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REGIONAL RECAPTURES OF BATS (CHIROPTERA, VESPERTILIONIDAE) RINGED IN EASTERN UKRAINE

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Regional Recaptures of Bats (Chiroptera, Vespertilionidae) Ringed in Eastern Ukraine. Vlaschenko, A., Prylutska, A., Kravchenko, K., Rodenko, O., Hukov, V., Timofieieva, O., Holovchenko, O., Moiseienko, M., Kovalov, V. — Bats are volant and highly mobile mammals that could cover up to 2000 km seasonally (one-way migration). But the level of mobility among different roosts sites in a breeding season, and among breeding areas and hibernation sites is poorly studied. With this communication, we aimed to present results of recaptures (51 cases with a distance of 0.5 km and more) of bats ringed in Kharkiv Region, Ukraine, from 2006 to 2018. The recaptures were obtained of three main study areas (NNP "Homilsha Forests" — 17 cases, Izium District — 5, Kharkiv City and surroundings — 27) and at two other localities of the Kharkiv Region. One recapture was obtained in Lugansk Region. The recaptures were received for five bat species (*Nyctalus noctula*— 35, *Myotis daubentonii*— 11, *Eptesicus serotinus* — 1, *Pipistrellus nathusii* — 1 and *Pipistrellus pygmaeus* — 3). The maximum distances were obtained to different species as follow *N. noctula* — 209.7 km, *M. daubentonii* — 24.8, *E. serotinus* — 14.5 km, *P. nathusii* — 1.1 km and *P. pygmaeus* — 1.2 km. For the first time, we confirmed that *N. noctula* that were born in forested areas of Kharkiv City surroundings moved to the built-up area of the city for hibernation. It is the first direct evidence of the existence of the resident population of this species in Ukraine.
Key words: short-distant movements, banding, migratory patterns, monitoring, bats, Ukraine.

Introduction

Bats have complex spatiotemporal population structure, which implies sex and age groups segregation during an annual cycle (e. g.: Strelkov, 1999; Rakhmatulina, 2000; Russo, 2002; Ibáñez et al., 2009). At temperate latitudes with pronounced seasonality, bats need roosts with different microclimate during breeding and hibernation. To find appropriate habitats, bats perform regional or long-distance migration between summer and winter grounds (Hutterer et al., 2005; Steffens et al., 2004; Weller et al., 2016; Voigt et al., 2017). Considering a high conservation priority of bats, information about spatial population structure and seasonal movements is pivotal for providing effective conservation management strategy. However, we still have scarce knowledge about their habitat use, especially on vast territories of Eastern Europe. Despite the fact that new technologies (such as GPS tagging) have provided insights into individual bat movements (e. g. Weller et al., 2016; Roeleke et al., 2016), ringing (or banding) so far remains a classic and comparably cheap method for studying bat movements on the middle- and long-distance spatial scales and over long time periods. Many papers (reviewed in: Hutterer et al., 2005; Steffens et al., 2004) summarized results of recaptures of ringed bats in Europe. They presented the information about the main directions of bat seasonal movements, long-distance and regional migratory patterns, as well as average and maximum distances for different species (Hutterer et al., 2005; Steffens et al., 2004). Data from Eastern European countries (the former Soviet Union) had contributed that reviews significantly, especially in the case of long-distance bat movement with data available up to the end of the 1980th (Panutin, 1980). Later, big-scale bat ringing programs in the Soviet Union were stopped, and for the last ten years, only one long-distant recapture of a bat had been reported from the territory of Ukraine, Russia and Belarus (Gashchak et al., 2015). However, the movement pattern of bats in the Eastern European countries could differ compared to well-studied Western European countries, according to a more continental climate on the East. In this way, data on bat movements from the East could contribute to the whole picture of movement patterns of species. The bat ringing program in Kharkiv Region has been running since 2002 (Vlaschenko, 2012) with more than 20 000 individuals of 13 bat species have been ringed until 2018 (unpublished). Previously, we presented results on longevity, local recapture (year by year in one roost), and few short-distance (or regional) recaptures (Vlaschenko, 2012; Vlaschenko et al., 2017). Since 2012, when the first review was published (Vlaschenko, 2012), we had obtained more information about regional recaptures (more than 0.5 km) of bats in the Region and aimed to summarize these results in this communication. These data are important for several reasons: 1) documentation of results of the ringing program; 2) better understanding the pattern in bat space use during an annual cycle; 3) present data on direction and distance of bat movements from Eastern Europe.

Material and methods

Study area and study sites

The main region of the bat ringing program is Kharkiv Region (49°37′ N 36°22′ E) (all recaptures but one were reported from this territory) that covers 31.4 thousand km² in north-eastern Ukraine. There is a border between forest-steppe (to the North) and steppe (to the South) nature zones in the southern part of the region. The terrain of the Kharkiv Region is plains area with a maximal elevation of 236 m above sea level in the north and minimal elevation of 90 m in the south-east. The mean annual temperature in the region is 8.1 °C, the mean January and July temperatures are –7 °C and +21 °C respectively, and annual precipitation does not exceed 540 mm. There are oak, pine and mixed forests covering 12 % of the Region (Golikov et al., 2011); the detailed map of bat research in forested areas in the Region is presented in V. Kovalov et al., 2019.

There were three main research polygons where the majority of bats were ringed over several years: Kharkiv City area and surroundings (including Liptsy mines), National Nature Park (NNP) "Homilsha Forests", Izium District. We visualized main recaptures on five maps according to species and territories (fig 1).

In this paper we use division of an annual bat cycle according to our previous results of a year-round monitoring of bats: period of spring migration (SM) — April 1st — 30th, breeding (B) May 1st — July 31st, autumn invasion or migration (swarming) (AI) August 1st — September 15th, autumn silence (AS) September 16th — end of October (preliminary), hibernation (H) November (preliminary) — March 31st (Kravchenko et al., 2017 a).

Bat ringing and recapture

During warm seasons of a year, in areas outside of the Kharkiv City (urban built-up areas), bats were caught by mist-nets and a plastic-trap. In the city area, bats were found in distinct buildings. For more information about methods of bat catching and seasons of study

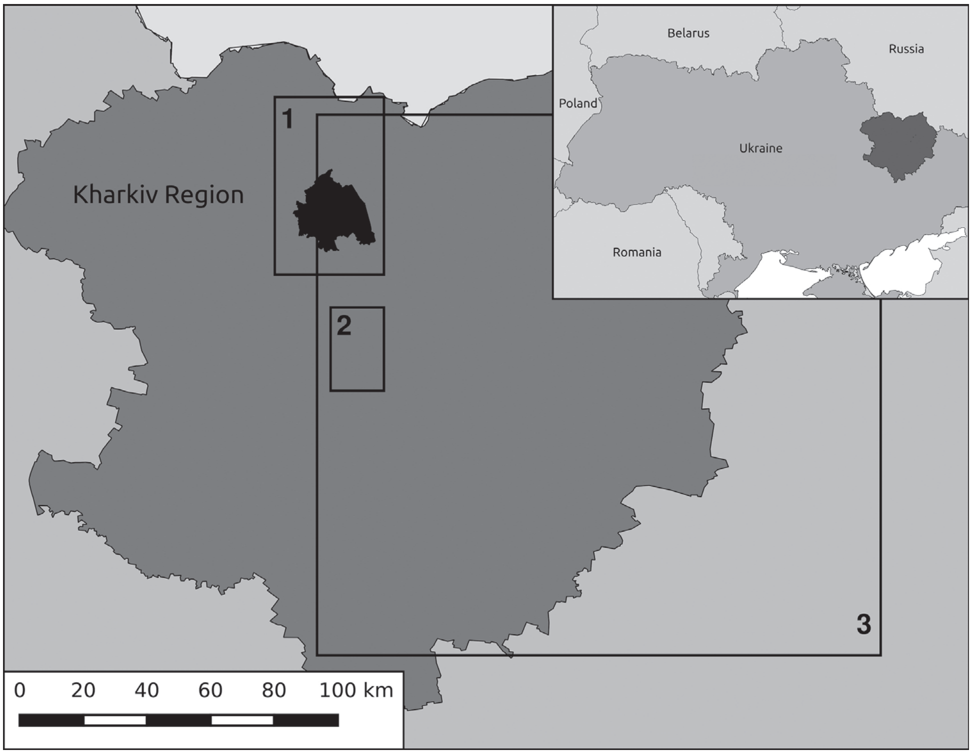

Fig. 1. Map of Kharkiv Region with territories of main recaptures: 1 — recaptures within Kharkiv City and surroundings; 2 — recaptures in NNP “Homilsha Forest”; 3 — recaptures outside of Kharkiv Region.

in forested areas see: Kovalov et al., 2019; Vlaschenko et al., 2016; Gukasova, Vlaschenko, 2011; for more information about the methods applied in the city area see: Kravchenko et al., 2017 a, and in Liptsy mines’ area see: Vlaschenko, Naglov, 2018. We distinguished two age groups of bats: ad = adult (specimens older than 1 year), and sad = subadult or 1st-year individuals (specimens younger than 1 year) (details of bats age identification see: K. Kravchenko et al., 2017 a). Specimens of an unclear age were classified as uncertain (un).

We used two types of aluminium rings during the whole period of the ringing program. At the first stage, in 2002–2009, bats were ringed with ornithological rings, which have sharp edges and were operated manually by a nail file. Since 2010, we started to use special bat-friendly rings. There are five series of rings for different size classes of bats. Each ring has a unique five-digit number and series-specific code: AT (internal diameter 2,4 mm), BT (2,9 mm), CT (3,2 mm), DT (4,2 mm) and ET (5,2 mm). In addition, each ring has information about the ringing centre and country of ringing (“Kiev, Ukraine”). All types of rings were manufactured by Polish company “Aranea” (Vlaschenko, 2012). We applied previously recommended way of wearing rings (Panutin, 1980): on the left forearm and the last digits of the number to the outside (Vlaschenko, 2012).

During warm seasons of a year, ringed bats were released at the same place or close to the catching site at the same or following night (e. g. Vlaschenko et al., 2016). In Kharkiv City, during the cold season of a year, bats were kept in rehabilitation centre under artificial hibernation conditions (Kravchenko et al. 2017 a, b) until spring. In spring, all bats were released during a special public event “The Bat Release Fest” at one location in Feldman Ecopark (the North border of Kharkiv City). In some cases, groups of bats, found during wintertime in other cities of Ukraine, were transported to the Bat Rehabilitation Center of Feldman Ecopark and later released at the Feldman Ecopark too (Vlaschenko and Prylutska, 2018)

All applied methods were ethical and respectful to animal welfare and conservation requirements of protected species, according to international standards (Sikes, 2016) and Ukrainian National Law.

Data analysis or map creation

The complete list of the recaptures is presented in the Appendix. Three main spatial clusters were created: NNP "Homilsha Forests", Kharkiv City area and surroundings (includes recaptures from Liptsy mines), and remote points were grouped together (Lysychansk and others). The recaptures had been systematized in sections according to spatial locations, one by one, by the date of ringing and/or release. For each spatial cluster, we divided recaptures into two groups: the first group with recaptures during one calendar year and the second group with bats recaptures from one of the following years. We calculated a mean value (X) and standard deviation (SD) for distances of recaptures, for sample size with three and more cases. In addition, we added information about the habitat type. Forested areas were recorded as "Forest" (forest areas within the Kharkiv City were categorised as this habitat type), building areas of Kharkiv and suburbs were noted as "Urban", two other categories: "Mine" and "Pit" included swarming and hibernation sites out of urban areas.

If there were a difference between the place of capture and the place of release, in the list of recaptured bats (Appendix) we presented locations of release also.

Distances between release points and recapture points were measured and all maps were created with a free software QGIS v. 2.18.11.

Results

General findings

In total, there are 51 recapture cases (with distance 0.5 km and more) reported since 2006 for five bat species (*Nyctalus noctula* — 35, *Myotis daubentonii* — 11, *Eptesicus serotinus* — 1, *Pipistrellus nathusii* — 1 and *Pipistrellus pygmaeus* — 3). The maximum distances according to species were as follows: *N. noctula* — 209.7 km, *M. daubentonii* — 24.8, *E. serotinus* — 14.5 km, *P. nathusii* — 1.1 km and *P. pygmaeus* — 1.2 km. Among the 51 recaptures, 17 cases were reported for the NNP "Homilsha Forests" (*N. noctula* — 9, *M. daubentonii* — 4, *P. nathusii* — 1 and *P. pygmaeus* — 3 cases); 5 cases were reported for Izium District (*N. noctula* — 2, *M. daubentonii* — 3 cases); 27 cases were reported for Kharkiv City and surroundings (*N. noctula* — 22, *M. daubentonii* — 4 and *E. serotinus* — 1 cases); and one case of recapture is from Lysychansk town (*N. noctula* — 1) and one is from Rubizhne village (*N. noctula* — 1) (for details see Appendix).

Recaptures in NNP "Homilsha Forests"

The detailed visualization of bat recaptures in NNP "Homilsha Forests" is presented in fig. 2, a, b. Among nine individuals of *N. noctula* recaptured in NNP "Homilsha Forests", five recaptures were reported for one year (X = 1 ± 0.269 km, min = 0.51, max = 1.31). For *P. nathusii*, *P. pygmaeus* and *M. daubentonii,* there was only one recapture for each species within one year, with distances in 1.1, 0.99 and 0.5 km respectively (recaptures N 10, 11 and 12 in the Appendix and fig. 2, b). Maximal distances of recaptures reported for different years were the following: 2.2 km for *N. noctula* (recaptures N 7 and 8 in the Appendix and fig. 2, b), *M. daubentonii* — 1.3 (case 17) and *P. pygmaeus* — 1.2 (recapture N 16).

Recaptures in Kharkiv City and surroundings

The detailed visualization of bat recapture cases in Kharkiv City and surroundings is presented on fig. 3a, b.

Among 22 individuals of *N. noctula* (fig. 3, a) which were recaptured in the city area and surroundings, seven cases were reported from one calendar year. Among them, three cases (F sad and 2 M sad) were from forest habitats toward urban area during breeding and autumn invasion periods (recaptures N 18, 19 and 22 in the Appendix) (X = 8.5 ± 3.083 km, min = 4.2, max = 11.21). Moreover, the recapture N 19, is the case when an individual was born in a forest in the vicinity of Kharkiv and moved to the urban area during an autumn invasion. Two recaptures were recorded for one year (M sad and M ad) with the opposite direction of migration, from an urban area (according to a location where they were found) to forest habitats (those bats were released in the forest of Feldman Ecopark) (cases: 21 and 24 in the Appendix). These bats were recaptured 13 and 51.4 km respectively out of hibernation area within the Kharkiv City. In addition, the recapture N 24 with a distance in 51.4 km is the recapture with the longest covered distance within the Kharkiv Region. Two other cases of one-year recaptures (F sad and M sad; N 20 and 23 in the Appendix) were movements within the built-up area in autumn invasion period both with distance in 5.5 km.

Other 15 cases of *N. noctula* recaptures were with a time period more than a year (recaptures N 25–39 in the Appendix). These individuals were found in three periods: hibernation (six recaptures), autumn invasion (eight recaptures) and breeding (one recapture).

Among these 15 individuals, six bats (3 F sad, 4 M sad and M ad) were released in the urban area and were recaptured in the urban area too. Eight bats out of 15 were released in the forest area and recaptured in Kharkiv City. The last individual was released in the forest area with the recapture in the forest area too. Five individuals were released in the forest area of Feldman Ecopark with 2 individuals (F ad and M ad) been recaptured in the urban area at the next or in two winters (cases: 30, 36 in the Appendix). They moved back to the built-up areas from the point of releasing on 11.2 and 8.5 km respectively. Three individuals (M sad and 2 M ad) were

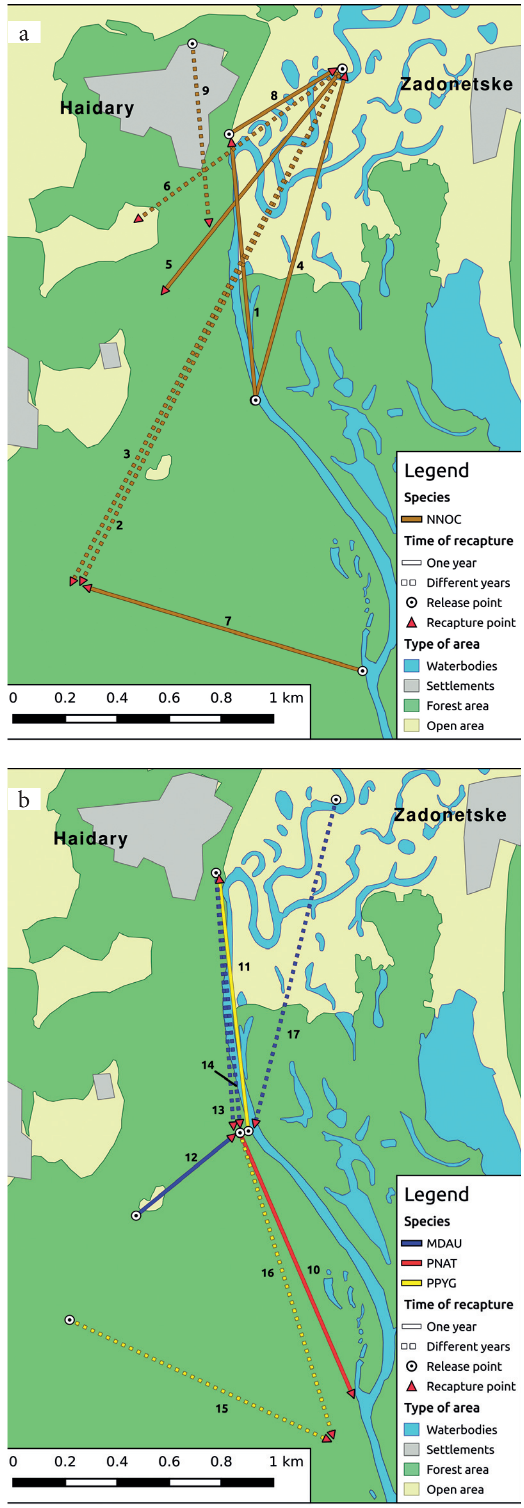

Fig. 2. Detailed map of bat recaptures in NPP "Homilsha Forests" area (research polygon N 2 according to fig. 1): a — recaptures of *N. noctula*; b — recaptures of other species (numbers of the arrows correspond to recapture number in the Appendix).

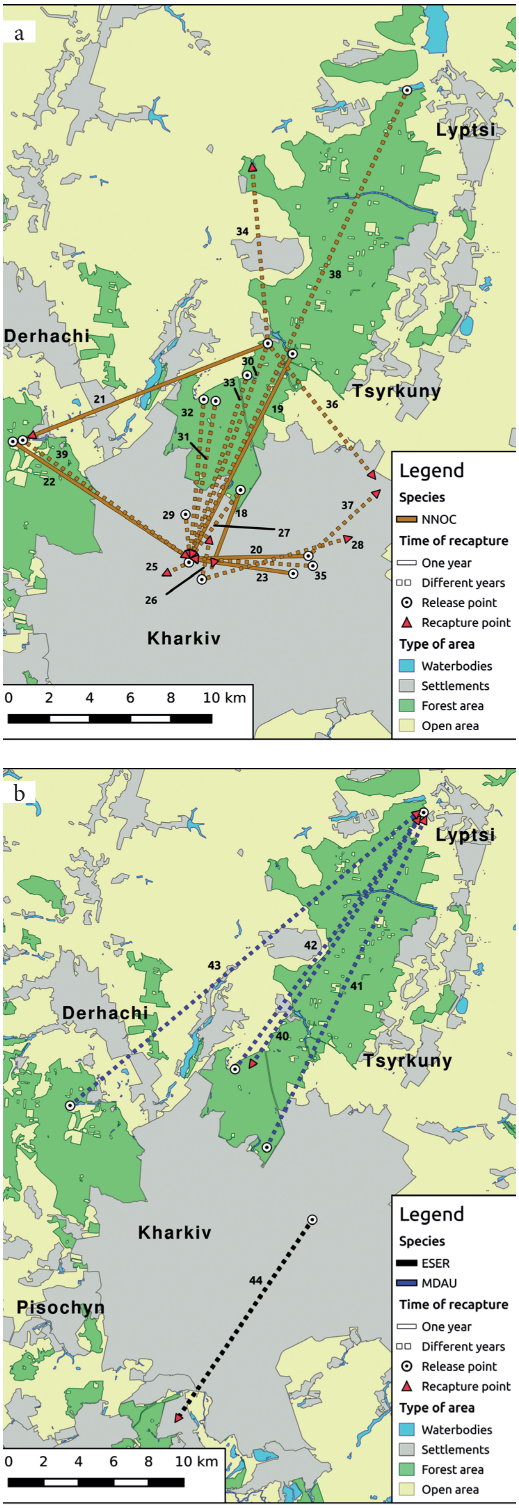

Fig. 3. Detailed map of bat recaptures in Kharkiv City area and surroundings (research polygon N 1 according to fig. 1): a — recaptures of *N. noctula*; b — recaptures of other species (numbers of the arrows correspond to recapture number in the Appendix).

recaptured in a forested area (cases: 21, 24, 34 in the Appendix, the case 24 see fig. 4) the distances were: X = 24.5 ± 19.145 km, min 8.9, max = 51.4. In the direction from forest towards city area we have 9 individuals (cases: 18–19, 22, 27, 31–33, 38, 39 in the Appendix). They were caught and ringed in breeding (n = 2) and in autumn invasion (n = 7). All of them were recaptured in the urban area in periods of autumn invasion (n = 3; 2 F sad, M sad), hibernation (n = 4; F ad, 3 M sad) and spring migration (n = 2; 2 M ad), in a distance: X = 10 ± 5.902 km, min = 4, max = 25.2.

The recaptures for different sexes of *N. noctula* in Kharkiv City and surroundings were as follows: females (n = 7) — X = 7.5 ± 3.43 km (min = 1.2, max = 11.2); males (n = 15) — X = 10.9 ± 12.18 km (min = 0.6, max = 51.4).

Besides *N. noctula*, we recaptured five individuals of other species in Kharkiv City and surroundings: *M. daubentonii* (n = 4) and *E. serotinus* (n = 1) (fig. 3, b). One recapture case of *E. serotinus* (F ad, case 44 in the Appendix) was obtained between the centre of the urban area and outskirts (14.5 km) (fig. 3, b). Among 4 *M. daubentonii* recaptures, one (case: 40 in the Appendix) had been described in the previous paper (Vlaschenko, 2012) already. This and other recaptures (cases: 41–43 in the Appendix) of *M. daubentonii* were movements between bat hibernaculum in Liptsy mines and surrounding forests, some of them were inside the administrative borders of Kharkiv City (fig. 3, b). In one case (case: 43 in the Appendix) we confirmed that an individual of *M. daubentonii* was born in a forest 24.8 km far from the Liptsy mines and moved there for hibernation. The mean of distance of all movements of *M. daubentonii* is X = 20.0 ± 3.06 km, min = 17.2, max = 24.8.

Recaptures in Izium District

Five recapture cases (*M. daubentonii* — 3; *N. noctula* — 2) were obtained in Izium District in two research locations in breeding and autumn invasion period; all of them had been described in the previous paper (Vlaschenko, 2012) already (cases: 45–49 in the Appendix). *M. daubentonii* covered X = 1 ± 0.628 km, min = 0.6, max = 1.9, inside one woodland area and between summer breeding area and autumn swarming location. Two *N. noctula* covered 0.7 and 1 km inside one forested area during the breeding period.

Recapture form Lysychansk town and Rubizhne village

Two recaptures of *N. noctula*, (case: 50 in the Appendix, fig. 4), were from territories far distant from the main research polygons (case: 51 in the Appendix, fig. 4). The first case is the recapture from Lysychansk town 209.7 km far from the point of releasing in Feldman Ecopark. That individual was from a group of *N. noctula* rescued in Lysychansk town December 8, 2016, and transported to Bat Rehabilitation Center in Kharkiv, they were rehabilitating all the winter and released in the nature in the vicinity of Kharkiv City.

The recapture case number 51 (Rubizhne village) is 3.9 km movement of subadult male inside one forested area in the breeding period.

Discussion

The new set of bat recaptures (presented in this paper) is a significant contribution to knowledge about annual spatiotemporal bat occurrence in the forest-steppe zone in Ukraine. In the period of 1939–1990, only 4003 bats were ringed (Godlevska, 2001) from the territory of Ukraine, and the total number of long-distance, regional and sedentary recaptures were less than ten cases (Hutterer et al., 2005). Previously reported the longest bat recapture (*P. pipistrellus* s. l., distance 1123 km) was from the territory of Central Ukraine to Bulgaria in 1960th (Hutterer et al., 2005). The other recaptures in that period were obtained from the Western border of Ukraine to Hungary, Poland and Slovakia with distances from 27 to 270 km for *Myotis* species and up to 200 km for *N. noctula* (Hutterer et al., 2005). The most recent (in 2014) recapture of *N. noctula* from Northern part of

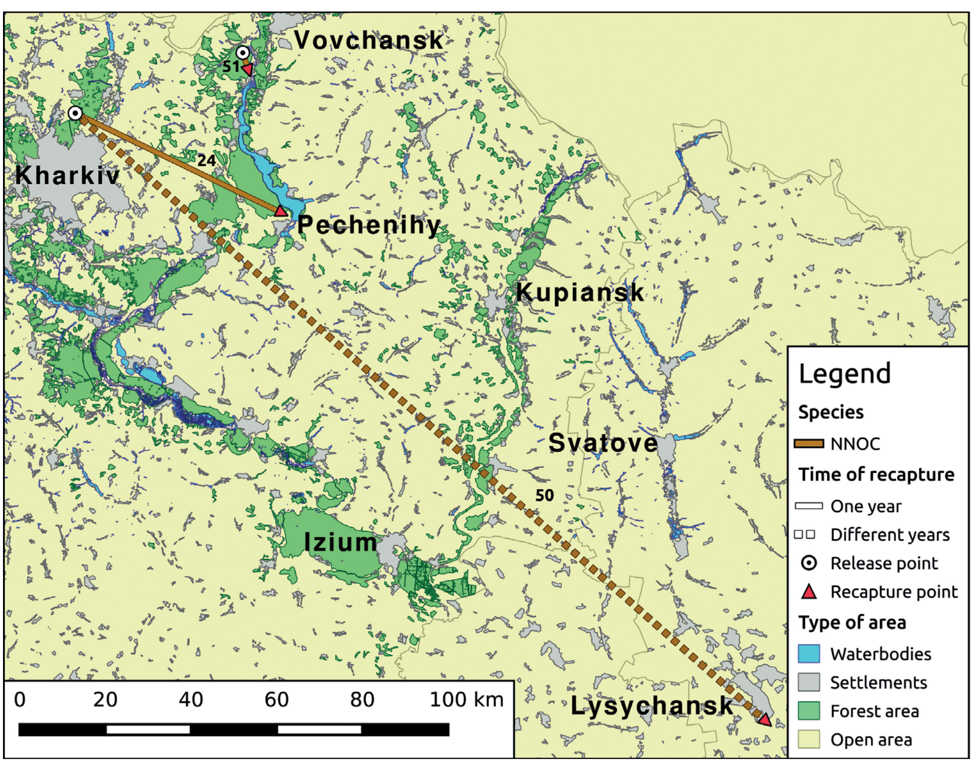

Fig. 4. Map of recaptures of *N. noctula* in Kharkiv Region (recaptures N 24 and 51), and the farthest recapture (N 50) from Kharkiv Region to Luhansk Region (research polygon N 3 according to fig. 1).

Central Ukraine to Hungary was with a distance of 800 km (Gashchak et al., 2015). In this communication we contributed data for the territory of Ukraine by such distances: more than 200 km — 1 case, more than 50 km — 1 case, on a range of distances 49–20 km — 3 cases, 19–10 km — 8 cases, 9–1 km — 25 cases, less than 1 km — 13 cases. On the base of our sample size, there were no differences in sex and age-based recapture distances.

Species spatial exploration and utilisation requirements have to be taken into account for developing sustainable conservation programs. Ukraine is still far behind from Central and Western European countries by the number of bat conservation actions, monitoring programs, research and conservation projects, etc. The data about bat movements on the local scale is needed for planning of borders and sizes of nature protected areas and developing local Bat Conservation Action Plans. Our results from NNP "Homilsha Forests", Izium District and Rubizhne village (recaptures in forested areas in breeding season) reveal information about the spatial distribution of bats in a breeding period. The results already obtained for *N. noctula*, *M. daubentonii* and *Pipistrellus spp.* showed that individual home range polygons for these species cover tens and hundreds of square kilometres (e. g. Boye, Dietz, 2005; Roeleke et al., 2016). From this point of view, our data is not new. At the same time, results from NNP "Homilsha Forests", for multiple years (cases 6–9 and 13–17 in the Appendix) indicate a long-term (maximum 7 years) inhabiting of this forest by bats during a breeding season. This confirms that conservation management applied for the area of the NNP "Homilsha Forests" is important for the protection of local bat populations and need to prolong it in the future.

Two of our field-research projects were aimed to find spatial connection between summer (breeding) areas and winter roost locations of *M. daubentonii* and some other resident species (see Acknowledgements). In fact, in this paper, we have presented two cases, for *N. noctula* and *M. daubentonii*, when a bat was born in a forested area close to hibernaculum and later moved there for overwintering. In the case of *M. daubentonii* (recapture case: 43 in the Appendix) an individual covers near 25 km from forest named Karavan (Dergachy District) to Liptsy mines. Liptsy mines are only one known place of mass winter aggregation of *M. daubentonii* for all Kharkiv Region and surroundings (Vlaschenko, Naglov, 2018), and seasonal movement of a bat to that mines is predictable. In opposite, in Karavan Forest the relative abundance of *M. daubentonii* is very low, 10-15 % (Kovalov et al., 2019; Hukov et al., 2019) and it was a very little chance that one of just tens ringed individuals would be recaptured. This recapture is an important argument for keeping the Karavan Forest under protection.

The most interesting results presented in this paper belong to the recaptures of *N. noctula* in Kharkiv City area and surroundings. In the middle of XX century, this species was estimated as long-distance migratory species (Abelentsev et al., 1956) in the European part of the former Soviet Union, with main SW direction of autumn migration, that could move up to 1500 km (Hutterer et al., 2005). But in a short period of time, from the end of 1980th until the end of 1990th, *N. noctula* changed the migratory strategy and formed numerous winter aggregations in urban areas of Eastern Europe (Strelkov, 2002; Godlevska, 2015). This process of changing of migratory behavior of *N. noctula* was monitored with high precision exactly in Kharkiv City. The first record of individual of this species in wintertime was done in 1986 (Vlaschenko, 2011), after a short gap in monitoring (1991–1998) since 1999 this species became the most numerous in wintertime in the city (Vlaschenko, 1999; Kravchenko et al., 2017 a). But the origin of these hibernating *N. noctula* was unclear. On the one hand, they could be long-distance migratory individuals that breed up to 1200 km far north (the northern border of the breeding range of *N. noctula*, S. Bogdarina, Stelkov 2003). In this case, *N. noctula* is still recognized as long-distance migratory species. On the other hand, these bats could be born in the vicinity of those cities, and in that case, we are observing the formation of sedentary populations at the northern part of hibernation range. Recaptures of individuals from forested area to Kharkiv City area (fig. 3, a) are the first evidence of existing sedentary population (or as a minimum a group) of *N. noctula* in a recently colonized part of a winter range of the species. The recapture data from cities (Kharkiv, recapture case: 25, 26, 30, 36, 37 in the Appendix) (Lysychansk, case 50 in the Appendix) indicates species winter ground fidelity in urban environments and long-term (Vlaschenko et al., 2017) usage of the cities during autumn invasion and hibernation seasons. Likewise in spite of the many existing threats for bats in the urban environment (e. g. Russo and Ancillotto, 2015; Kravchenko et al., 2017 a; Vlaschenko et al., 2019) the home fidelity for hibernation sites in the cities suggest that maybe hibernation could be successful year by year. Moreover, *N. noctula* uses all the heterogeneous landscape of urban area and surrounding during one period of a bat life cycle, in different periods and in different years. From this point of view such "new" kind of migratory status and spatial occurrence (compare to simple migration between summer and winter habitats) more vulnerable to human activity, and could be a part of ecological trap for this species (Vlaschenko et al., 2019). Vice versa, the heterogeneity of urban landscape (different kinds of roost sites, unfrozen waterbodies in wintertime, street-lights attracting insects, short-distance to city periphery with natural vegetation for air-hawking bat species) could promote species survival by providing diverse possibilities for roosting and feeding on shorter distances. In any case, the "new" type of spatial-temperate population structure of *N. noctula* raises a new level of responsibilities from people towards urban bats (Kravchenko et al., 2017 a; Vlaschenko et al., 2019). Both, non-governmental organizations and governmental authorities should provide more bat education, conservation and rescue actions in cities.

When we started the ringing program in 2002 we expected to get long-distance recaptures of *N. noctula* (Vlaschenko, 2012) by analogy with results from Voronezh Reserve (Voronezh Region, Russia) (Panutin, 1980; Hutterer et al., 2005). At first, the absence of long-distance recaptures we interpreted by the low research activity in regions of potential winter stay (Crimea Peninsula, Caucasus, Balkans and etc.) of the species (Vlaschenko, 2012). However, our regional recaptures mostly support the hypothesis that the absence of long-distance recaptures could be the result of forming the real sedentary population of *N. noctula*. Moreover, the results of stable isotope analysis (Kravchenko et al., 2018) indicated that in winter aggregation of *N. noctula*, the proportion of long-distance migrants decrease, in favour of the increasing proportion of locally-born bats for last 12 years.

On the one hand, these 51 regional recaptures are not a big number, considering the time and resources consumed. However, these results are unique for the territory of Ukraine and even for the most territory of the former Soviet Union countries. Therefore, in our opinion, the bat ringing programme has to be continued. There are preliminary 5000–7000 bats that already wearing rings and live in the surroundings of Kharkiv and the region. The research objective is to intensify observations of these bats, involving additional techniques, as telemetry and GPS tagging for getting new data about spatial population structure.

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Appendix

List of recaptured bats in the Eastern Ukraine on distance more than 0.5 km, 2006–2018:
Abbreviations: Bat species acronyms: *Mdau — Myotis daubentonii*; *Eser — Eptesicus serotinus*; *Nnoc — Nyctalus noctula*; *Pnat — Pipistrellus nathusii*; *Ppyg — Pipistrellus pygmaeus*. Symbols of sex and acronyms of age: F — female; M — male; ad — adult individual; sad — subadult individual; un — sex and/or age were unidentified. Date of record: 20.02.2008 — dd.mm.yyyy; Geographical coordinates: in decimal values.
Symbols of seasons of a year according to bat life-cycle (Kravchenko et al., 2017a): spring migration — SM (April 1st — 30th); breeding — B (May 1st — July 31st); autumn invasion or migration — AI (August 1st — September 15th); autumn silence — AS (September 16th — end of October); hibernation — H (November (preliminary) — March 31st).
Symbols of capture methods: mist-netting — MN; captured from a roost site — R; find in a city — CR.
In the List for some records in Kharkiv City we gave two dates and two seasons, the first data is the day of the record and the second one, in brackets, is the date of release in the Feldman Ecopark area. We divided by semicolons dates, point coordinates, season of a year and type of catching.

National Nature Park "Homilsha forests"

N	Species and ring number	Released (captured) and ringed: date, point coordinates, season of a year, type of catching	Recaptured: date, point coordinates, season of a year, type of catching	Distance, km
		"Homilsha forests" *N. noctula* one year		
1	*Nnoc* F ad C006620	13.07.2007; 49.62554 N, 36.33329 E; B; MN.	14.07.2007; 49.61782 N, 36.32396 E; B; MN.	1

2	*Nnoc* F sad ET00043	03.07.2008; 49.62298 N, 36.32732 E; B; MN.	16.07.2008; 49.62554 N, 36.33329 E; B; MN.	0,5
3	*Nnoc* F sad ET00091	05.07.2008; 49.61411 N, 36.32863 E; B; MN.	16.07.2008; 49.62554 N, 36.33329 E; B; MN.	1,2
4	*Nnoc* M sad DT01277	14.07.2011; 49.61411 N, 36.32863 E; B; MN.	18.07.2011; 49.62298 N, 36.32732 E; B; MN.	0,8
5	*Nnoc* M ad DT01308	16.07.2011; 49.60477 N, 36.33436 E; B; MN.	20.07.2011; 49.60782 N, 36.31909 E; B; R.	1
		“Homilsha forests” *N. noctula* different years		
6	*Nnoc* F ad C006612	13.07.2007; 49.62554 N, 36.33329 E; B; MN.	04.07.2008 49.62517 N, 36.33299 E; B; R.	0,5
7	*Nnoc* F sad C006623	13.07.2007; 49.62554 N, 36.33329 E; B; MN.	10.07.2008; 49.60782 N, 36.31909 E; B; MN.	2
8	*Nnoc* F sad C006623	13.07.2007; 49.62554 N, 36.33329 E; B; MN.	20.07.2011; 49.60782 N, 36.31909 E; B; MN.	2
9	*Nnoc* M ad C006315	12.07.2006; 49.62641 N, 36.32531 E; B; R.	01.11.2013; 49.620277 N, 36.326186 E; In an owl (*Strixaluco*) pellet	0,8
		“Homilsha forests”other species one year		
10	*Pnat* F sad BT00131	05.07.2008; 49.61411 N, 36.32863 E; B; MN.	08.07.2008; 49.60477 N, 36.33436 E; B; MN.	1,2
11	*Ppyg* F ad AT00143	06.07.2011; 49.61411 N, 36.32863 E; B; MN.	18.07.2011; 49.62298 N, 36.32732 E; B; MN.	0,8
12	*Mdau* F sad BT02091	07.07.2011; 49.61169 N, 36.32319 E; B; MN.	07.07.2011; 49.61411 N, 36.32863 E; B; MN.	0,5
		“Homilsha forests” other species different years		
13	*Mdau* F ad A056819	13.07.2006; 49.62298 N, 36.32732 E; B; MN.	29.04.2008 49.61411 N, 36.32863 E; SM; MN.	0,8
14	*Mdau* F A05681?	13.07.2006; 49.62298 N, 36.32732 E; B; MN.	09.05.2009 49.61411 N, 36.32863 E; B; MN.	0,7
15	*Ppyg* F ad BT00236	10.07.2008 49.60782 N, 36.31909 E; B; MN.	03.07.2011 49.60352 N, 36.33299 E; B; R.	1
16	*Ppyg* F ad BT01921	29.06.2009 49.61411 N, 36.32863 E; B; MN.	03.07.2011 49.60352 N, 36.33299 E; B; R.	1,3
17	*Mdau* F sad BT00305	16.07.2008; 49.62554 N, 36.33329 E; B; MN.	06.07.2011 49.61411 N, 36.32863 E; B; MN.	1,15

Kharkiv City and surroundings

№	Species and ring number	Released (captured) and ringed: date, point coordinates, season of a year, type of catching	Recaptured: date, point coordinates, season of a year, type of catching	Distance, km
		N. noctula one year		
18	*Nnoc* M sad DT02064	28.08.2011; 50.03813 N, 36.2542 E AI; MN.	07.09.2011; 50.004393 N, 36.227882 E; AI; CR.	4,2

19	*Nnoc* F sad DT06137	25.07.2014; 50.09847 N, 36.29302 E B; MN.	19.08.2014; 50.006779 N, 36.227137 E; AI; CR.	11
20	*Nnoc* F sad DT10934	22.08.2016; 50.006770 N, 36.305709 E; AI; CR.	29.08.2016; 50.006779 N, 36.227137 E; AI; CR.	5,7
21	*Nnoc* M sad DT12527	09.03.2017 (25.03.2017); 50.101664 N, 36.280024 E; H; CR.	02.07.2017; 50.057528 N, 36.108639 E; B; MN.	13,2
22	*Nnoc* F sad DT13920	07.08.2017; 50.057528 N; 36.108639 E; AI; MN.	29.08.2017; 50.006779 N, 36.227137 E; AI; CR.	10,2
23	*Nnoc* M sad DT12849	27.08.2017; 50.006770 N, 36.305709 E; AI; CR.	15.11.2017; 50.006779 N, 36.227137 E; H; CR.	5,7
24	*Nnoc* M ad DT14951	17.01.2018 (14.04.2018); 50.101664 N, 36.280024 E; H (SM); CR.	11.07.2018; 49.899375 N, 36.933074 E; B; MN.	52
		N. noctula different years		
25	*Nnoc* F sad ET00459	19.11.2008; 50.006779 N, 36.227137 E; H; CR.	06.04.2012; 50.001437 N, 36.212821 E; SM; CR.	1,1
26	*Nnoc* M sad DT02271	14.09.2011; 50.004393 N, 36.227882 E; AI; CR.	16.12.2013; 50.017328 N, 36.235362 E; H; CR.	5,2
27	*Nnoc* M sad DT04180	18.08.2012; 50.00439 N, 36.22788 E; AI; MN.	19.11.2015; 50.006779 N, 36.227137 E; H; CR.	4,1
28	*Nnoc* M sad DT04311	20.11.2012; 50.004393 N, 36.227882 E; H; CR.	28.03.2013; 50.013462 N, 36.340316 E; H; CR;	8,1
29	*Nnoc* M sad DT04822	24.08.2013; 50.01214 N, 36.22914 E; AI; CR.	04.03.2014; 50.038669 N, 36.364256 E; SM; CR.	0,6
30	*Nnoc* F ad DT03682	25.01.2014 (23.03.2014); 50.101664 N, 36.280024 E; H; CR.	13.03.2015; 50.006779 N, 36.227137 E; H; CR.	11,3
31	*Nnoc* M sad DT06346	07.08.2014; 50.0629 N, 36.24419 E AI; MN.	26.03.2015; 50.006779 N, 36.227137 E; H; CR.	7,8
32	*Nnoc* F ad DT08062	07.08.2014; 50.07657 N, 36.23601 E AI; MN.	22.11.2015; 50.006779 N, 36.227137 E; H; CR.	7,8
33	*Nnoc* M sad DT05672	12.08.2014; 50.08616 N, 36.27209 E; AI; MN.	09.03.2015; 50.006779 N, 36.227137 E; H; CR.	9,5
34	*Nnoc* M ad DT08348	02.12.2014 (28.03.2015); 50.101664 N, 36.280024 E; H; CR.	04.07.2016; 50.18124 N, 36.26901 E; B; MN.	8,8
35	*Nnoc* M ad DT07401	03.11.2015 50.006770 N, 36.305709 E; H; CR.	04.04.2016 50.006779 N, 36.227137 E; SM; CR.	5,7
36	*Nnoc* M ad DT07564	06.12.2015 (03.04.2016); 50.101664 N, 36.280024 E; H (SM); CR.	21.12.2017; 50.041748 N, 36.354048 E; H; CR.	8,5
37	*Nnoc* F sad DT10917	22.08.2016; 50.006770 N, 36.305709 E; AI; CR.	17.01.2018; 50.038669 N, 36.364256 E; H; CR.	5,5
38	*Nnoc* M ad DT10350	11.07.2016; 50.213077 N, 36.375648 E; B; MN.	10.04.2018; 50.006779 N, 36.227137 E; SM; CR.	25,3

39	*Nnoc* M ad DT13353	03.08.2017; 50.057528 N, 36.108639 E; AI; MN.	01.04.2018; 50.006779 N, 36.227137 E; SM; CR.	10,2
		Kharkiv other species different years		
40	*Mdau* M sad B028597	29.03.2008; 50.205333 N, 36.378562 E; H (SM); MN.	19.05.2011; 50.07617 N, 36.24348 E; B; MN.	16
41	*Mdau* M ad BT02175	18.08.2012; 50.037204 N, 36.251235 E; AI; MN.	26.08.2013; 50.205333 N, 36.378562 E; AI; MN.	20,7
42	*Mdau* M ad BT02255	08.08.2014; 50.07657 N, 36.23601 E; AI; MN.	24.01.2013; 50.205333 N, 36.378562 E; H; R.	17,4
43	*Mdau* M sad BT05174	05.07.2017; 50.058361 N, 36.114222 E; B; MN.	01.09.2018; 50.205333 N, 36.378562 E; AI; MN.	25
44	*Eser* F ad DT10615	03.11.2016; 50.006770 N, 36.305709 E; H; CR.	02.03.2017; 49.898789 N, 36.190837 E; H; CR.	14,5

Izium District

№	Species and ring number	Released (captured) and ringed: date, point coordinates, season of a year, type of catching	Recaptured: date, point coordinates, season of a year, type of catching	Distance, km
45	*Mdau* M sad A056832	20.07.2006; 49.181361 N, 37.011481 E; B; MN.	24.07.2006; 49.173819 N, 36.986781 E; B; MN.	3
46	*Mdau* F un A05686(4/6)	24.07.2006; 49.173819 N, 36.986781 E; B; MN.	26.08.2006; 49.174661 N, 36.995478 E; AI; MN.	0,5
47	*Mdau* M ad A056872	24.07.2006; 49.173819 N, 36.986781 E; B; MN.	26.08.2006; 49.174661 N, 36.995478 E; AI; MN.	0,5
48	*Nnoc* F ad ET00641	05.07.2009; 49.111389 N, 37.403889 E; B; MN.	10.07.2009; 49.106944 N, 37.413333 E; B; MN.	0,7
49	*Nnoc* M sad ET00666	07.07.2009; 49.108333 N, 37.414167 E; B; MN.	15.07.2009; 49.111389 N, 37.403889 E; B. MN.	1

Records from other locations

№	Species and ring number	Released (captured) and ringed: date, point coordinates, season of a year, type of catching	Recaptured: date, point coordinates, season of a year, type of catching	Distance, km
50	*Nnoc* M sad DT11327	08.12.2016 (25.03.2017); 50.101664 N, 36.280024 E; H; CR.	31.03.2018; 48.85472 N, 38.47389 E; H; CR.	210
51	*Nnoc* M sad DT12690	10.07.2017; 50.224472 N, 36.812028 E; B; MN.	17.07.2017; 50.190694 N, 36.828806 E; B; MN.	4