**I. A. Trach; V. G. Petruk, Dr. Sc.(Eng.)., Prof.; V. A. Ishchenko, Cand. Sc. (Eng.), Assist. Professor; P. M. Turchyk**

# INFLUENCE OF TRANSPORT INFRASTRUCTURE ON ECOLOGICAL SAFETY OF MAMMALS

*The impact of transport infrastructure on ecologycal safety of mammals is studied. Environmental effects of the transport system, such as: habitats loss and transformation, disturbance due to emissions and edge effects, mortality due to traffic, habitats fragmentation and interruption of migration routes are analyzed.*

***Keywords:*** *ecological safety, transport infrastructure, mammals, edge effects, habitats fragmentation.*

## Introduction and problem setup

Ukraine is situated at the crossroads of migration routes of many wildlife species. The main threats to biodiversity are human activity and the destruction of natural habitats. Environment destruction happens due to plowing, deforestation followed by change of land usage target, land draining or irrigation, intensification of transport complex and landscape fragmentation, industrial, residential and suburban construction, etc. It is worth to highlight a transport system from limiting factors for wildlife populations. Besides, our time is characterized by an unprecedented scale of transportation. Transport services industry and agriculture, much of it is involved in serving people. Accordingly, scale of transport influence on environment is increased [1, 4]. Traffic on roads and railways disturbs ecological processes, increases animal mortality, leads to ecosystems degradation and populations isolation. Many wild animals are killed on the roads under the wheels of cars or facing them in flight [1 – 5].

Today, there are no effective developments for animals protection from vehicles in Ukraine. Much attention is paid to these problems abroad (Seiler, 2001; Langevelde, Jaarsma, 2004). For example, in Central Arizona (USA) the subways and bridges for animals are built along national highways with high probability of facing with wild animals. Such a practice is implemented in all countries which care about the wildlife conservation and driving safety, as animals not only create dangerous situations on the roads, but they are valuable components of natural ecosystems bordered with people.

Transport infrastructure has the following effects on wildlife and landscapes: direct habitats destruction in cases of road or water channel building or another building; chemical pollution by emissions from vehicle engines, fuel leaks, chemicals washing out by rain water or dust forms of chemical compounds; isolation of separate parts of habitats, populations, organisms or ecosystems (fragmentation); living organisms colliding with vehicles; landscapes change, impact on hydrological network, oppression of internal species. Significant influence happens in the space, causing fragmentation of landscapes and habitats, fragmentation of areas to sizes leading to the extinction of certain species or communities [6].

**The purpose of the work** is investigation of transport infrastructure influence on ecological safety of mammals.

## Main part

Biodiversity conservation, rational natural resources management, reducing the consequences of negative human impact on the living organisms are not possible without deep comprehensive study of animal populations. One of the directions of such research is studying the migration of populations and consequences of their fragmentation as a result of anthropogenic influence. Analysis of these studies shows the evidence of negative impact of roads and whole transport system on wildlife population. Roads are artificial barriers in the environment fragmenting it and isolating some areas, that leads to decreasing of wildlife populations and corruption of ecosystems

stability. The problem of wild animals' mortality on the roads is connected to increasing number of vehicles and traffic density as well as to development of road infrastructure which fragment the landscapes, create artificial barriers to animals migration and increase the potential threat to the existence of their populations [6-7]. Fragmentation of infrastructure leads to the dismemberment of wildlife habitats and it is a prerequisite to a corruption of connectivity as objects of infrastructure without movement can be considered as permeable for animals. The fences create a real barrier to animals' movement. The denser fence is, the harder for smaller sized animals overcome the barrier.

The most influential parameters correlating with landscape fragmentation degree is population density, gross domestic product per capita, density of passenger traffic (1000 passengers-km/km$^2$) and rate of commodity circulation (1000 tons per capita). Transport is a sector existing at the intersection of the production sector and the service sector. It does not create wealth but provides transportation of goods and people, developing relationships between companies, industries, regions [7-10].

Road landscapes are specific ecosystems whose peculiarity is caused by properties of road transport operation. When considering the road landscapes, the main focus is on negative impact of transport on the environment, which mostly comes down to pollution. The environmental impact of road landscapes on the environment can be compared to the impact of industrial landscapes, but in the case of industrial landscape impact focuses on limited areas, and in the case of road landscape (elongated, linear) – on much larger areas.

The result of roads operation and their interaction with the environment is not only road landscapes, but also gradual formation and active functioning of peculiar road ecozones. By spatial scale road ecozones are much larger than road landscapes. Road landscape research indicate that road ecozones are complex formation comprising several micro zones: zone of anthropogenic impact, zone of chemical contamination, zone of pollution and destruction of soil, zone of water pollution, zone of air pollution, zone of energetic pollution, zone of light effects, zone of aesthetic pollution (Fig. 1).

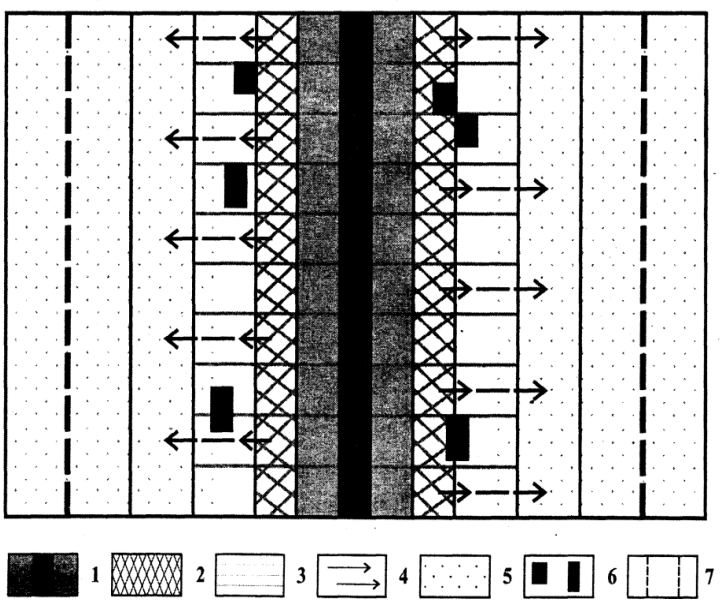


Figure 1 – Road ecozones (ideal case): 1 – zone of road; 2 – zone of technogenic impact; 3 – zone of chemical contamination; 4 – zone of energy pollution; 5 – zone of air pollution; 6 – zone of aesthetic pollution; 7 – zone of landscape pollution.

Above mentioned micro zones form together the micro zone of landscape pollution. This micro zone conduces to corruption of regenerative capacity of natural or existing road landscapes, and to

habitats destruction. In this case the state of the environment is corrupted, at which the self-regulation and restoration of biosphere components are provided. In the reserve-technological road line the side and adjacent landscape ecotones are appeared with corrupted ecosystems whose functioning is supported by the following groups of factors:

barrier factors (slopes, excavations, hedges, screens, roads) preventing the natural migration of species to their habitats, sharing genetic information, reproduction, nutrition);

disturbed (noise, vibration, light) scaring animals and changing their habitat;

factors contributing to chemical contamination of habitats;

factors leading to facing animals with cars and deaths on the roads.

It should be noted that highways impact on wildlife in other way than forest roads or railways. Sometimes the overall effect of environment fragmentation as a result of transport infrastructure can be quite unpredictable. Therefore, environmental effects assessment during road construction requires special studies.

Factors determining the risk of facing animals and vehicles are well known. They are traffic intensity, animals activity, their population density and biological rhythms associated with reproduction and migration.

Table 1 shows main types of transport infrastructure and its possible environmental impact.

Table 1

**Types of transport infrastructure and their environmental impacts**

| Type of infra-structure | Highways | Secondary roads | Tertiary roads | Railways |
|---|---|---|---|---|
| Regional gradation | barrier<br>isolation<br>mortality<br>disbalancing | barrier<br>isolation<br>mortality | corridor | fragmentation<br>corridor<br>mortality |
| Local gradation | barrier<br>disbalancing mortality | mortality<br>disbalancing<br>loss of habitat part<br>barrier | loss of habitat part<br>corridor | mortality<br>disbalancing<br>loss of habitat part<br>corridor |

In this table environmental effects are placed in the order of significance of their influence on the environment. Thus, highways create a larger barrier to wildlife than small roads or railways. Their impact should be studied first. Habitats losses due to roads construction are more important in local gradations. Regional highways can eliminate from a landscape up to 10 hectares per 1 linear kilometre of road. However, secondary and tertiary roads accounting their large numbers form joint effect which may exceed the highways effect. Therefore, the spatial distribution during new road construction should be a priority in the planning.

Transport networks divide natural habitats into small isolated areas and create barriers between them. This division can have following primary effects: reducing the size of habitat parts to such a degree that these parts can not maintain viable populations of important species; resulting to such a mutual isolation, when individuals can not move between habitat parts, and therefore, their population will be reduced. Due to these processes of habitats dividing by transport networks the secondary effects are formed having become one of the most serious global threats to wildlife [8-10].

The primary factors have a negative impact on biodiversity and cause a number of negative environmental consequences: habitats loss, barrier creation, bruising and wounding, vehicle facing with wild animals, disturbance and pollution, ecological functions of roadsides, development of infrastructure edges. Secondary factors usually exist outside the responsibility of the transport sector, but should be considered in strategic environmental assessments, as well as in assessments of impact on the environment. In areas where secondary linear development along existing road

network is the main threat to important wildlife conservation strategies, the measures to reduce road noise or to withdraw some roads should be provided. One of the major secondary threats related to infrastructure development is increase of people's access and disturbance. Networks of small forest roads allow hunters and tourists the access to wildlife habitats. Some projects have to include the establishment of sites for car parking or roadside parking lanes to minimize wildlife disturbance. However, when the object of infrastructure is already built, it is very difficult to restrict the access to the adjacent area, even if it has the highest protection level.

## Conclusions

To ensure the balance of ecosystems it is better to avoid road construction where possible. If there is no possibility to avoid new construction or reconstruction, one should establish constructions for crossing the roads by animals. These structures must include special passages for wild animals: bridges, "green" bridges designed especially for wild animals, culverts, drainage pipes, etc. Some mammals avoid crossing two lane roads with a traffic rode even less than 100 vehicles per day, so the constructions for road crossing are needed even on small roads of non-intensive use.

## REFERENCE

1. Best Management Practices for wildlife Corridors / P. Beier, D. Majka, S. Newell [and others] // Northern Arizona University January. – 2008. – Vol. 1. – № 3. – P. 1 – 14.

2. Daily G. C. Nature's services: societal Dependence on Natural Ecosystems / G. C. Daily. – Island Press, Washington, 1997. – 392 p.

3. Dodd N. L. Evaluation of measures to minimize wildlife-vehicle collisions and maintain wildlife permeability across highways in Arizona, USA / N. L. Dodd, J. W. Gagnon, R. E. Schweinsburg // Animal-vehicle collision reduction. – ICOET 2003 Proceedings. – 2003. – P. 353 – 354.

4. Habitat Fragmentation due to Transportation Infrastructure. WILDLIFE AND TRAFFIC [Електронний ресурс] / A European Handbook for Identifying Conflicts and Designing Solutions (Project: COST 341). – 2003. – Режим доступу: http://www.iene.info/wp-content/uploads/COST341_Handbook.pdf.

5. Langton T. E. S. Reasons for preventing amphibian mortality on roads / T. E. S. Langton // Amphibians and roads. Shefford: ACO Polymer Products. – 1989. – № 3. – P. 75 – 80.

6. Langevelde van F. Using traffic flow theory to model traffic mortality in mammals / Van F. Langevelde, C. F. Jaarsma // Landscape ecology. – 2004. – Vol. 19. – P. 895 – 907.

7. Puky M. Amphibian mitigation measures in Central-Europe / M. Puky // Proceedings of the International Conference on Ecology and Transportation. Lake Placid. – 2003. – P. 413 – 429.

8. Roberge J. -M. Usefulness of the Umbrella Species concept as a conservation Tool / J. -M. Roberge, P. Angelstam // Conservation Biology. – 2004. – Vol. 18. – P. 76 – 85.

9. Rybacki M. Zagrożenie płazów na drogach Pieninskiego Parku Narodowego / M. Rybacki // Pieniny – przyroda i człowiek. – 1995. – № 4. – P. 85 – 97.

10. Seiler A. Ecological effects of roads. (A review) / A. Seiler // Introductory Research Essay (Department of Conservation Biology) SLU Uppsala. – 2001. – № 9. – P. 1 – 40.

***Trach Iryna*** – Postgraduate student with the Department of Ecology and Environmental Safety.

***Petruk Vasyl*** – Dr. Sc.(Eng.)., Prof., Director of the Institute of Environmental Safety and Monitoring.

***Ishchenko Vitaliy*** – Ph. D., Associate professor, Head of the Department of Ecology and Environmental Safety.

***Turchyk Pavlo*** – Assistant with of the Department of Ecology and Environmental Safety.
Vinnytsia National Technical University.