Impact of Struma Motorway on selected wildlife populations and effectiveness assessment of defragmentation facilities

Main highlights of research conducted in the period 2017-2020

Transnational Experience Exchange Workshop

Dupnitsa, Bulgaria, 11-12 May 2022

Nina Stoilova, Road Infrastructure Agency

Grounds for carrying out the research work

- Research project in support of PhD students, Research Fund "The impact of AM Struma on model populations of vertebrates and evaluation of the effectiveness of defragmentation facilities", 2017.
- Research project in support of PhD students, Scientific Research Fund "The influence of Struma Motorway on the structure and dynamics of model populations of vertebrates.", 2018
- In 2020 is a protected dissertation with the subject: "The influence of Struma Motorway on model populations of vertebrates and evaluation of the effectiveness of defragmentation facilities", 2017.
- Although it is a dissertation, I believe that the scientific work could be a good basis for the development of the project.

Objectives and tasks

Objective 1: To determine the impact of the Struma Motorway on model vertebrate populations

- ***Basic tasks:***
- ***Analysis of the legal basis, strategic and administrative documents and projected impacts of the motorway on biodiversity***
- ***Determination of species composition and number of vertebrates along the Struma River***
- ***Determination of target and model species***
- ***Determination of the landscape and linear corridors in the area***
- ***Determining structural connectivity of highway habitats (highway transparency)***
- ***Evaluation of fragmentation***
- ***Determination of total permeability based on multicriteria analysis***
- ***Analysis of wildlife mortality data in Kresnen Gorge and definition of "critical points"***

Objective 2: Evaluation of the effectiveness of defragmentation facilities in the scope of AM Struma

- ***Basic tasks:***
- ***Field survey to record technical, landscape and anthropogenic characteristics of the considered facilities***
- ***Monitoring of the realized transitions on specialized and non-specialized facilities***
- ***Identification of significant facilities for the movement of model species***
- ***Defining movement behavior***
- ***Assessment of functional connectivity of habitats and effectiveness of the wildlife crossings***
- ***Assessment of culverts, fences and guiding structures***
- ***Determination of measures to increase the efficiency of all facilities within the scope of the highway and the general permeability of the highway***
- ***Determination of key components for effective landscape design and site location of wildlife crossings***

Analysis of legal basis, strategic and administrative documents

BASIC TASKS:

- Collection of data on carried out procedures under Environmental Protection Act, Law on Biodiversity and protected Areas Act
- Analysis of the fulfilled conditions and mitigating measures from Decisions No. 1-1/2008. and Decision No. EO-7/2013 of the Ministry of Environment and Water (MoEW)

METHODOLOGY:

- Analysis of all current general and special regulations in accordance with the Unified Methodology for Functional Analysis of Regulations Core Principles by Jones, 2010
- Implementation of measures and conditions from decisions and opinions of the MoEW

Analysis of legal basis, strategic and administrative documents

CONCLUSIONS:

1. The administrative order for the processing of investment proposals, according to the requirements of the Environmental Protection Act, Biodiversity Law and Protected Areas Act, has been complied with. An analysis of the legal basis shows that the measures laid down in the main EIA Decision, as well as those from the Decisions on route displacements and reconstructions of linear networks, have been implemented.
2. Gaps in terms of the effectiveness of wildlife crossings are mainly found in the components that are not enshrined in the final administrative acts, and some of the measures turn out to be inexpedient. (Noise protection walls in order to limit the mortality of protected species in the Kocherinovo Nature Reserve or lack of instructions for placing bird nets at the Rilska River bridge facility).
3. I believe that a more detailed description of the technical and landscape parameters in the EIA Decisions is necessary or, on the contrary, a more general set of measures with the aim of their detailed processing by experts in the specific areas at a later stage of the design.

Landscape permeability (biocorridors)

Basic tasks:

- Determination of transverse landscape corridors in the area based on total forestation, connectivity between ecologically significant habitats, main mountain ranges and Natura 2000 sites
- Determining the linear corridors within the scope of the landscape through the preparation of a spatial model using ArcGis 10.4 based on the distance from settlements, land use, slope, topography, etc.

Methodology:

- Designing Wildlife Corridors with ArcGIS (Beier, 2007)
- Conceptual steps for designing wildlife corridors (Beier, 2007)
- Evaluation of the corridor according to the 4-level assessment of Sicirec Group B.V., 2008 (1- buffer zone or wild habitat, 2- landscape corridor, 3- linear corridor, 4 – stepping stone corridor)
- Evaluation of the corridor according to the 3-level evaluation of dr. Karin Ullrich (1- corridor of national importance, 2- corridor of regional importance, 3- local corridor)
- "Bottle neck" corridors (Clevenger A. and M. Huijser, 2011)

Established landscape corridors

Wolf (Canis lupus)
Biocorridor Ostritsa - Vitosha (Lot 0)
Biocorridor Konyavska Planina - Verila (Lot 1)
Biocorridor Oranovsky Prolom (Lot 3)
Natura 2000 site - Kresna - Ilindenci (Lot 3)

Bear (Ursus arctos)
Biocorridor Ostritsa - Vitosha (Lot 0)
Biocorridor Verila - Konyavska Planina (Lot 1)
Biocorridor Oranovsky Prolom (Lot 3)
Natura 2000 site Ilindenci (Lot 3)

Tortoises (Testudo sp.)
Biocorridor Ostrica – Vitosha (Lot 0)
Biocorridor Ostritsa - Konyavska Planina (Lot 1)
Biocorridor Skrino - Konyavska Planina (Lot 2)
Biocorridor Oranovsky Prolom (Lot 3)
Natura 2000 site Kresna - Ilindenci (Lot 3)
Natura 2000 site Rupite-Strumeshnica (Lot 4)

Caspian turtle (Mauremys Caspica) and European pond turtle (Emys orbicularis)
Natura 2000 site Rupite-Strumeshnica (Lot 4)

Otter (Lutra lutra)
Biocorridor Skrino - Rila Buffer - Kresna(Lot 2)
Natura 2000 site Kresna - Ilindenci (Lot 3)
Natura 2000 site Rupite-Strumeshnica (Lot 4)

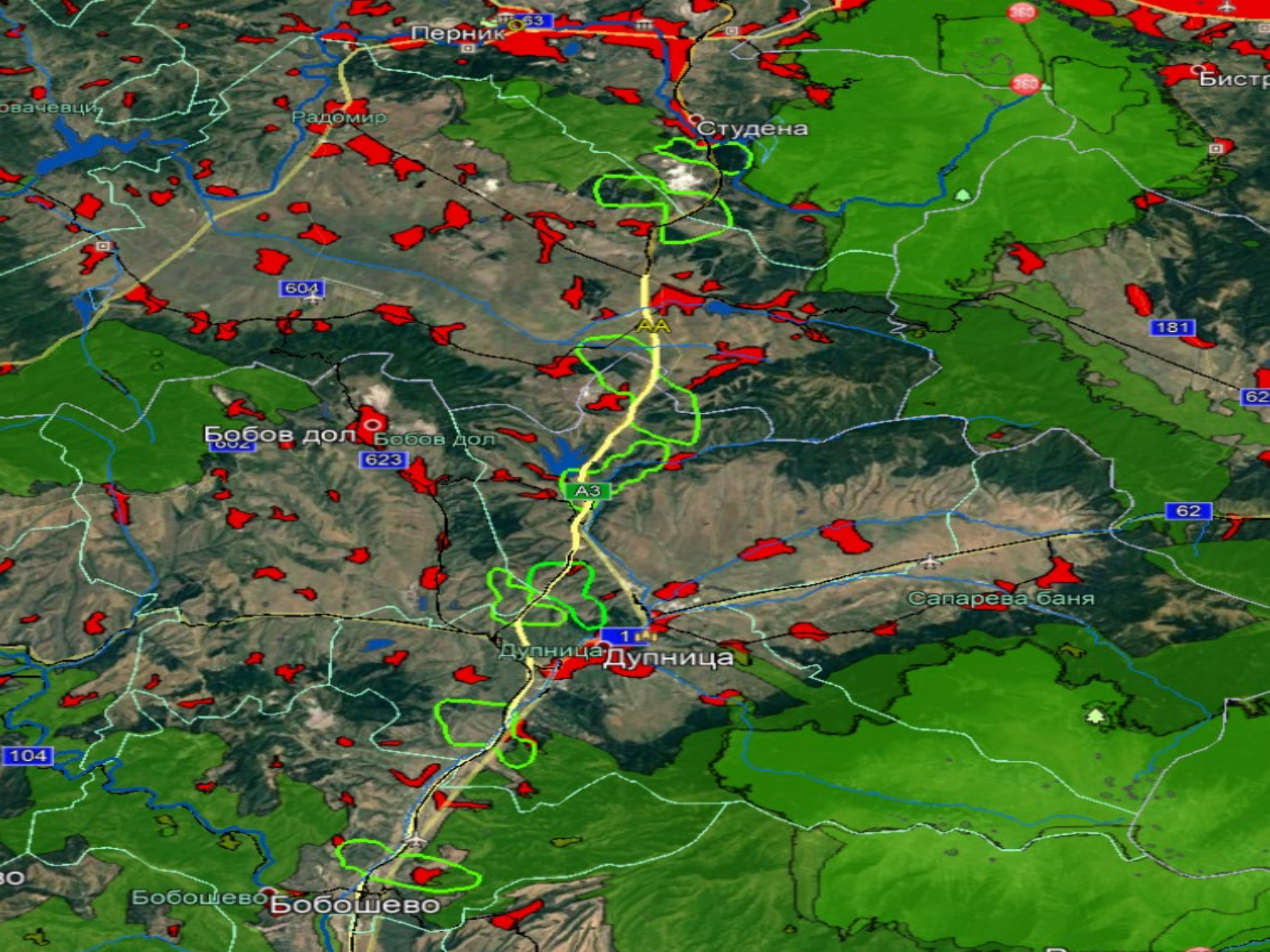
European ratsnake (Zamenis situla) and four-lined snake (Elaphe quatorlineata);
Natura 2000 site Kresna - Ilindenci (Lot 3)
Natura 2000 site Rupite-Strumeshnica (Lot 4)

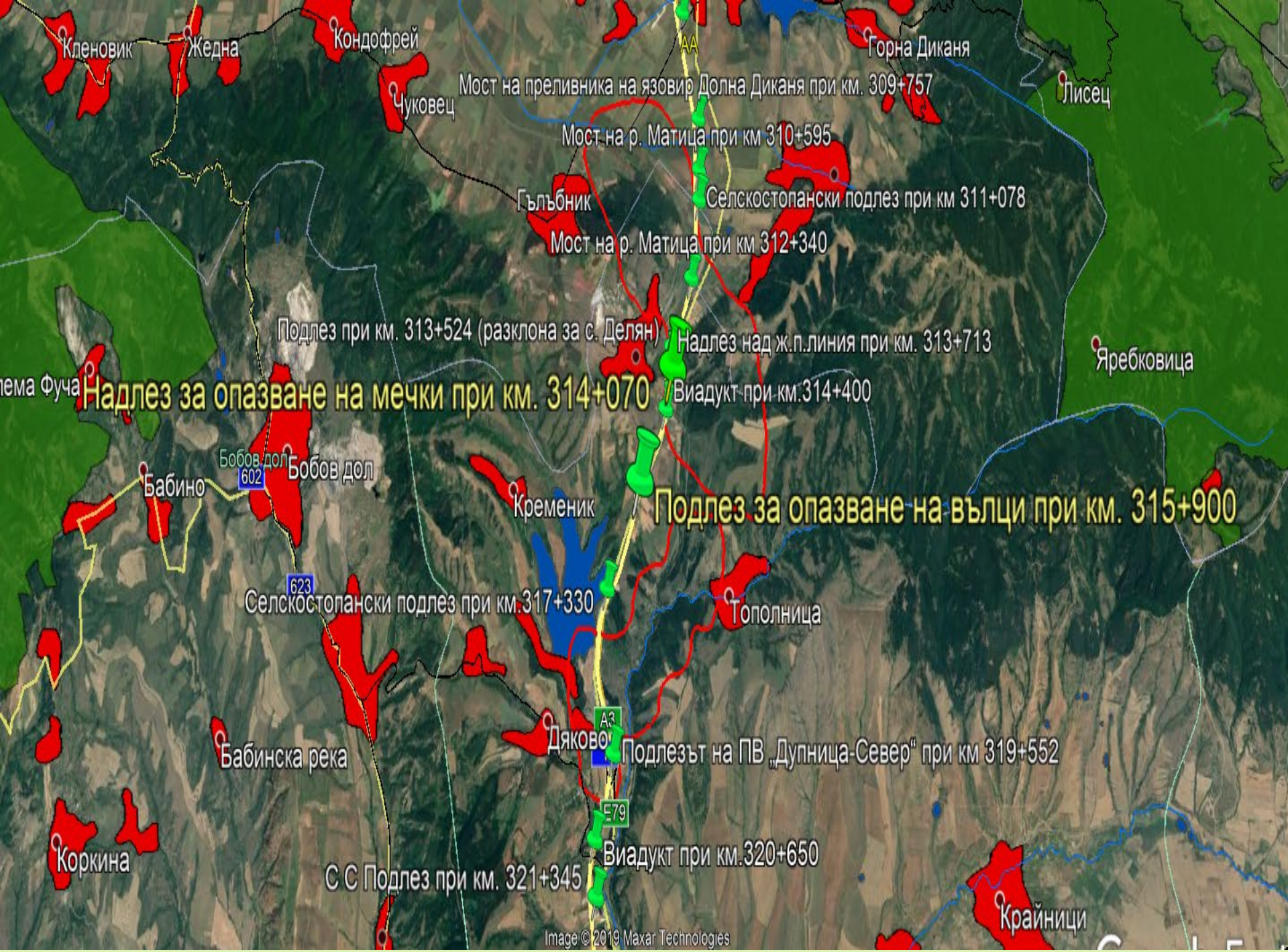
Established linear corridors

For the analysis of the linear corridors within the scope of the first three sections of the "Struma" AM, we used a geographic information system ArcGis 10.3.1. model.

The input layers are as follows:

- Route of AM "Struma“
- Water bodies
- Settlements
- Protected Areas
- Natura 2000 sites
- Land use
- Slope
- Topographic map


Перник
Радомир
Студена
Бобов дол
Бобов дол
Сапарева баня
Дупница
Дупница
Бобошево
Бобошево
604
623
63
181
62
104
1
А3
АА


Кленовик
Жедна
Кондофрей
Чуковец
Мост на преливника на язовир Долна Диканя при км. 309+757
Горна Диканя
Лисец
Мост на р. Матица при км 310+595
Гълъбник
Селскостопански подлез при км 311+078
Мост на р. Матица при км 312+340
Подлез при км. 313+524 (разклона за с. Делян)
Надлез над ж.п.линия при км. 313+713
Яребковица
Надлез за опазване на мечки при км. 314+070
Виадукт при км.314+400
Бобов дол
Бобов дол
602
Бабино
Кременик
Подлез за опазване на вълци при км. 315+900
623
Селскостопански подлез при км.317+330
Тополница
A3
Дяково
Подлезът на ПВ „Дупница-Север“ при км 319+552
Бабинска река
E79
Коркина
Виадукт при км.320+650
С С Подлез при км. 321+345
Крайници
Image © 2019 Maxar Technologies

Linear corridors

- **Conclusions:**
- In terms of medium and large mammals, the following landscape corridors are crossed within the scope of the examined sections: Biocorridor "Ostritsa - Vitosha" (Lot 0), for which we register complete fragmentation, Biocorridor "Konyavska planina - Verila" (Lot 1) and Corridor "Skrino" - Rila Buffer" which have good permeability for mediums and large mammals. Biocorridor "Skrino - Rila buffer - Kresna" (Lot 2) is along the route with more significant importance for small to medium mammals (mostly in relation to the otter (Lutra lutra). The corridor is not fragmented.
- In the studied area from km 288 to km 359, we also established 8 linear corridors by means of GIS analysis. Our assessment shows that Corridor 1 (Sudena village), Corridor 2 (Staro Selo village), Corridor 6 (German town) and Corridor 7 (Slatino village) are completely fragmented, while Corridor 2 (Delyan village), corridor 3 (Topolnitsa village), corridor 4 (Piperovo village) and corridor 5 (Dupnitsa town) have high permeability for large mammals.

Objective 3: Determination of the species composition and number of vertebrates along the Struma River

Basic tasks:

- *Review of literature data on species composition*
- *Analysis of EIA data for the site and the Standard Natura 2000 data forms of nearby areas*
- *A transect method for determining occurrence and abundance within lot 1 extent*
- *Conducting a survey of the local population*
- *Identification of target species*
- *Defining model types*

Determination of model and target species

Methodology of Ford A., A. Clevenger, 2010 for the effective selection of model species

1. Ursus arctos (Brown bear)
2. Canis aureus (Golden jackal)
3. Canis lupus (Grey wolf)
4. Vulpes vulpes (Red fox)
5. Felis silvestris (Wild cat)
6. Cervus elaphus (Red deer)
7. Capreolus capreolus (Roe deer)
8. Sus scrofa (Wild Boar)
9. Martes foina (Beech marten)
10. Meles meles (European badger)
11. Mustela putorius (European polecat)
12. Lepus europaeus (European hare)
13. Mustela nivalis (Least weasel)
14. Erinaceus europaeus (European hedgehog)
15. Lutra lutra (Eurasian otter)
16. Reptiles and amphibians

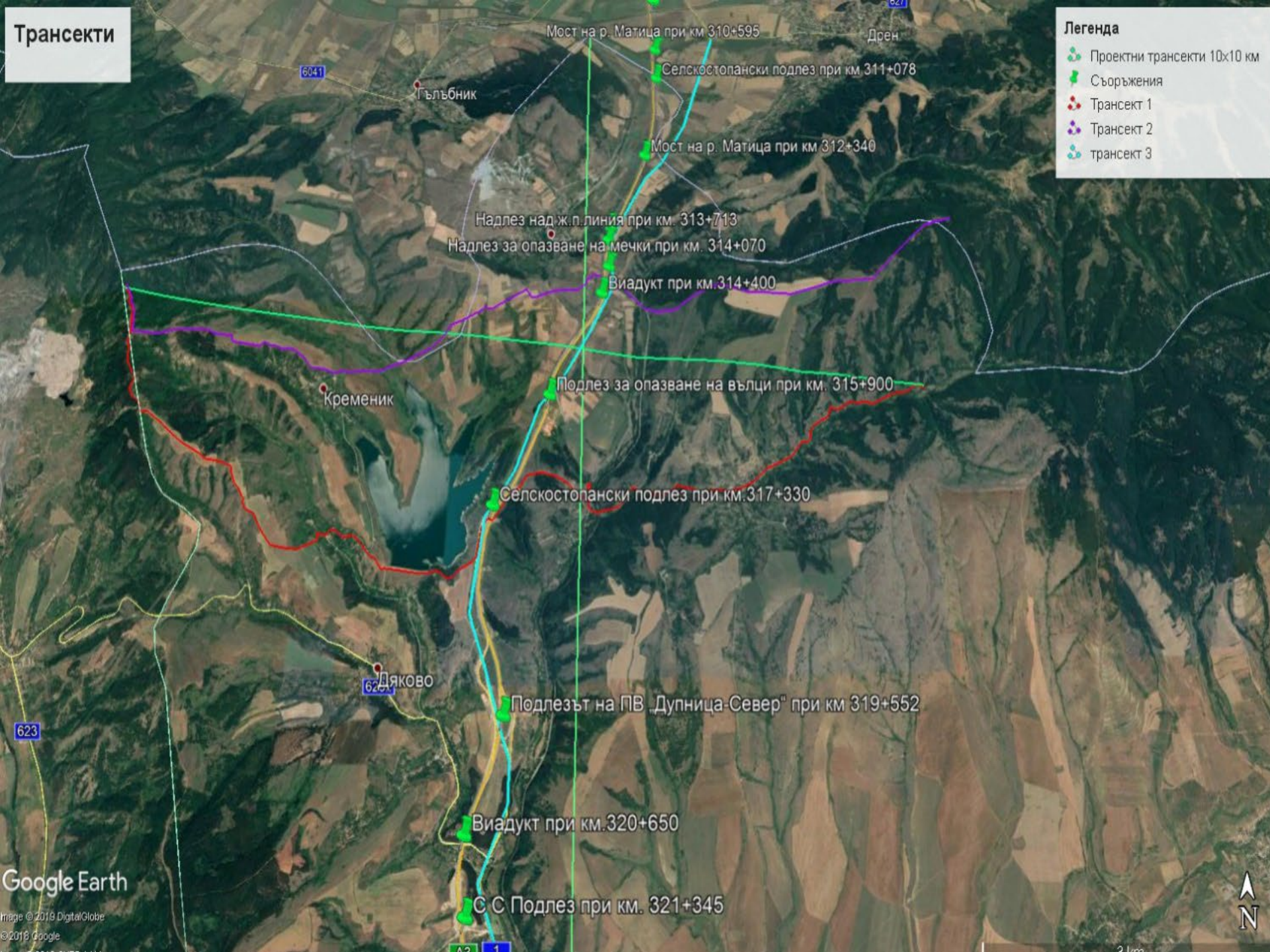
Determination of model and target species

In view of their requirements regarding passage structures (size, location, distances from settlements, tolerance to human presence), the studied species of large and medium mammals are divided into 4 groups (Table IV.1.9.1), as proposed by Kachamakova, 2017 distribution:

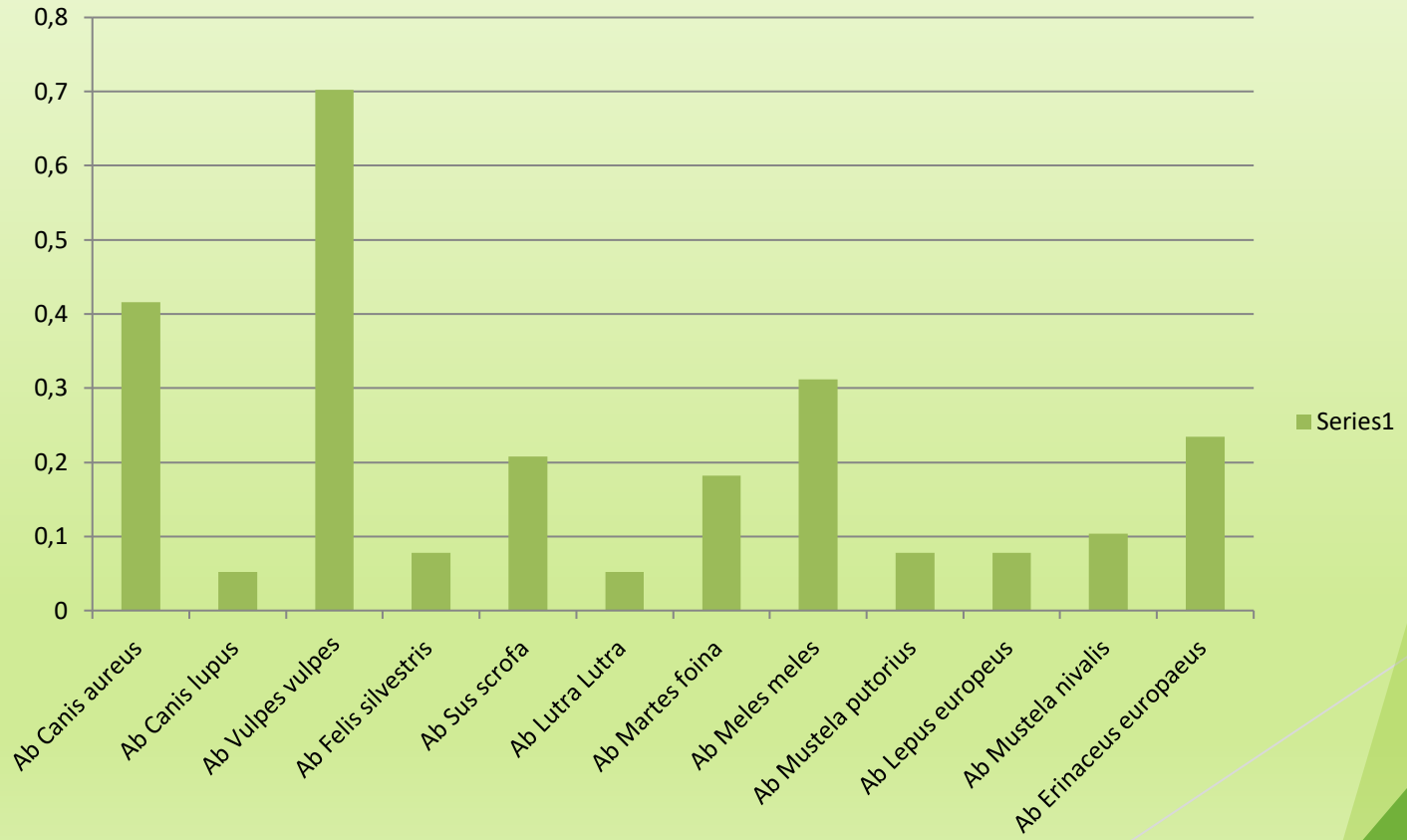
Group	Species	Index of opening above which the facility is considered appropriate
1	Beech marten, red fox, wild cat, badger, hadgehok, least weasel, European polecat, otter	1
2	Wolf, golden jakal	2
3	Roe deer, wild boar, hare	3
4	Brown bear, red deer	4
5	Reptiles&amphibians	Not applicable

Density, abundance and occurrence of model species

- Abundance was recorded using the transect method and calculated using the formula A = n/L*1000, where n is the number of traces of vital activity, and L is the studied route in linear meters.
- Occurrence is defined as a percentage/part of the number of sites where the species is registered. F= n/N*100, n - number of test sites in which the species was registered, N - total number of test sites.
- The test sites are 10 km by 10 km in size, in order to cover a minimum perimeter for the brown bear (Ursos arctos, Linnaeus, 1758). Abundance and occurrence reporting was done only in the section of Lot 1, where the passages for large mammals are located.
- The species occurrence poll/inquiry was developed for the specific scientific study, according to the "Methodology for carrying out a survey of public opinion". It is consistent with the objectives of the study, but also with the standards for this type of statistical study. (Appendix 5)


Трансекти
Легенда
Проектни трансекти 10x10 км
Съоръжения
Трансект 1
Трансект 2
трансект 3
Мост на р. Матица при км 310+595
Селскостопански подлез при км.311+078
Гълъбник
Мост на р. Матица при км 312+340
Надлез над ж.п.линия при км. 313+713
Надлез за опазване на мечки при км. 314+070
Виадукт при км.314+400
Кременик
Подлез за опазване на вълци при км. 315+900
Селскостопански подлез при км.317+330
Дяково
Подлезът на ПВ „Дупница-Север" при км 319+552
Виадукт при км.320+650
С С Подлез при км. 321+345
Google Earth
Image © 2019 DigitalGlobe
© 2016 Google
N

Reported abundance by species



Comparability between Lot 1 data obtained by the transect method and those obtained by the local population survey:

Species	Total number of registrations by transect method	Number of respondents who confirmed the presence of the species in the scope of lot 1	Match ratio (1 - full match, 0 - no match)
Ursus arctos	0	3	0
Canis aureus	16	6	0.4
Canis lupus	2	6	0.3
Vulpes vulpes	27	11	0.4
Felis silvestris	3	5	0.6
Cervus elaphus	0	0	1
Capreolus capreolus	6	10	0.6
Sus scrofa	8	9	0.9
Lutra Lutra	2	5	0.4
Martes foina	7	9	0.8
Meles meles	12	11	0.9
Mustela putorius	3	9	0.3
Lepus europaeus	3	6	0.5
Mustela nivalis	4	8	0.5
Erinaceus europaeus	9	11	0.8

Determination of species composition and population number of vertebrates along the Struma River

Conclusions:

- By means of a transect method in the study area, we found the strongest presence of the species of red fox (Vulpes vulpes), badger (Meles meles), jackal (Canis aureus) and those of the family Mustelidae). No traces of vital activity of red deer (Cervus elaphus), brown bear (Ursus arctos) and wolf (Canis lupus) were recorded.

- Data on the presence of a brown bear (Ursus arctos) are highly controversial. According to the local population, the species is present, while the data from the field work as well as those from the photo traps indicate the opposite.

Determining structural connectivity of highway habitats (highway transparency)

BASIC TASKS:

Taking technical characteristics of facilities (dimensions, sections, slopes, physical barriers, etc.)

Evaluating the suitability of the various technical facilities for the passage of animals from a specific model group according to Huber's methodology

Calculation of transparency by kilometer, by sections and for the entire highway and for individual model groups

Structural connectivity of freeway habitats (freeway transparency and percent permeability)

Methodology:

- The recording of the technical characteristics of the facilities was carried out according to the scheme of Gurrutxaga, 2010 for determining the section of the facility, according to the following formula: W*H/L, where W is the width of the facility, H is the height and L is the length.
- Assessment of the suitability of the facilities will be carried out according to a ten-point system, used for the first time in the Republic of Croatia (Huber, 2002, Kusak, 2005) for a similar type of study and adapted for Bulgarian conditions by Racheva, 2005.
- Percent permeability was calculated using the formula P = (1/L)*100, where P is the percent permeability, L is the total length of the studied section, and 1 is the total length of structures passable for a specific target group.
- The estimate per kilometer or also called "transparency" (Racheva, 2005) is the general estimate of all objects to the length of the section. It is divided into three main categories:

  weak – with an overall rating per kilometer from 0 to 1.5;

  medium – with a total rating per kilometer of 1.5 to 2.5;

  high – with a total rating per kilometer above 2.5.

Section	Milledge	Settlements	Number of facilities	Widht	Assessment according Huber	Assessment per km	Width to Length/ in %	Bio-corridor
LOT 0	From km 288 to km 293	From road junction Dragichevo to Studena village	4	32.00	6	1.2	0.64%	
LOT 0	From km 293 to km 298	From Struden v. to Bosnek v.	7	45.50	7	1.4	0.91%	Ostritsa – Vitosha
LOT 0	From km 298 to km 303	From Bosnek to Staro selo	5	24.50	4	0.8	0.49%	
LOT 0	From km 303 to km 308	From Staro selo to Dolna Dikanya	2	62.00	3	0.6	1.24%	
LOT 1	From km 308 to km 313	From Dren to Delyan	4	84.50	5	1	1.69%	
LOT 1	From km 313 to km 318	From Delyan to Dyakovo	6	383.00	27	5.4	7.66%	Konyavska planina Mtns. – Verila Mtns.
LOT 1	From km 318 to km 323	From Dyakovo to Blatino	4	584.50	19	3.8	11.69%	
LOT 2	From km 323 to km 328	From Piperovo to Golyamo selo	2	958.00	18	3.6	19.16%	
LOT 2	From km 328 to km 333	From Dupnitsa to Dzherman	5	517.00	21	4.2	10.34%	
LOT 2	From km 333 to km 338	From Dzherman to Usoyka	3	77.80	4	0.8	1.56%	
LOT 2	From km 338 to km 343	From Slatino do Mursalevo	5	44.00	11	2.2	0.88%	
LOT 2	From km 343 to km 348	From Mursalevo to Borovets	5	485.00	16	3.2	9.70%	
LOT 2	From km 348 to km 353	From Kocherinovo to Byalo pole	6	861.00	36	7.2	17.22%	Skrino – Rila bufer
LOT 2	From km 353 to km 359	From Byalo pole to Zelenodol	4	56.00	12	2.4	1.12%	Skrino – Rila bufer
		Total	**63**	**4214.00**	**189**			

Table V.3.3 : Results for transparency determined by lots/road sections

Road section/ LOT	Miledge	Length of the road section	Number of facilities	Width of the facility	Width to lenght	Assessment according Huber	Assessment per km	Total assessment
LOT 0	From km 287+546 to km 305+469	17.93	17	108.50	0.61%	19	1.1	weak
LOT 1	From km 305+469 to km 322+000	16.53	14	767.00	4.64%	43	2.6	high
LOT 2	From km 322+000 to km 359+453.82	37.45	31	3337.80	8.91%	127	3.4	high
Total		71.907	62	4214.00	5.86%	189	2.62	

Structural connectivity of habitats along the motorway (motorway transparency and percent permeability)

Conclusions:

The section from km 348 to km 353 between the village of Kocherinovo and the village of Byalo Pole on Lot 2 with a rating of 7.2 and fully ensuring the ecological corridor "Skrino - Rila Buffer" is the most passable for mammals, followed by the section from km 313 to km 318 (the village of Delyan to the village of Dyakovo) with an estimate of kilometer 5.4, which in turn provides the corridor "Konyavska planina - Verila“

The "Ostritsa - Vitosha" corridor is completely fragmented.In terms of transparency, the newly constructed sections show a much higher permeability than the first section of the highway. Transparency in general in the scope of Lot 1 and Lot 2 is high, and low is registered only on Lot 0.

However, we believe that the bear-relevant corridors are more likely at the beginning of the highway, where permeability is determined to be weak.

Determining functional habitat connectivity and effectiveness of wildlife crossings

BASIC TASKS:

- **Monitoring of realized wildlife crossings using photo traps, track strips and tracks in the substrate.**
- **Monitoring of passing wild animals on non-specialized facilities by means of field survey**
- **Analysis of the results for the effectiveness compared to the expected according to literature data, according to realized crossings and according to the abundance of model species in the area**
- **Determination of seasonal and diurnal movement behavior (dynamics, group and "avoidance" behavior)**

Functional connectivity of habitats (facility efficiency)

Methodology:

- Trace bands (Yanes et al, 1995, Rodriguez et al, 1997)
- Photo traps records(Clevenger A. and M. Huijser, 2011)
- Tracking (Veenbaas, and Brandjes, 1999)

An assessment of the effectiveness of wildlife crossings was compared with crossing data and data on species diversity and abundance of model species. Using statistical methods in data analysis requires control and a sufficiently large sample (Clevenger and Waltho, 2005).

Efficiency of facilities

Results:

- **Registrations of reptiles and amphibians**

A total of 20 species from the classes of reptiles and amphibians were registered within the scope of the study. Their registration was done during the field surveys, and the date and location of registration were recorded for each registered species. 7 of the registrations were made within the scope of Lot/Section 3, 6 of tunnel 1 by road section.

A key reptile corridor within the scope of the study area is Tunnel No. 1 from km 324+460 to km 324+840.

Another facility with a greater concentration of reptile and amphibian species is at the Slatinska River.

The species Hermann's tortoise (Eurotestudo hermanni) and dice snake (Natrix tessellata) have the most registrations, 4 and 3 respectively. A full description of the registrations is given in Table V.5.1

The area of Kresnensko defile and Lot 4 are also key corridors along the route in terms of reptiles and amphibians.

Efficiency of facilities

Results:

- Mammal registrations

By means of photo traps 5 facilities were monitored (overpass for bears, underpass for wolves, viaduct at km 320+650. In total, 448 trap days were carried out with 140 registrations through photo traps. The photo traps at the Bridge over the Struma River near the village of Studena and River Canal at km 321 +500 were stolen as soon as they were put in. Despite the impossibility of conducting a field survey, clear signs of wildlife crossing were reported at both facilities.

Track registrations do not have a statistical character, as the fieldwork was conducted once a month. A total of 64 trail registrations were made, with the data used to determine a portion of the phototrap registrations and to prepare the model species list.

On the overpass, only a few registrations are observed per month, and on the underpass, the average number of registrations is one per day.

Efficiency of facilities

Results:

Passages of the following model species were recorded through tracks and photo traps:

Vulpes vulpes (42 records); non identified (28); Canis aureus (16); Meles meles (12); wolf/jackal (11); Martes foina (7), Muscardinus avellanarius (6); Felis silvestris (5); Sus scrofa (3); Capreolus capreolus (3); group of foxes (2) Felis catus (2); Lepus europeus (1); Mustela nivalis (Weasel); group of non identified (1); group of jackals (1); Erinaceus europaeus; Lustra lutra.

Total: 140 crossings

*The number of wildlife crossings for each species is presented in the brackets

Photo V.5.5: Records of roe deer *Capreolus capreolus* from 2017

Снимка V.5.8: Снимки от регистрации на вида Дива свиня

Photo V.5.8: Records of wild boar

Снимка V.5.10: Регистрации на вида Felis silvestris (Дива котка)

Photo V.5.10: Records of wild cat *Felis sylvestris*

Снимка V.5.6: Снимки от регистрация на преминавания на Vulpes vulpes (Лисица).

Photo V.5.6: Records of red fox *Vulpes vulpes* crossings

Photo V.5.8: Records of marten/weasel/polecat through camera traps at the overpass and tracking at the underpass

Снимка V.5.7: Снимки от регистрации на Meles meles (Язовец)

Photo: V.5.7: Records of *Meles meles*

Efficiency of facilities

CONCLUSIONS:

- At the time of the study, the wildlife crossings in question had not reached their target performance. Even with the recorded significantly higher utilization of the Wolf Conservation Underpass at km 315+900 compared to the Bear Conservation Overpass at km 314+070, the facility is about 14 times less efficient than predicted.
- The limited number of crossings of the model species is primarily a derivative of the low density of their populations in the area, as a result of unsuitable habitats and a highly anthropogenic environment.
- The area within the range of the two wildlife crossings in question (Lot 1) has high transparency and a high frequency of passable facilities, some of which have denser and well-formed vegetation corridors than those of the crossings. (Ex: Agricultural underpass at km 317+330). The section lacks the so-called "bottle neck" effect and the wild animals are scattered between the different types of equipment, which is also a possible reason for the realized low efficiency.
- Both of the facility's target species are not recorded either in the study area or within wildlife crossings. We believe that the Overpass for the protection of bears at km 314+070 is not suitable for the species, while the Underpass for the protection of wolves at km 315+900 is defined as a facility with a good location, technical indicators and landscape. The underpass is suitable for the target species, as well as for a large part of the model species.
- The possible reasons for unrealized registrations of the brown bear species (Ursus arctos) within the scope of the Overpass for Bear Protection at km 314+070 are related to the local features of the relief and vegetation in the area of the facility, namely the lack of a linear vegetation corridor, good landscaping and good visibility from the facility (unconforming slope), its proximity to a residential area and the I-1 highway, in combination with a number of limiting factors, such as hunting and grazing activities, compromised noise protection, etc.
- The possible reasons for unrealized registrations of the wolf species (Canis lupus) in the scope of the underpass are: the short operational period, for which the so-called "learning curve" was not reached, the poor quality of some of the photographic material, which does not allow accurate determination of the passing animals .Regarding the model species, there is a tendency for higher equipment efficiency in winter periods compared to summer periods, which we attribute to their higher propensity for risky behavior and their migration to the lower parts of their ranges in winter.
- The activity during the daylight hours is especially lower compared to the activity at night. There is no clear trend for crossings in either direction, but more registrations are still made in the westbound direction. The behavior of passing species is varied, but surveying behavior or extremely fast crossings predominate. Group crossings have also been detected.
- Our research strongly confirms the general scientific opinion that low visibility is limiting for predators, and cross-section of gear for ungulates. At the Overpass for the protection of bears at km 314+070, the activity of predators is particularly low, and at the Underpass for the protection of wolves at km 315+900, registrations of ungulates are almost absent, and an "avoidance" reaction for the roe deer (Capreolus capreolus) was also registered)

Preparation of multi-criteria permeability analysis

BASIC TASKS:

- Field survey
- Identification of significant technical, landscape and anthropogenic features that enhance the effectiveness of wildlife crossings and allow free movement of vertebrates.
- Development of a facility rating scale
- Assessment of facilities
- Determination of total permeability based on multicriteria analysis and comparison with transparency data.
- Determination of significant facilities with optimal location and technical characteristics within the scope of Struma Motorway, allowing smooth movement of model species

METHODOLOGY:

- Methodology adapted from Clevenger and Waltho, 2000

Multicriteria Permeability Analysis

Results:

For the purpose of the field analysis, all large facilities, a total of 64, included in the scope of 3 of the sites were visited.

The indicators that are important for increasing or decreasing the efficiency of the passage of wild animals, I determined on the basis of the literature review, which are as follows: altitude, distance from settlements or other infrastructure objects, technical characteristics (length, height and section), forest cover, slope, presence or absence of human activity, noise, obstacles and attractions.

For facilities with a high defragmentation value, we have defined all facilities with a total score above 15, such are 3 of the facilities in the scope of Lot 0, 1 in the scope of Lot 1 and 3 in the scope of Lot 2, that is, out of a total of 64 facilities, only 7 facilities have all technical and landscape features to be designated as wildlife crossings.

Multicriteria Permeability Analysis

Conclusions:

1. Data from the multi-criteria analysis show that no single facility possesses the full set of characteristics that would define it as a suitable wildlife crossing.
2. The highest model value is a bridge over a river at 295+050 with 18 points, which has a defragmentation value only for model groups 1 and 2.
3. Facilities with a defragmentation value for large mammals, on the other hand, have relatively low ratings - tunnel No. 1 from km 324+460 to km 324+840 is rated 15t./27t., Tunnel No. 2 from km 351+115 to km 351+470 is with 12t./27t. and Overpass for protection of bears at km 314+070 is 12t./27t.
4. Out of a total of 64 facilities, only 7 facilities have all the technical and landscape characteristics to be designated as wildlife crossings. For facilities with high defragmentation fineness, we have identified facilities with a total score above 15, such are three of the facilities within the scope of Lot 0, one within the scope of Lot 1 and three within the scope of Lot 2.
5. Bear protection overpass at km 314+070 is not among the facilities with a high fragmentation value according to the model. There is a significant difference between the Clevenger score (12pts/27pts) and that of Huber (9pts/10pts), in connection with which we believe that despite the many advantages for quick and easy transparency determination, Huber's simplified model ignores essential performance indicators.6. We believe that transparency is a broad-based indicator that practically rarely meets theoretical conclusions and represents a complex of situational components, the most insignificant of which at first glance could have a serious impact on the efficiency of a given facility.

CONCLUSION:

Applying general patterns to the design of wildlife crossings is proven to be an inappropriate approach.

Every detail of these facilities can be decisive for their effectiveness. The site selection approach for wildlife crossings should be based on extensive input and benchmarking to determine the best technical and landscape features that satisfy the biological characteristics of the widest range of target species.

The adaptation of facilities provided in the technical projects, which coincide with well-formed plant corridors and correspond to the main behavioral characteristics of the model species, we consider as an approach that will minimize costs and increase the good public opinion of the planned activities.

Landscaping, along with choosing an appropriate location, is a key component of effective landscape design. The landscape design for wildlife crossings should be prepared with the help of a zoologist and be tailored to the surrounding habitats and target species.

Wildlife corridors should be considered in terms of an overall connectivity system with sufficient density, diversity of structures and landscape approaches to ensure connectivity for the entire community, not just individual target species. The legal framework, in turn, could provide greater freedom of design decisions and greater control over their implementation and effectiveness.

Despite the seemingly high transparency of the facilities within the Struma AM, they could not be effective passages for animals due to complex reasons such as high population density, the lack of sufficiently dense vegetation and, in general, undisturbed landscape corridors.

In this aspect, we can conclude that the lack of continuous landscape corridors, as well as the appropriate landscaping of the facilities, is no less a limiting factor for the passage of wild animals along the facilities than the human presence.

The concept of moving the passages away from settlements and other urbanized objects is inexpedient, since in their essence roads are highly anthropogenic structures, exclusively aimed at their proximity to settlements, and limiting human presence within their scope is practically impossible. On this basis, we believe that the presence and passage of wild animals along built structures should be further stimulated and supported, rather than expected as a function of their permeability.

In order to protect the species diversity of all groups of mammals and the essential connections between adjacent habitats and populations, it is not appropriate to have a fenced road section longer than 10 km without a wildlife crossing facility longer than 5 km of fenced section without underpass designated as a passage for wild animals.

Thank you for your attention!!!