present and Future”, Tallinn, pp 36-40.

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Meiner, A. edited by. 1999. Land Cover of Estonia. Implementation of CORINE Land Cover project in Estonia. Tallinn, 133p.

Kull, T. edited by. 1999. Estonian Biodiversity Strategy and Action Plan. Tartu, 184p.

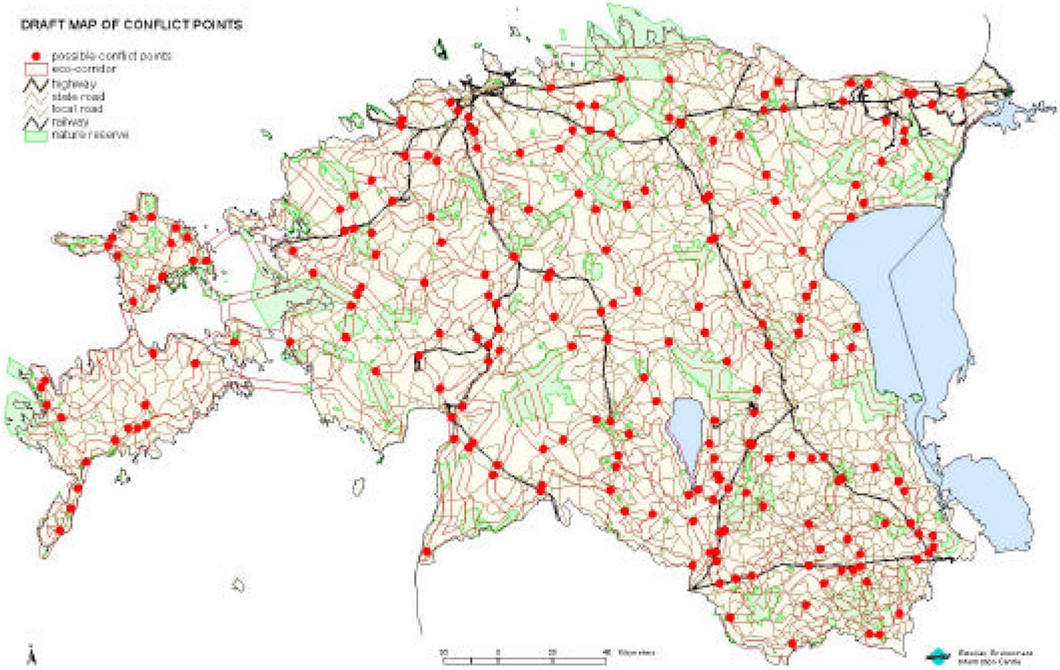
Internet:

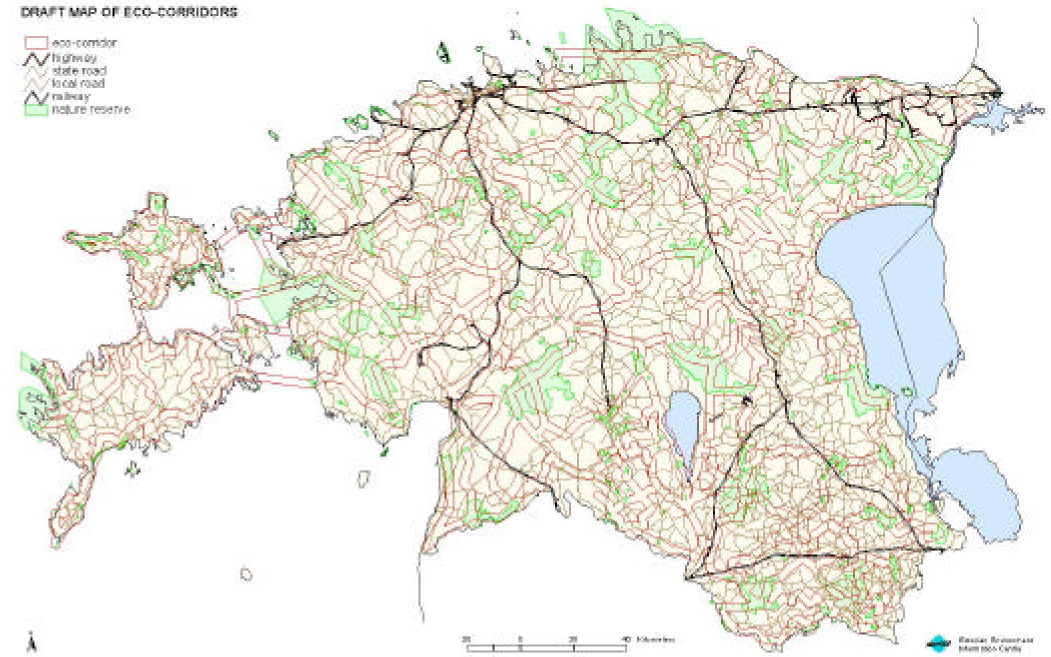
Home page of Estonian State Road Agency (in Estonian):
http://www.mnt.ee/

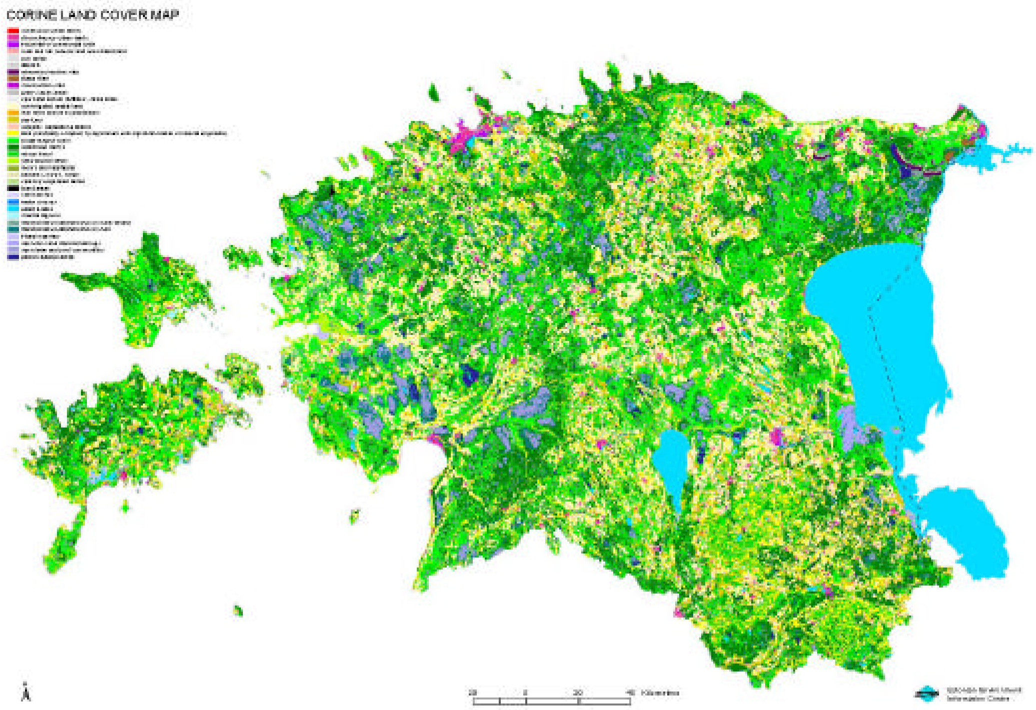
Home page of Statistical Office of Estonia:
http://www.stat.ee/wwwstat/eng_stat/

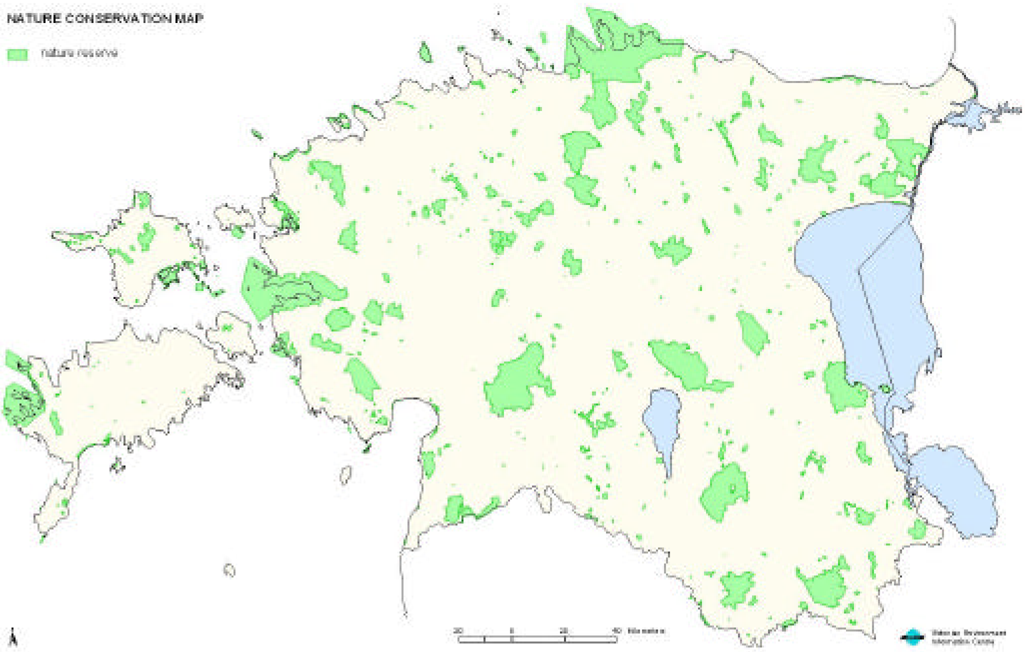
Annexes

Annex 1. CORINE LandCover map
Annex 2. Transportation infrastructure map
Annex 3. Nature conservation map
Annex 4. Map of eco-corridors
Annex 5. Map of main conflict areas
Annex 6.
List of protected and threatened species in Estonia
Protected:
Annex 7.
List of protected and threatened habitats in Estonia
Annex 8. Map of new section of Tallinn-Tartu road (T2)


DRAFT MAP OF CONFLICT POINTS
possible conflict points
eco-corridor
highway
state road
local road
railway
nature reserve
20 0 20 40 Kilometers


DRAFT MAP OF ECO-CORRIDORS
eco-corridor
highway
state road
local road
railway
nature reserve
20 0 20 40 Kilometers


CORINE LAND COVER MAP
20 0 20 40


NATURE CONSERVATION MAP
nature reserve
20 0 20 40

MAP OF NEW SECTION OF TALLINN-TARTU ROAD

TRANSPORTATION INFRASTRUCTURE MAP