BATS (MAMMALIA, CHIROPTERA) IN CROSS-BORDER AREAS IN BULGARIA AND GREECE

Results from the project „Sustainable bats conservation in cross-border area" (BatsConserve) - TCP "Greece-Bulgaria 2014-2020"

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Introduction

Bats are one of the most numerous vertebrate animals on Earth. They have an extremely important role in maintaining ecological balance. Over 30 species of insectivorous bats have been identified within Europe. They are an important natural regulator for the abundance of insects that are their main food. At the same time, their low productive potential (they only give birth once a year) and the gathering of tens to thousands of individuals in one roost, most often these are karst caves, determine their high vulnerability. Population survival is largely dependent on human activity, such as agricultural and forestry management practices. Effective direct conservation measures are implemented in essential roosts.

Bats are subjects of protection as under national laws of each country of Europe as under international agreements such as The Habitats Directive of EU.

One of the characteristics of the bats in border regions of Bulgaria and Greece is that they consist of both species with wide distribution and abundance, and of rare species with limited range. This publication presents the main project results of „Sustainable bats conservation in the cross-border area" (Bats-Conserve) and it has the aim to enhance the knowledge of significant habitats of bats as well as the condition of their populations under the influence of natural and anthropogenic factors.

Study areas

The territorial scope of the BatsConserve project includes the transboundary territories along the Mesta River on both sides of the border and caves from the area of the Eastern Rhodopes (Momchilgrad - Komotini), with a total area of 35,000 ha. The object of study in the area Momchilgrad - Komotini are caves and shelters for bats in the area. The selected territorial scope of work (spatial boundaries) is divided into separate polygons numbered with a unique number / identifier.

The polygons proposed for field study in Bulgaria and Greece are 17 and have a total area of 35075.28 ha, respectively, 11 polygons with a total area of 24660.15 ha in Bulgaria and 6 polygons with a total area of 10415.13 ha in Greece. Fieldwork was conducted in these territories in 2018 and 2019.

The territories selected cover a variety of habitats, including cave shelters, galleries, bunkers, rock formations, karst areas, old-growth forests, wetlands, water bodies. One of the main criteria for their selection was the absence or insufficient information on the species diversity of bat fauna.

Some of the polygons are fully or partially situated in protected areas under the national legislation on both countries and in protected sites under the Habitats Directive of the European Natura 2000 Network: GR1130010 Limnes Vistonis, Ismaris - Limnothalasses Porto Lagos, Alyki Ptelea, Xirolimni, Karatza, GR1140004 Koryfes Orous Falakro, BG0001030 Rodopi-Zapadni, BG0001021 Reka Mesta, BG0000220 Dolna Mesta, BG0001028 Sreden Pirin-Alibotush and BG0001032 Rodopi-Iztochni. The studied area is in a broad altitude range from the sea level (wetlands near Porto Lagos) to 2100 m above the sea level (Falakro mountain) with a variety of environmental conditions and the presence of roosts (karst and volcanic caves, mine galleries, bunkers, rock piles, etc.) in which the bat fauna was very poorly studied or unknown.

After determining the territorial scope of the work, sources of information relevant to the object and the scope of study

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were identified, and all available data on the bat fauna in the project area were obtained.

The next step was fieldwork. As a result of the field studies, a publicly available database on the distribution of bats in the study polygons was prepared. Geoportal was created, which is maintained and supplemented with information from the studied polygons. The developed models for the degree of suitability of the territory for each identified or potentially existing species can serve to apply specific conservation measures for the conservation of bat fauna.

The main objectives of the research were to determine the species composition of bats and to identify specific threats to the populations.

Methods

The following common methods were used for determining the abundance and species composition of bats:

✓ Visual inspection of roosts (caves, bunkers, abandoned buildings, rock piles, etc.) – bats are determined on the basis of their characteristic morphological features. Colonies and individuals are photographed for their accurate photo counting;

✓ Capture – with the help of using standard polyester nets for bats and so-called traps for bats (Harp trap), placed at the entrance of caves, under bridges, near bunkers, close to rocky slopes and above water surfaces. Right after the species is identified, he is released. The field team is licensed to catch bats for the purpose of the project, issued by the MOEW № 759/13.11.2018.;

✓ Registration and analysis of emitted echolocation and social sounds of bats – there are ultrasounds detectors used for bats. The registered ultrasounds were recorded in wav-format by electronic media. For the purpose of species determination, the following basic sound characteristics were measured and reported:

- Frequency with maximum sound energy;
- Maximum and minimum frequency of the sound;
- Duration of the sound;
- Interval between emitted consecutive sounds;
- Form of the sonogram (**fig. 1**).

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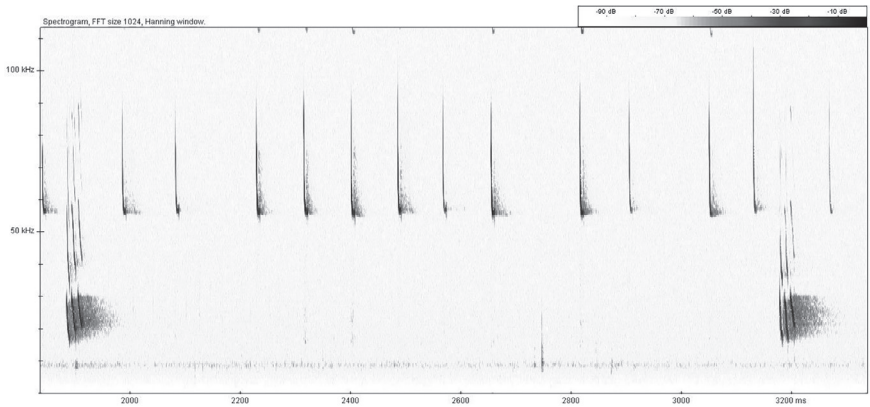

Fig. 1. Sonogram of echolocation and social sound of Soprano pipistrelle (Pipistrtellus pygmaeus).

Results

In the surveyed polygons, 27 species were identified, or almost 70 % of the known species for Southern Bulgaria and the Aegean Sea part of Greece. The typical composition of bats' communities inhabiting important cave roosts, on the territory of Bulgaria has been revealed, as well the territory of Greece.

The collaboration with the Greek colleagues was also successful with three joint field studies conducted: in the Maroneia cave during September 2018, in the valley of Mesta river and Maroneia cave in September in the spring of 2019. Extremely high activity and presence of a large population were found from Blasius's (*Rhinolophus blasii*) and Schreiber's bent-winged bat (*Miniopterus schreibersii*) during the time of autumn migration period in Maroneian cave and the rare forest species Bechstein's myotis (*Myotis bechsteinii*) was registered on the entrance of Maroneia cave together with 6e Lesser horseshoe bat (*Rhinolophus hipposideros*), Mediterranean horseshoe bat (*Rhinolophus euryale*) and Schreiber's bent-winged bat (*Miniopterus schreibersii*). It is interesting to note that all four types were active even at an outside temperature close to 0^0 C.

Collected valuable information on species composition and territorial distribution for the following bat species has been collected:

1. Greater horseshoe bat (*Rhinolophus ferrumequinum*) – typical species on the Balkan Peninsula without the highest parts of the mountains. Characteristic of karst areas (Benda et al 2003). In the studied area it is one of the most common species. There is a hibernation colony of about 100 individuals in Samara cave, v. Samovila. Single bats (1 – 7) inhabit the karst caves (Maroneia cave, the cave "Folia Drakou", caves around v. Kremen, artificial galleries and as well as abandoned military fortification facilities on Greek territory („Bartisheva fortress", „St. Nikolas fortress", „Kastillo fortress" and „Fortress Pyramidoides").

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2. Lesser horseshoe bat (*Rhinolophus hipposideros*) - Typical specie for the territory of the Balkan Peninsula, found around 1500 m altitude. It mainly uses underground habitats – natural caves and artificial galleries. It is connected with karst regions with rich vegetation. It is often found in settlements. The species is found in the study area in a total of 14 fields almost always along with the Greater horseshoe bat, representing natural karst caves, military bunkers and artificial mine galleries with single individuals.

3. Mediterranean horseshoe bat *(Rhinolophus euryale)*, Blasius' horseshoe bat (*Rhinolophus blasii*), Mehely's horseshoe bat (*Rhinolophus mehelyi*): In study area the three types of horseshoe bats, forms most often mixed colonies. Hibernation colony was registered in Samara cave, village of Samovila, numbering around 70 individuals. Especially high flight activity was registered on the entrance of Maroneia cave in September 2018, as more than 90 % of the registered echolocation ultrasounds belonged to Mediterranean horseshoe bat. Manuel's Cave near the village of Ribnovo is a breeding roost for the mentioned horseshoe bats. Mediterranean and Blasius' horseshoe bats are registered in the cave "Folia Drakou".

4. Lesser mouse-eared myotis *(Myotis blythii)* and Greater mouse-eared bat *(Myotis myotis)* – Both species often occur together, forming mixed colonies. Their species differentiation on the terrain is often difficulty, because of their similar morphological features of the two species. Most habitats are between 100 and 800 m altitude. Yearly, inhabit underground shelters – karst, volcanic and sea caves and mine galleries. Single hibernating individuals, were established in Samara cave, v. Samovila, in old bridge constructions of river Mutnitsa and r. Mesta in Bulgaria, on the Greek territory – over the water surface of the Potamoy dam, in abandoned military bunkers („Fortress Pyramidoides"), and a breeding colony from around 100 individuals had occupied the entrance parts of the Maroneia cave in April.

5. Western barbastelle *(Barbastella barbastellus)* - a typical inhabitant of humid and old deciduous, mixed and coniferous forests in the sub-mountainous and mountainous regions of the country. The highest is the number roost found in over 500 m altitude (Benda et al. 2003). Flight activity of the species during the autumn period was recorded in the region of Ribnovo village, over the Mesta river and around water area near Musomishte village.

6. Schreiber's bent-winged bat *(Miniopterus schreibersii)* - It is spread throughout the country without the highest parts of the mountains. Most habitats are between 100 and 600 m altitude. A frequent and numerous inhabitant of the caves in the lower parts of the country, as it forms one of the most numerous bat colonies in Europe, numbering tens of thousands of individuals. Breeding colony of the species of about 1200 individuals was formed in April in the Samara cave in the village of Samovila. Permanent inhabitant of the Maroneia cave, where it was registered as during the autumn period as well in the spring. A significant breeding roosts is also the Manuel's Cave near village of Ribnovo. The species is hunting far from its roosts, as being registered with relatively high flying activity over the rocky seaside of Maroneia, illuminated port of Agios Charalampos, valley of Varbitsa river in Eastern Rhodopes.

7. Long-fingered bat *(Myotis capaccinii)*- It occurs in the whole country, in the moutains up to 1500 m. Extremely cave-dwellers – forming large colonies (up to several thousand individuals). Most habitats are between 100 and 600 m. It is typical inhabitant of karst areas – often in forest landscapes. No significant colonies were found during the current research – a single bat was recorded in the Maroneia cave in September 2018, and in April 2019 – 7 individuals.

8. Geoffroy's bat *(Myotis emarginatus)* - It inhabits karst regions, parklands, without caves areas, and is found in base-

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ments of abandoned buildings, churches and houses, old military bunkers and other shelters. It prefers areas with bush and woody vegetation. Most roosts are in low-mountain belt (400-500 m) (Benda et al. 2003). Flight activity of the species was recorded in the area of Maroneia cave in September 2018 and April 2019, during October around rock niches over Mesta river, small ponds Domus dere river near Petrelik and near bridge constructions above Matnitsa river.

9. Bachstein's myotis *(Myotis bechsteinii)*- Characteristic forest specie in beech and mixed forests in the 800-1450 m. The species is known as stationary and does not perform large seasonal migrations (Benda et al. 2003). His presence was confirmed in the Manuel's Cave near village of Ribnovo, where probably hibernates.

10. Noctule bat *(Nyctalus noctula)* – Common and often specie. Forest-dwellers, often settled in tree hollows. Attached to areas with widespread of deciduous and mixed forests, parks, gardens, settlements. It is also found in the mountains above 1200 m. During the study, the Noctule bat was registered relatively rare – single flying individuals were observed in Maroneia and in the valley of the Varbitsa river, the Eastern Rhodopes, around rock niches of Mesta river (September), diluted forests, volcanic niches to water bodies and stone bridges in Eastern Rhodopes (Tihomir village).

11. Lesser noctule *(Nyctalus leisleri)*- Probably occurs in the lower parts of the country, and in the mountains up to 1500 m. It inhabits forest areas with a relatively warm climate. It is registered in October and November along the Mesta river, in the lower stream on the Kazalach river, Dolno Kapinovo village, on Kesibir river (Tihomir village), around rock formations near the village of Tatul, in April on Sap dere river in mixed forest.

12. Greater noctule bat *(Nyctalus lasiopterus)* – A rare, forest species with insufficiently well researched biology. The roosts (summer and winter) are hollows and rock crevices, which sometimes are shared with the Common noctule or species from genus *Pipistrellus*. (BENDA et al. 2003). Characteristic of the type of echolocation sounds were recorded during autumn period in the region of Ribnovo village, Western Rhodopes.

13. Grey big-eared bat (*Plecotus austriacus)* – It is mainly found in the lower parts of the country. In the mountains up to 1400 m. Prefers low, open spaces with steppe character, farmlands, river valleys, settlements (BENDA et al 2003). He was once found in karst cave near the village of Samovila, Eastern Rhodopes. A larger number of species were registered on Greek territory – in the entrance parts of the bunkers „Bartisheva fortress“ – October, „Fortress Pyramidoides“ – April, the entrance parts of the “Folia Drakou” – October and Maroneia caves – April.

14. Common pipistrelle *(Pipistrellus pipistrellus)* – One of the most common species of bats in Bulgaria and in the project territory. Daily roosts are tree hollows in different semi-enclosed spaces and crevices in man-made buildings. It is also considered for synanthropic specie. It hunts over various habitats – open areas with single trees, forest and scrubland facies, very often within the boundaries of the settlements. The species is registered with high hunting activity from the sea level to the high mountainous area of the mountain Falakro: rocky coastal habitats in Maroneia, along the coastal residential areas, the wetlands in Porto Lagos, the valley of the Varbitsa river in Eastern Rhodopes and the high mountain ridges of the Bald mountain (Falakro).

15. Soprano pipistrelle *(Pipistrellus pygmaeus)* – Common bat: from the high parts of the mountains to the coastal areas. It inhabits deciduous, coniferous and mixed forests, often found in settlements, gardens, parks, adheres to water areas

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– lakes, large rivers. It is located in the vicinity of the village of Ribnovo. With a relatively high flying activiy was recorded in the forest territories of the Western Rhodopes near the village of Ribnovo.

16. Natterer's bat *(Myotis nattereri)*- It occurs all over the country in the middle mountain range – usually up to 1500 m altitude, in parks, forests, orchards, often near water bodies and in settlements. They usually fly around 5 m high, between tree crowns and rarely around 15 m above their tops. The specie is set once at the entrance of the Maroneia cave during April 2019.

17. Savi's pipistrelle (*Hypsugo savii)* – It inhabits rocky and karst areas, mountain pastures, grassy terrains and valleys, forests regions, open arable lands. The daily and winter roosts of the species are mainly associated with rocky habitats. It is located in the area of the rocky seashore of Maroneia.

18. Nathusius' pipistrelle (*Pipistrellus nathusii*) – Migratory species with pronounced yearly dynamics of their abundance on the territory of the Balkan Peninsula. During the autumn period it is numerous on the Bulgarian Black sea coast when migratory from many thousands of groups of individuals is observed. It occupies tree hollows and sticks to water bodies (Ivanova & Gueorguieva, 2005; Pandourski, 2004). The species is extremely numerous during the autumn migration period in the wetland area along the coast of the White sea coast and the forest areas near Ribnovo village in Western Rhodopes.

19. Kuhl's pipistrelle (*Pipistrellus kuhlii*) – A species characteristic of the southern parts of the Balkan Peninsula. It is closely related to rocky habitats but also has a high degree of synanthropic species. During the survey, it was often found in rocky habitats along the Maroneia coast.

20. Serotine bat *(Eptesicus serotinus)* – Widespread to about 1600 m above the sea level. The species is considered as stationary, but migrations of several tens of kilometers have been observed. Prefer open areas with group of trees as well as rock areas. It is often found in settlements. It is mainly found in the mountainous parts of the studied polygons – the Western Rhodopes in the region of the village of Ribnovo and open pit areas of Bald mountain (Falakro) at altitude of 1900 m.

21. European free-tailed bat (*Tadarida teniotis*) – The habitats of the species are mostly rock areas, high buildings, bridges. It forms small colonies of several dozen individuals. He flies out during dusk, moving far away from the roost and it flies at a height of dozens of meters. His flight is at high altitude – fast. Summer and breeding colonies are in rocks and walls of buildings. It is active during the late autumn period (Benda et al. 2003, Papadatou et al, 2008). The species was found during previous studies from Pandourski (2014) near Dolna kula village in the Eastern Rhodopes, Slavyanka mountain (POPOV etc., 2014) and "Borovo" Forestry in Western Rhodopes. Our studies have shown that the species is common in Greek territory (Maroneia and Bald mountain (Falakro) at a heght above 2000 m at temperature around 4 degrees, the entrance areas of the bunkers zones „Bartisheva fortress" and „Fortress Pyramidoides", rock piles, around groups of old tree hollows along the river and artificial pond near village of Volakas. In Bulgaria, has been found in the valley of Varbitsa river in Eastern Rhodopes, around the rock niches on the right side of Mesta river, near a small dam close to village of Teplen.

22. Particoloured bat *(Vespertilio murinus)* – Migratory species, which is why there is a pronounced seasonal dynamic in its abundance. It inhabits predominantly mountain forests during the summer and during autumn migration it can be found in variety of habitats with an abundant supply of food, even at sea level. The species is common in autumn, as well in the wetlands

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of Porto Lagos and in the high parts above 1000 m above the sea level in the Western Rhodopes and Bald mountain (Falakro).

23. Daubenton's myotis *(Myotis daubentonii)* – Forest species, with its hunting areas mostly large water bodies, along the rivers and lakes, in cultural landscapes. The hunting takes place in small groups or in pairs. Summer roosts are in tree hollows, crevices in buildings (Pandourski, 2004). Foraging individuals are recorded above water surface of the Varbitsa river in Eastern Rhodopes.

Discussion

The established rich species composition of bat assemblage is related to the diversity of geomorphologic conditions in the studied cross-border area. In natural and artificial underground habitats (caves, mine galleries) three medium-sized horseshoe bat species are dominating – *Rhinolophus euryale*, Rh. *blasii* and *Rh. mehelyi*, as well as the Greater horseshoe bat (*Rh. ferrumequinum*), Lesser horseshoe bat (*Rhinolophus hipposideros*) and Shreiber's bent-winged bat (*Miniopterus schreibersii*), whose abundance exceeds 1200 individuals in April. The mountain range of species is enriched with the presence of the only representative of the family Molossidae – European free-tailed bat (*Tadarida teniotis*) (**fig. 16**). The role of wetlands in the region of Porto Lagos is particularly important (**fig. 17**), as it provides food for numerous migrating populations during the autumn of Nathusius's pipistrelle (*Pipistrellus nathusii*), Common pipistrelle (*Pipistrellus pipistrellus*) and Particoloured bat (*Vespertilio murinus*). Among the dominating species in the dry rocky habitats we should mention also Savi's pipistrelle (*Hypsugo savii*) and species from genus *Pipistrellus*.

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Threats

Bats are vulnerable to many anthropogenic impacts that affect not only their roosts, but also neighboring habitats of importance during different stages of their life cycle.

The analysis of the status of bat assemblage in the border are along the Mesta river, has shown that a major threat to bats in Greek territory is the open marble extraction method, which leads to a lasting change in the natural character of ecosystems. Significant bat roosts (Manuel's Cave, for example near village of Ribnovo in Bulgaria and Maroneia cave in Greece) have been affected by unregulated visits and vandalism.

In the region of Komotini the main factor of impact is intensive agriculture – cotton growing on large areas close to wetlands, of particular importance during the migration periods. A concomitant threat is the use of chemicals in agriculture. On Bulgarian territory significant threats occurs as a result of unregulated penetration into bat's cave-roosts and from pollution – unregulated landfills and pollution of river flows due to the absence of sewage systems in settlements and direct discharge of wastewaters into natural water bodies.

The field studies and analyses conducted within the project „Sustainable bats conservation in the cross-border area" (Bats-Conserve) are the basis for planning adequate measures for the conservation of bat populations, taking into account the specific characteristics of the assemblage and habitats.

As a result of the project implementation a Database was created. The database includes validated, structured and systematic spatial data available for the project area, the results of the field studies carried out, identified threats in the project area, conservation status of species found in the project area, inductive models for habitats and the spread of bats in the territory, the location of at least 800 houses for bats in the project area and others. The database format is ESRI File Geodatabase (*.gdb), with the data in the coordinate system WGS84 UTM 35N.

Within the project implementation Spatial Data Infrastructure (Geoportal) in English was designed and created, which is integrated into the BatConserve project website and allows access to the database through the project websie. The Geoportal contains layers relevant to the subject of the project: spatial data on the Natura 2000 ecological network, for the project area falling within the territorial scope of Bulgaria and Greece; protected areas according to the national legislation of Bulgaria and Greece; boundaries of the polygons created for the purpose of the project; models of the distribution of bat habitats; identified potential threats to bat fauna in the project area, etc.

Three Guidelines on bats conservation have also been developed. They contain good land use practices and measures to contribute to the conservation of bats:

- Guideline on the conservation of bats in farmland;
- Guideline on the conservation of bats in forest areas;
- Guideline on the conservation of bats in urban environment.

As part of the conservation measures, 800 bat boxes were mounted in the project territory.

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