# THE STATE OF THE FAUNA OF BATS IN THE UKRAINIAN AZOV REGION IN MODERN ENVIRONMENTAL CONDITIONS

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**ABSTRACT**

The article presents the results of regional surveys of bats in 2010-2020 in places planned for the construction of wind farms. The almost complete transformation of the steppe into agrocenoses bordered by forest belts and irrigation canals undoubtedly affected bats against the background of global warming. With the use of modern ultrasonic detectors, licensed computer programs and an electronic library of voices, 15 species were found in the Ukrainian Pryazovia. Their greatest diversity (11–13 species) is recorded between the Dnieper valley and the Crimean Peninsula, where intensive migration flows take place. Probably, in this bottleneck, bats migrating from the northern and northeastern continental regions cross the land and join those moving along the Azov coast. During the winter, with limited research in this period, 8 species were identified, during spring and autumn migrations – 13 and in summer – 11 species.

In recent years in the Ukrainian Pryazovia there has been a decrease in the number of *Pipistrellus pygmaeus* and *Eptesicus serotinus*, as well as an increase in groups of *Nyctalus noctula, Pipistrellus kuhlii, Pipistrellus nathusii* and *Vespertilio murinus*. In all seasons the least common and not numerous were *Plecotus auritus, Myotis daubentonii, Nyctalus lasiopterus, Nyctalus leisleri, Hypsugo savii* and *Barbastella barbastellus*.

**Key words**: Ukrainian Pryazovia, global warming, detector, bat, wind power plant, research

## INTRODUCTION

The fauna, distribution and number of bats on the territory of our state can still be considered insufficiently studied. Despite the appearance of a large number of articles and 4 monographs

[1, 23, 24, 25], in most regions of Ukraine bats remain the least known mammals. These animals were particularly affected by significant global warming, which helped to reduce the duration of hibernation, changed the rhythm of this process, as well as the cyclical development of insects, which are their main food. The lack of long-term regional research hinders not only the writing of reviews, but also the dissemination of knowledge about these unique animals, as well as the implementation of measures aimed at protecting and preserving their diversity.

The aim of the work is to acquaint the scientific community with the results of the study of bats in the Ukrainian Pryazovia during the significant global warming, which we have been carrying out in 2010-2020.

## METHODS AND EXPERIMENTAL PROCEDURES

The research was conducted in a narrow strip (up to 100 km wide) of the Sea of Azov coast from Mariupol to the Sivash Lake exclusively in places planned for the construction of wind farms (WPPs): Manhush (Donetsk region); Berdiansk, Prymorsk, Prymorsk-II, Botiieve, Zaporizhzhia (Zaporizhzhia region); Novotroitske, Overianivka, Myrne and Chaplynka (Kherson region); Armiansk and Dzhankoi (Crimea). Part of the research was conducted on the protected territories (the Azov-Sivaskyi National Nature Park (NNP), the Pryazovskyi NNP, the Meotyda NNP). The length of this area was about 600 km (Fig. 1).


**Fig. 1.** Research Areas: 1 – Chaplynka; 2 – Armiansk; 3 – Askaniia-Nova; 4 – Solone Lake; 5 – Overianivka; 6 – Sadky (Biriuchyi Island); 7 – Mordvynivka; 8 – Melitopol; 9 – Stepanivka-I; 10 – Botiieve; 11 – Orlivka; 12 – Naberezhne (Obytichna spit); 13 – Prymorsk; 14 – Novopetrivka; 15 – Manhush.

The research methodology was developed according to the recommendations of the "Surveillance and Monitoring Methods for European Bats Guidelines produced by the Agreement on the Conservation of Populations of European Bats (EUROBATS)" [26] taking into account the experience of European researchers [5]. Given the applied significance of

research [9], it was carried out under the supervision of international expert groups: Mott MacDonald (the UK), Ramboll Environ (Poland), CDM Smith (the USA) and ERM (Romania).

Ultrasound detection throughout the night was carried out by certified ultrasonic detectors (Table 1) mostly during the spring and summer-autumn seasons: at stationary vantage points with the installation of devices at a height of 2.5 m; in separate vantage points; on transects with a length of 500 m to 11 km, the number of which corresponded to the approximate standard of 1 km / 500 ha of the project area of the wind farm.

**Table 1**. Features of the use of ultrasonic detectors

| Research methodology | Ultrasonic detectors (quantity), years of application | | |
|---|---|---|---|
| | Pettersson D240x (n = 2) | Pettersson D500x (n = 3) | LunaBat DFR-1 PRO (n = 1) |
| Manual detection at vantage points for 10 minutes | 2010-2020 | 2013-2014 | – |
| Automatical detection throughout the night at a stationary vantage point | – | 2013-2020 | 2019-2020 |
| Research on transects (on foot) | 2011-2020 | 2013 | 2019-2020 |
| Research on transects (by car) | – | 2018-2019 | 2019-2020 |

On all transects, 3-5 evenly spaced places were selected, on each of which an ultrasound examination of the vocal activity of bats was carried out for 5 min. Therefore, the duration of observations within 1 transect was 37-50 minutes taking into account the 3-5 minute walking transitions between them. Besides, additional research sites which seemed sufficiently representative to estimate the distribution and number of bats were selected around each stationary vantage point (Table 2). The distance between them was 2.5–3.0 km that to some extent corresponds to the distances of daily forage movements of bats.

**Table 2**. Locations and characteristics of research

| № | Nearest settlement | Location | | Term of research: years (months) | Number of signals | Duration, min |
|---|---|---|---|---|---|---|
| | | Latitude | Longitude | | | |
| 1. | Armiansk | 46º06'55.40" | 33º41'17.27" | 2010, 2012, 2013 (IV-IX) | 400 | 3019 |
| 2. | Chaplynka | 46º21'51.56" | 33º32'07.06" | 2012, 2013, 2017, 2018, 2020 (III-XI) | 3206 | 21080 |
| 3. | Askaniia-Nova | 46º27'27.13" | 33º52'21.22" | 2010-2020 (I-XII) | 9609 | 59760 |
| 4. | Overianivka | 46º13'22.74" | 34º22'31.31" | 2017, 2018, 2020 (III-XI) | 958 | 5912 |
| 5. | Solone Lake | 45º53'03.18" | 34º27'08.12" | 2010, 2011, 2012 (IV-X) | 278 | 3698 |
| 6. | Sadky | 46°06'16.93" | 35°03'56.59" | 2011, 2014, 2017 (VIII-IX) | 650 | ? |
| 7. | Melitopol | 46°50'38.78" | 35°21'46.56" | 2012-2020 (I-XII) | 34630 | 217490 |
| 8. | Mordvynivka | 46°44'19.52" | 35°22'07.42" | 2011, 2012, 2014, 2016 (III-XI) | 7034 | 56413 |
| 9. | Stepanivka-I | 46°27'31.25" | 35°30'32.13" | 2012, 2015, 2017, 2018, 2019 (V-VIII) | 2274 | ? |
| 10. | Botiieve | 46°41'00.04" | 35°50'25.68" | 2010-2020 (III-X) | 4116 | 36073 |
| 11. | Orlivka | 46°42'26.58" | 36°01'54.31" | 2018, 2019, 2020 (III-X) | 1225 | 16462 |
| 12. | Naberezhne | 46°30'30.61" | 36°09'03.93" | 2011, 2016, 2018 (IV-V, VIII-IX) | 622 | ? |
| 13. | Prymorsk | 46°44'03.62" | 36°21'06.27" | 2013, 2018, 2019, 2020 (III-X) | 2145 | 28805 |
| 14. | Novopetrivka | 46°49'39.41" | 36°53'43.94" | 2020 (III-VII) | 197 | 2758 |
| 15. | Manhush | 47°03'03.85" | 37°18'00.81" | 2019, 2020 (V-X) | 1554 | 15176 |
| Total: | | | | | 68898 | >466646 |

No animal capture was performed during the studies. Exceptions were the accidental detection of bats in some hiding places (for example, in a flower pot on the balcony, in a broken tree) during migration and wintering.

**Identification**

In the process of interaction with each other, bats emit social acoustic signals, which are similar in physical and technical characteristics to the sounds of other mammals. However, in flight, they use signals that have maximum amplitude in the ultrasonic range of 20–120 kHz [12]. On the one hand, echo analysis allows bats to distinguish obstacles as well as small objects, which is important for orientation in space and when searching for food. On the other hand, the constant production of ultrasonic signals by these animals allows researchers to determine the presence, number of bats and their spatial movements with the help of detectors.

Previously, we used the licensed computer programs BatSound 4.1 and BatExplorer 2.1 [28] to determine the species composition. Despite their apparent perfection, they did not make a clear distinction between species whose signal frequencies overlapped, for example, the *Pipistrellus kuhlii – Pipistrellus nathusii* and *Plecotus auritus – Plecotus austriacus*, and so on. The situation has been significantly improved with the use of the European Bat guideline [2] and the electronic library of voices of European bat species BatLib Application [27].

Ultrasonic detectors (Pettersson D500x or LunaBat DFR-1 PRO) are able not respond to extraneous sounds that do not belong to bats. However, this ability is not absolute and during their operation, especially in automatic mode, a lot of extraneous noise is recorded on the memory card. That's why before analyzing the vocal activity of bats, the selection of sounds belonging only to these animals was performed using the BatSound computer program (Fig. 2). However, despite the latest equipment and modern software, the species of all bats could not be determined at each research site. Some of them were identified to the genus, for example: *Plecotus sp.* or *Myotis sp.*

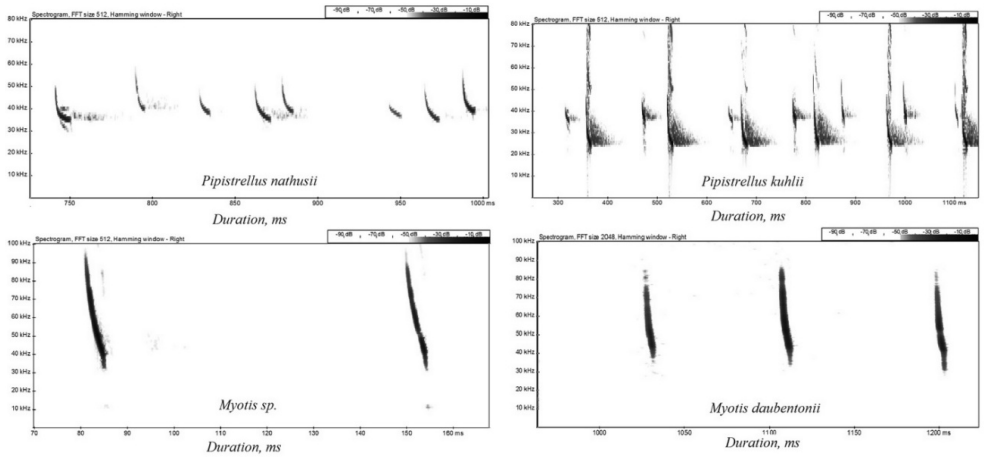


**Fig. 2.** Spectrograms of the *Nathusius pipistrelle, Kuhl's pipistrelle, Myotis sp*. and *Daubenton's Bat*

Of the almost 69,000 tracks, we were unable to accurately identify 983 tracks, which amounted to 1.44%. In particular, we have never come across *Myotis aurascens*, found on June 27, 1908 in the Provalskyi steppe in the modern Luhansk region [11]. In July 2008, the *Myotis aurascens* was registered with the help of an ultrasonic detector west of the village of Bezimenne in the Novoazovsk district of the Donetsk region on the coast of the Sea of Azov [8]. In 2013, several individuals of this species were found in the same administrative district during the winter [3].

In August 2010, one adult male of the *Myotis aurascens* was caught with a mist net in the Vasylivka district of the Zaporizhzhia region on the Velyki Kuchugury islands (the Dnipro River) in the Velykyi Luh National Nature Park [18].

## RESEARCH RESULTS AND DISCUSSIONS

There were detected 15 species of bats in a large area of the Ukrainian Pryazovia in different seasons of the year. Their greatest diversity (11–13 species) is characteristic of places where intensive migration flows take place (Table 3). First of all, these are the points: 1 (Armiansk), 2 (Chaplynka) and 3 (Askaniia-Nova), which are located between the Dnieper valley and the Crimea Peninsula. It is possible that in this bottleneck, bats migrating from the northern and northeastern regions cross the land and join those moving along the coast of the Sea of Azov, and vice versa. To these points should be added Melitopol (7), which is located on the banks of the Molochna River, along the floodplain of which is also noticeable the movement of a large number of animals. A relatively large variety of bats occurs at points 10 (Botiieve), 11 (Orlivka) and 13 (Prymorsk), located directly on the northern shore of the Sea of Azov, along which autumn and spring migration flows are particularly strong [9, 20].

Table 3. Variety of bats and places of their detection

| Species | Research sites in accordance with Table 2 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| *Plecotus auritus* | + | + | + | + | – | – | + | – | – | + | – | – | – | – | |
| *Plecotus austriacus* | – | + | + | + | – | – | + | + | + | + | + | + | – | – | + |
| *Myotis mystacinus* | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + |
| *M. daubentonii* | – | – | – | – | – | – | – | – | – | + | – | – | – | – | – |
| *Nyctalus lasiopterus* | + | – | + | – | – | – | + | – | – | – | – | – | + | – | – |
| *Nyctalus noctula* | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + |
| *Nyctalus leisleri* | + | – | – | – | – | – | + | – | – | + | – | – | – | – | + |
| *Pipistrellus kuhlii* | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + |
| *Pipistrellus nathusii* | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + |
| *Pipistrellus pipistrellus* | + | + | + | + | + | – | + | + | + | + | + | + | + | + | + |
| *Pipistrellus pygmaeus* | – | + | + | + | – | + | + | + | + | + | + | – | – | – | + |
| *Hypsugo savii* | – | + | – | – | – | – | +? | – | – | + | – | – | – | + | – |
| *Vespertilio murinus* | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + |
| *Eptesicus serotinus* | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + |
| *Barbastella barbastellus* | + | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total: | 11 | 11 | 11 | 10 | 7 | 7 | 13 | 9 | 9 | 13 | 9 | 8 | 8 | 8 | 10 |

According to zoologists who worked in Askaniia-Nova in the first third of the twentieth century, it is known that *Nyctalus noctula, Nyctalus lasiopterus, Nyctalus leisleri, Vespertilio murinus,*

*Pipistrellus pipistrellus, Pipistrellus nathusii* were exclusively migratory species in the steppe zone of Ukraine [13]. In the following years, with a significant change in the ecological situation and global warming, the fauna of bats has changed greatly. After 1979, in Askaniia-Nova, the party has been registered all year round, and its winter colonies appeared in the village. Later, with the help of an ultrasonic detector, extremely rare species were detected: *Nyctalus leisleri, Pipistrellus pipistrellus, Pipistrellus nathusii* [14].

The most numerous species in all research sites was the *Pipistrellus kuhlii*, the expansion of which from the Caucasus began in the 80s of the twentieth century [17]. For unknown reasons, some of the animals began to settle in the northeastern direction [16] and some – in the west, along the coast of the Sea of Azov. In 1975, this bat was found in Rostov [22], in 1985 – in Melitopol [14]; by 1990, the *Pipistrellus kuhlii* occupied all the Pryazovia region and became a numerous species in many settlements [19].

Distribution of this bat on the territory of Ukraine continues today [25]. So it is not surprising that in all places of our research the share of the *Pipistrellus kuhlii* was: 41.9 % – Askaniia-Nova; 58.1 % – Armiansk, Chaplynka and 74.9 % – Mordvynivka. Everywhere this figure was close to 50% or even exceeded this value. The second species in number was the *Vespertilio murinus*: 5.3 % – Solone Lake; 5.8 – 11.4 % – Overianivka; 16.2 % – Askaniia-Nova and 8.0 % – Prymorsk.

In the 50s of the twentieth century the *Vespertilio murinus* occurred sporadically throughout Ukraine, and it was most numerous near the Sivash Lake. In the 80s of the twentieth century, the *Vespertilio murinus* was a rare species (3 finds) in Rostov located in the lower reaches of the Don River [22] and in the Rostov region in general [7]. Until recently, it was considered rare and settled in the Black Sea Biosphere Reserve [15], and in the Crimea – a rare and migratory species [6]. In 2011-2012, this species, despite our intensive and regular research, was not detected on the east coast of the Molochnyi Estuary [20]. Given that the *Vespertilio murinus* was subsequently found in all places of our research and, moreover, its number became significant, we can state the increase of its groups in the Ukrainian Pryazovia.

In recent years, in all places of Pryazovia, against the background of a decrease in the number of *Pipistrellus pipistrellus* and *Eptesicus serotinus*, there has been an increase in the number of groups of *Nyctalus noctula*, the share of which was: 2.6 % – Solone Lake; 4.9 % – Overianivka; 12.3 % – Mordvynovka; 5.8 % – Prymorsk and 21.5 % – Askaniia-Nova. In some places the share of the *Pipistrellus nathusii* was quite significant: 5.3 % – Askaniia-Nova; 22.4 % – Overianivka; 4.0 – 15.0 % – Solone Lake, which is connected with migrations of this dendrophilous species and their stops in settlements in the absence of forest. In several places of the research region (Krasnoperekopsk: 12–14.04.13; Askaniia-Nova: 16–29.07.13, 12–20.04.15 and 19–21.05.15) the *Nyctalus lasiopterus* was recorded, 1 specimen of which from Melitopol (November 7, 1898) was kept in the Natural History Museum of Simferopol [10]. In 2020, in the warm winter weather, the ultrasonic signals of the *Nyctalus lasiopterus* were recorded by P. Horlov in Melitopol, as well as near Prymorsk [21]. Due to the rarity of the species, its identification passed an additional expert verification, which confirmed the accuracy of species identification.

The biological cycle of bats in the Ukrainian Pryazovia can be divided into 4 unequal periods, the duration of which varies greatly over the years (Table 4). It should be noted that to a large extent, our knowledge of the presence of certain species of bats in different places during the biological cycle is related to the depth and abundance of regional research. But in some places we have not been able to fully cover all its phases.

**Table 4.** The maximum number of bat species at the sites of detection and by phases of the biological cycle

| Phases of the biological cycle | Research sites in accordance with Table 2 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| Wintering (XI-III) | – | 6 | 7 | 4 | – | – | 5 | 4 | – | 4 | 3 | – | 2 | – | 5 |
| Spring migration (IV-V) | 8 | 8 | 9 | 8 | 6 | – | 11 | 7 | 5 | 10 | 7 | 6 | 7 | 5 | 8 |
| The emergence and breeding of a new generation (VI-VII) | 5 | 7 | 7 | 7 | 7 | 6 | 10 | 8 | 6 | 7 | 7 | – | 7 | 5 | 8 |
| Autumn migration (VIII-X) | 10 | 10 | 9 | 10 | 7 | 6 | 11 | 9 | 9 | 11 | 9 | 8 | 8 | 7 | 10 |

Wintering is the longest (November-March), but there are quite warm days, when in January and February the evening temperatures can reach + 6-8 ºC, and in the first decade of March – +10ºC. During this period, we managed to record 8 species of bats on the territory of the Ukrainian Pryazovia. At points 2 (Chaplynka), 3 (Askaniia-Nova), 7 (Melitopol) and 8 (Mordvynivka), where most research was conducted, males and females of the *Plecotus*

*austriac*us and *Plecotus auritus* were found during the winter, females of the Vespertilio murinus, males and females of the *Pipistrellus kuhlii* and the *Nyctalus noctula* (Table 5).

**Table 5.** Species diversity of bats at the sites of detection during wintering

| № | Species | Chaplynka | Askaniia-Nova | Overianivka | Melitopol | Mordvynivka | Botiieve | Orlivka | Prymorsk | Manhush |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. | *Plecotus auritus* | + | + | | | | | | | |
| 2. | *Plecotus austriacus* | + | + | | | | | | | |
| 3. | *Nyctalus noctula* | + | + | + | + | + | + | + | + | + |
| 4. | *Pipistrellus kuhlii* | + | + | + | + | + | + | + | + | + |
| 5. | *P. nathusii* | + | + | + | + | + | + | + | | + |
| 6. | *P. pygmaeus* | | + | | | | | | | |
| 7. | *Vespertilio murinus* | + | + | + | + | + | + | | | + |
| 8. | *Eptesicus serotinus* | | | | + | | | | | + |
| Total: | | 6 | 7 | 4 | 5 | 4 | 4 | 3 | 2 | 5 |

Warm weather in years with frequent winter warming (2011/12; 2013/14; 2019/20) prompted bats to stop hibernation and search for food. As the concentration of the *Nyctalus noctula* at this time is too small to fully compensate for energy costs, this has resulted in the depletion and death of a significant number of animals. The *Pipistrellus kuhlii* is resistant to cold air and it is able to show activity at a temperature of + 7–10 ºC. We have repeatedly seen bats flying in late November – early December.

Transition of the average temperature through +10 ºC, which means the beginning of phenological spring, is a trigger signal to the beginning of spring migration. In Pryazovia in warm years, it begins in late March and lasts until early May. However, the bulk of bats migrates in April, and if in autumn the animals fly low above the ground, in the spring most of them fly at an altitude of about 100 m. Usually during the spring migration, clusters of bats are not expressed. In total, we recorded a temporary presence of 13 species of bats during this biological phase (Table 6).

**Table 6.** Species diversity of bats at the sites of detection during spring migration

| № | Species | Armiansk | Chaplynka | Askaniia-Nova | Overianivka | Solone Lake | Melitopol | Mordvynivka | Stepanivka-I | Botiieve | Orlivka | Naberezhne | Prymorsk | Novopetrivka | Manhush |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | *Plecotus auritus* | | | + | | | | | | | | | | | |
| 2. | *Plecotus austriacus* | | | + | | | + | + | | + | | | | | + |
| 3. | *Myotis mystacinus* | + | + | + | + | | + | | | + | + | | + | | + |
| 4. | *Nyctalus lasiopterus* | + | | + | | | | | | | | | | | |
| 5. | *Nyctalus noctula* | + | + | + | + | + | + | + | + | + | + | + | + | + | + |
| 6. | *Pipistrellus kuhlii* | + | + | + | + | + | + | + | + | + | + | + | + | + | + |
| 7. | *P. nathusii* | + | + | + | + | + | + | + | + | + | + | + | + | + | + |
| 8. | *P. pipistrellus* | + | + | + | + | + | + | + | | + | + | + | + | | + |
| 10. | *P. pygmaeus* | | + | | | | | | | | | | | | |
| 11. | *Hypsugo savii* | | | | + | | +? | | | + | | | | | |
| 12. | *Vespertilio murinus* | + | + | + | + | + | + | + | + | + | + | + | + | + | + |
| 13. | *Eptesicus serotinus* | + | + | + | + | + | + | + | + | + | + | + | + | + | + |
| Total: | | 8 | 8 | 10 | 8 | 6 | 9 | 7 | 5 | 9 | 7 | 6 | 7 | 5 | 8 |

Undoubtedly, interesting during the spring migration are isolated cases of detection of *Hypsugo savii* on 09 / 10.04.2020 near the villages of Overianivka and Botiieve and, with a certain amount of doubt, on 18 / 19.04.2020 in Melitopol (Table 6), as well as on 06 / 07.09.2018 in the village of Chaplynka (n = 3) and on 08 / 09.06.2020 near the village of Novopetrivka (n = 1) during the autumn migration (Table 8). After all, this species is quite rare even within the area on the southern coast of Crimea [6].

The summer fauna of bats in the Ukrainian Pryazovia is represented by 7-9 species (Table 7), which occurred at almost all vantage points. The most numerous everywhere were: *Nyctalus noctula, Vespertilio murinus, Eptesicus serotinus, Myotis mystacinus, Pipistrellus kuhlii, P. nathusii, P. pipistrellus. Plecotus auritus* and *Plecotus austriacus*, as well as *Nyctalus lasiopterus* and *Nyctalus leisleri* were rare. Given the randomness of the meetings and the singularity of the latter, we cannot confirm with much certainty the nature of their presence in the region in the summer.

**Table 7.** Species diversity of bats at the sites of detection during the birth and offspring rearing

| № | Species | Armiansk | Chaplynka | Askaniia-Nova | Overianivka | Solone Lake | Sadky | Melitopol | Mordvynivka | Stepanivka-I | Botiieve | Orlivka | Prymorsk | Novopetrivka | Manhush |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | *Plecotus auritus* | | | | | | | + | | | | | | | |
| 2. | *Plecotus austriacus* | | | | | | | + | + | | | | | | + |
| 3. | *Myotis mystacinus* | + | + | + | + | + | + | + | + | + | + | + | + | + | + |
| 4. | *Nyctalus lasiopterus* | | | + | | | | | | | | | | | |
| 5. | *Nyctalus noctula* | + | + | + | + | + | + | + | + | + | + | + | + | + | + |
| 6. | *Nyctalus leisleri* | | | | | | | + | | | | | | | |
| 7. | *Pipistrellus kuhlii* | + | + | + | + | + | + | + | + | + | + | + | + | + | + |
| 8. | *P. nathusii* | + | + | + | + | + | + | + | + | + | + | + | + | + | + |
| 9. | *P. pipistrellus* | | + | + | + | + | + | + | + | + | + | + | + | + | + |
| 10. | *Vespertilio murinus* | | + | + | + | + | + | + | + | + | + | + | + | | + |
| 11. | *Eptesicus serotinus* | + | + | + | + | + | + | + | + | + | + | + | + | + | + |
| Total: | | 5 | 7 | 8 | 7 | 7 | 7 | 10 | 8 | 7 | 7 | 7 | 7 | 6 | 8 |

The largest species diversity of bats (n = 15) in the places of our research was recorded during the autumn migration (Table 8).

**Table 8.** Species diversity of bats at the sites of detection during the autumn migration

| № | Species | Armiansk | Chaplynka | Askaniia-Nova | Overianivka | Solone Lake | Sadky | Melitopol | Mordvynivka | Stepanivka-I | Botiieve | Orlivka | Naberezhne | Prymorsk | Novopetrivka | Manhush |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | *Plecotus auritus* | + | | | + | | | + | | | + | | | | | |
| 2. | *Pl. austriacus* | | + | + | + | | | + | + | + | + | + | + | | | + |
| 3. | *Myotis mystacinus* | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + |
| 4. | *M. daubentonii* | | | | | | | | | | + | | | | | |
| 5. | *Nyctalus noctula* | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + |
| 6. | *N. lasiopterus* | | | | | | | + | | | | | | + | | |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7. | *N. leisleri* | + | | | | | | + | | | + | | | | + |
| 8. | *Pipistrellus kuhlii* | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + |
| 9. | *P. nathusii* | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + |
| 10. | *P. pipistrellus* | + | + | + | + | + | | + | + | + | + | + | + | + | + | + |
| 11. | *P. pygmaeus* | | + | + | + | | + | + | + | + | + | + | | | | + |
| 12. | *Hypsugo savii* | | + | | | | | | | | | | | | | |
| 13. | *Vespertilio murinus* | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + |
| 14. | *Eptesicus serotinus* | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + |
| 15. | *Barbastella barbastellus* | + | | | | | | | | | | | | | | |
| Total: | | 10 | 10 | 9 | 10 | 7 | 7 | 12 | 9 | 9 | 12 | 9 | 8 | 8 | 7 | 10 |

If most of the animals found were expected migrants, the only meeting of the *Barbastella barbastellus* at the end of September, 2012 near Armiansk and registration of 3 *Myotis daubentonii* on 16 / 17.05.2014 near the village of Botiieve were a wonder. The "raids" of these species, which are not characteristic for field landscapes, testify to our limited knowledge about distribution of rare and not numerous bats in our country.

Of course, the transition from one phase of the biological cycle to another is gradual, as evidenced by the results of our research in Melitopol (Fig. 3). In March-April 2020, 5-180 sounds were recorded every night, which undoubtedly belonged to animals that wintered in the town. But in June, their number rose sharply to 125-470. When the peak reached in late June and early July (440-470), the migration wave subsided and the period of birth of young animals and their breeding began, which lasted until the last days of July. Already in mid-August 2020, the peak of the first autumn migration wave was registered in Melitopol, which generally lasts until August, 20-25 in the Ukrainian Pryazovia.

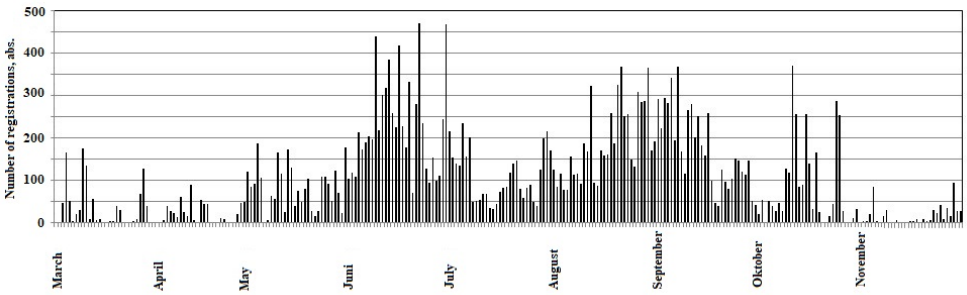


**Fig. 3.** Dynamics of activity of bats in Melitopol, 2020

From the beginning of July to the middle of August, there was a local increase in the number of bats due to birth, which was joined by other animals that appeared as a result of migration processes. In 2020, the second wave of migration lasted from late August to late September. It was characterized by 3 peaks (350 signals) and 3 depressive phases (120-180 signals per night), as well as a rapid decrease in animal activity (40-47 signals) at the end of the month, which could be caused by rapid cooling in much of Eastern Europe. In general, in many coastal areas, this wave becomes noticeable from late September to the third decade of October, but in cold weather it may not be. In the first decade of November this year, after a short migration surge, wintering of bats began. Although in some years in the last decade of October, no active individuals were found.

## CONCLUSION

In 2010–2020 from Mariupol to the Sivash Lake, 15 species of bats were recorded at the locations planned for the construction of wind power plants using 6 certified ultrasonic detectors (Pettersson D240x, D500x; LunaBat DFR-1 PRO).

In the study area during the wintering, with limited research in this period, 8 species were found, during the spring and autumn migrations – 13 and in summer – 11 species. In all seasons, the least common were *Plecotus auritus, Myotis daubentonii, Nyctalus lasiopterus* and *Nyctalus leisleri, Hypsugo savii and Barbastella barbastellus.*

The greatest species diversity of bats (n = 10–12) was found in the narrowest gap between the Dnieper River and the Sea of Azov, as well as in the coastal strip, where the main flow of migrating animals takes place.

During migrations in the Ukrainian Pryazovia, bats willingly stop in tree hollows in parks, artificial forests and forest belts, various cliffs and buildings, which they use as temporary hiding places. In some of them they form small colonies and even overwinter.

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