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Space use by European bison during the first year after reintroduction according to GPS-collars' data

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Abstract: We analyzed space use of four European bison (*Bison bonasus L.*) females, which were released to the wild in three regions of the European part of Russia. The females were fitted with GPS collars in order to obtain data about their locations. Observation period was from the release until the 8th month of their presence in a free-ranging group, i.e. from January until mid-July. For each female her home range during 15 consecutive days and sequential changes of these home ranges were determined. One female showed untypical behavior: she migrated far off the protected area. Two females of three showed similar pattern of space use. The size of their home ranges was small. Strongly different relief of the two regions didn't influence their spatial behavior. The pattern of space use by third female was influenced by stable (more than 10 animals) resident group of European bison, dwelling in the same territory. The home range of the third female has reached the size, typical to the mixed European bison groups, already during the first year.

Key words: European bison, reintroduction, home range, space use, GPS collar

Introduction

Reintroduction of rare and endangered animal species is one of the key measures to save them and to conserve Earth biodiversity. It promotes species conservation, but also makes simpler the task of the maintenance of their viable number in captivity (Kleiman 1989). Results of this study may be important for providing further measures for the protection of European bison (*Bison bonasus L.*). Beginning of the successful restoration of European bison number is a positive example of collaboration among people, organizations and countries, and also is a result of several successful reintroductions (Pucek *et al.* 2004).

The main aims of this study were to describe the space use of European bison during the first year after reintroduction, and to reveal factors that influence its patterns. To achieve these aims it was necessary to fit reintroduced European bison

with GPS collars, and then to analyze obtained data with GIS technologies and on the basis of available knowledge about the place of reintroduction.

Study area

Studied females of European bison were reintroduced within already existing E. bison groups in three regions of the European part of Russia.

The first of studied groups was reintroduced in Kaluzhskie Zaseki Nature Reserve (53.6°N 35.7°E) which is located in Ulyanovo district of Kaluga region. Since 2001 free-ranging group of European bison (48 at the moment of release) has been dwelling in this Reserve.

The second reintroduction took place in Bryansky Les Biosphere Reserve (52.5°N 34.1°E), which is located in Suzemka district of Bryansk region. We observed two females of this group. The first reintroduction of European bison in Bryansky Les Biosphere Reserve was commenced in 1996, but no European bison have remained in this reserve by 2001.

The third reintroducion was performed in Arkhiz part (Kizgych forestry) of the Teberdinsky Biosphere Reserve (43.5°N 41.3°E), which is located in the Karachai-Cherkess Republic (Russia). The nature reserve is located in mountains of the North Caucasus (Main Caucasus Ridge). European bison were reintroduced in the valley of river Kizgych (river Kuban basin), which is located meridionally at the height 1490 m a.s.l. The valley is bordered by Chaget-Chat ridge (max 2965 m a.s.l.) from the West, and by Uzhum ridge (max 3126 m a.s.l.) from the East. The first release of European bison in the Teberdinsky Biosphere Reserve took place in 1964. Only 5 European bison dwelt in the valley at the moment of the studied group's release.

Materials and methods

In the present paper we analyze material from 4 GPS collars, fitted to the female European bison.

First studied female (her pedigree No and name are: 11140 Musyanya) was introduced within a group in the Kaluzhskie Zaseki Nature Reserve in 2008 from the Breeding Center of the Prioksko-Terrasny Nature Reserve. The group was released from the enclosure in November 2008. Musyanya was fitted with GPS GSM collar (made in A.N. Severtsov Institute of Ecology and Evolution) in March 2009. Until than she already joined the free-ranging group for 4 months.

Second (her pedigree No and name are: 8622 Muzavra) and third female (her pedigree No and name are: 9002 Feisha) were introduced within a group in the Bryansky Les Biosphere Reserve in 2011 from the Breeding Centers of the Prioksko-Terrasny Nature Reserve and the Oksky Nature Reserve, respectively. Feisha

have been taken to the Breeding Center from Helsinki Zoo for reproduction, after the end of the reproductive period she was sent with the group of youngsters to the Bryansky Les Biosphere Reserve, where she gave birth twice. The females were fitted with Russian GPS Argos collar "Pulsar" in January 2012. A week after that, the group was released from the enclosure.

The fourth female (her pedigree No and name are: 10026 Megida) were taken within a group in the Teberdinsky Biosphere Reserve in 2012 from the Breeding Center of the Oksky Nature Reserve. The female was fitted with Russian GPS Argos collar "Pulsar" in November 2012. The female left the enclosure in December 2012.

All E. bison females were immobilized with anesthetizing mix of "Zoletil" and "Xila", injected intramuscularly with the Cap-Chur, Dan-Inject or Telinject tranquilizer dart guns. We excluded from the analysis data from the animals which were outside the enclosure during 7 days after the immobilization. Behavior of the animal after anesthesia could differ from the natural one (White, Garrott 1990).

GPS GSM collar was programmed to determine location 3 times per day with 8h intervals (Minaev, Purikov 2013). GPS Argos collars "Pulsar" were programmed to determine location 4 times per day with 6h intervals (Salman 2013).

Musyanya's collar worked 124 days and transmitted only 33% of possible data. We analyzed all obtained locations, without making the sample even. Muzavra's collar worked 163 days until her death and transmitted 85% of potential locations. Before analysis we excluded data from the week before her death. Feisha's collar worked 383 days until her death. We analyzed only data from 42 days before Feisha's return to the enclosure. During these days the collar transmitted 96% of potential locations. Megida's collar worked 215 days and transmitted 70% of potential locations. We analyzed only data from 165 days after her release from the enclosure. In order to make the sample even we filtered data. We excluded locations, determined by GPS at 23:00. Data on the locations at that time were transmitted only in 20% of days of the study.

Studied period for the each European bison female was divided into 15-days intervals. For each of these intervals we determined female's home range using Minimum Convex Polygon method (MCP100%) (Hayne 1949). We didn't use Fixed Kernel method because the number of locations for several 15-day intervals was too small. We considered that sequential home ranges changed if geometric mean of the proportions of their squares' overlap relative to each other was less than 50%. We determined the shift of the sequential home ranges using distance between centers of the home ranges. The center was determined using Spider Distance Analysis. The center is a point with the minimal sum of distances from it to the all locations.

Organization of the primary data for further analyses, calculation of distances and azimuths of shifts were conducted using OziExplorer 3.95.5s. Home range construction using MCP100% method and calculation of the square of the polygon's

overlap were conducted using MapInfo 11.5. Spider Distance Analysis was conducted using Animal Movement V.2 module (Hooge, Eichenlaub 2000) for ArcView 3.2a. Results and mathematical calculations were merged in MS Excel 2010. Statistical analysis was conducted using STATISTICA 8.0.

Results

Figures 1–4 show locations, their sequential connection and home ranges (MCP100%) of European bison females in the first year after reintroduction for the whole period of the study.

Being in a free-ranging group, from 5th until 8th month (April–July) after the reintroduction Musyanya home range reached 60 km^2 (Fig. 1). Contacts of the Musyanaya's group with the resident group of European bison were detected since reintroduced European bison have been in the enclosure.

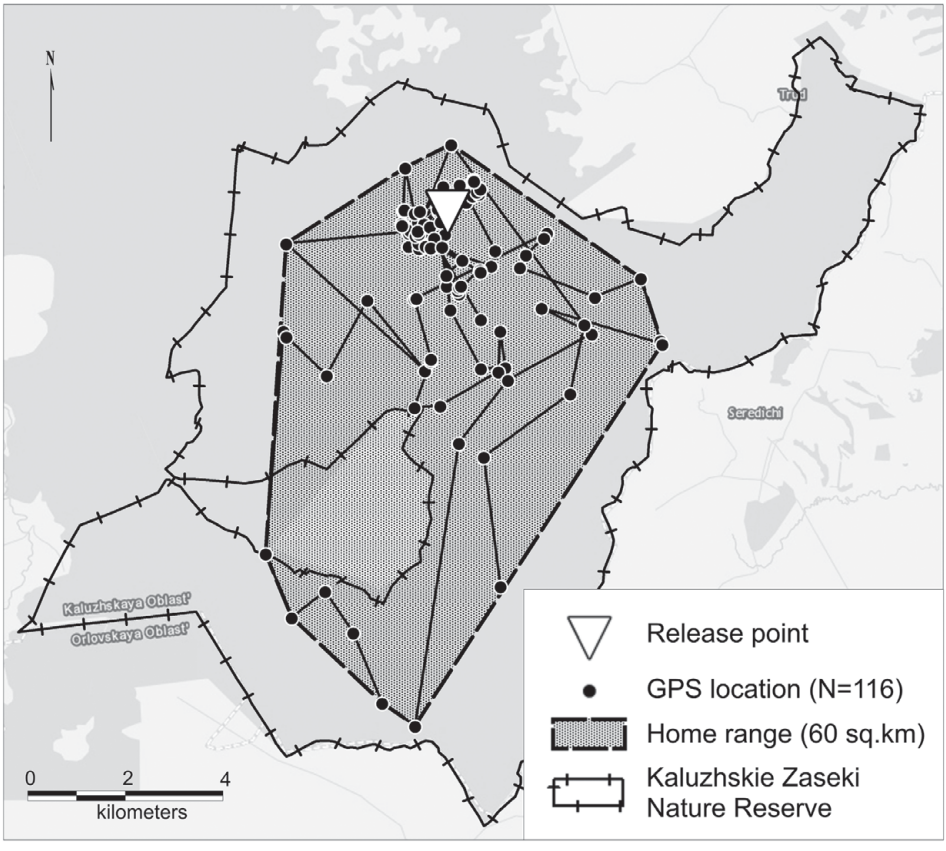

Fig. 1. Musyanya's home range from 5th until 8th month (April–July) after the reintroduction.

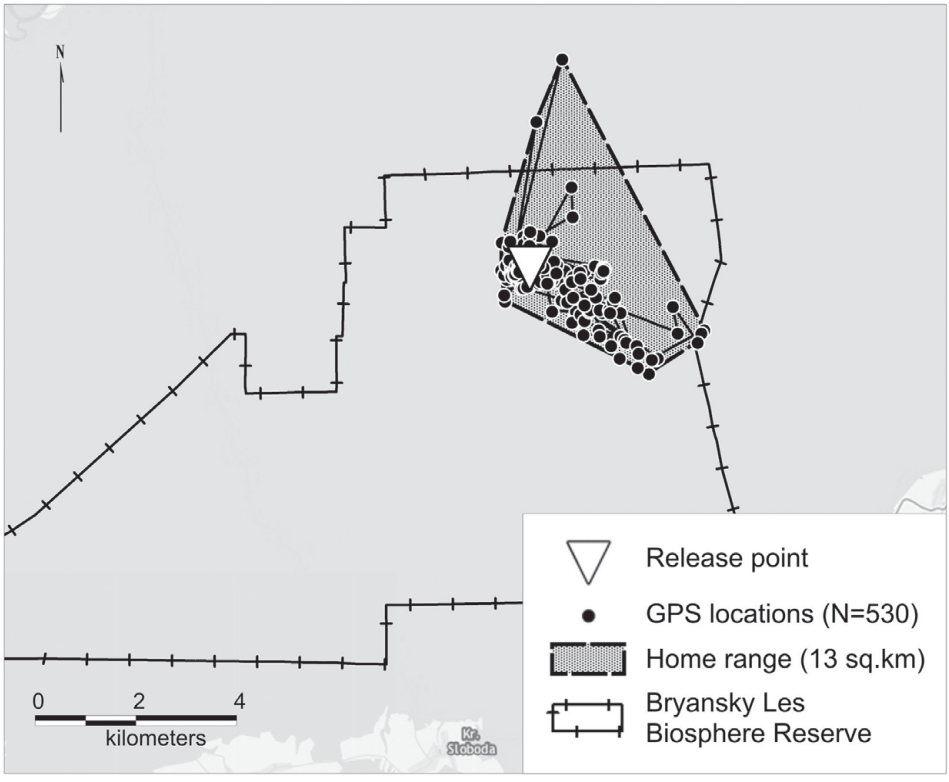

Fig. 2. Muzavra's home range from 1st until 5th month (February–June) after the reintroduction.

Muzavra home range during the first 5 months (February–June) after the reintroduction reached 13 km^2 (Fig. 2). Feisha during the first 1.5 month (February–early March) left the release area and territory of the Bryansky Les Biosphere Reserve and attempted to migrate northward. During this time her home range was 695 km^2 (Fig. 3). Muzavra and Feisha were in the same reintroduced group, consisting of 11 European bison. Muzavra was a dominant female of the group in the enclosure. Feisha was a subdominant in the group, 2 months before the release she calved. Just 7 days after the release Feisha began to migrate northwards. Muzavra followed Feisha and moved 4 km away from the release site, but returned to the feeding site at the same day. The group has divided: 6 individuals went with Feisha, 3 remained with Muzavra. 37 days after Feisha and six other individuals left the Bryansky Les Biosphere Reserve the whole group was directed into the fencing and after placing them in the transport cages brought back to the enclosure. After 2 weeks all those animals except Feisha and her calf, had been released and joined Muzavra's group. After that Feisha remained in the enclosure.

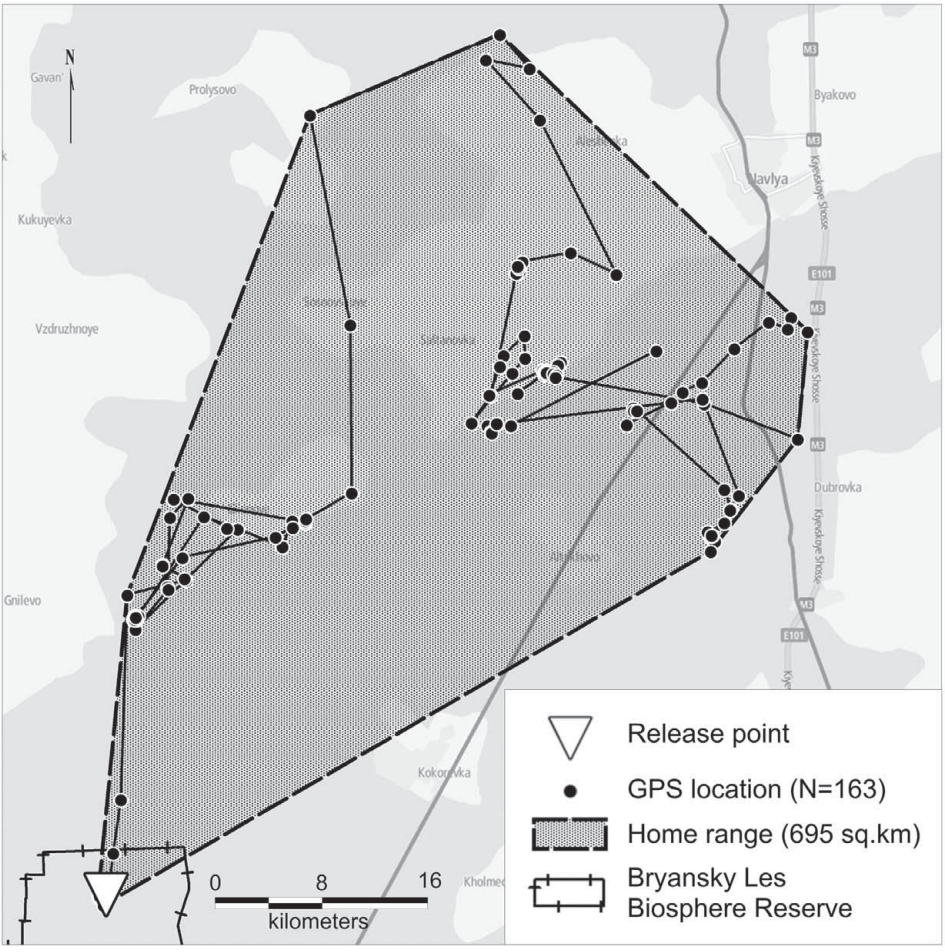

Fig. 3. Feisha's home range during 1.5 month (February–early March) after the reintroduction.

Megida's home range during the first 5.5 months (January–June) after the reintroduction reached 17 km^2 (Fig. 4).

Results of changes of 15-days home ranges of Musyanya are shown in Table 1. We observed gradual increase of home range from 4.5 until 7.5 months after release. Since the 6th month after release (May) home range didn't change.

Results of changes of 15-days home ranges of Muzavra are shown in Table 2. Home ranges didn't show a gradual increase of the area. They remained small and varied insignificantly. Almost all revealed changes happened due to insignificant shifts in different directions from the feeding site. It is worth to mention only one change early in May, when the home range increased to 3.5 km^2 and shifted to 1.1 km, and then in the second half of May returned to the initial size.

Results of changes of 15-days home ranges of Feisha are shown in Table 3. We excluded these results from the further analysis.

Results of changes of 15-days home ranges of Megida are shown in Table 4. During the first 5 months (January–May) after reintroduction her home range showed very smooth tendency to increase. Significant changes during this period were not detected. In the first half of the 6th month after the reintroduction (first half of June) an abrupt increase of the home range size was caused by the movement of the group's for almost 9 km.

For the visual comparison results of changes of 15-days home ranges of Musyanya, Muzavra and Megida relative to time after the reintroduction were shown in Figure 5A and relative to calendar season – in Figure 5B.

We compared samples of squares of 15-days home ranges (further on – space use) for Muzavra and Megida relative to time after the reintroduction. Space use by these two females in the first 5 months was the same (Wilcoxon pair test, $T=14$, $p=0.17$). Besides, we revealed positive correlation of changes of home ranges of Muzavra and Megida from the 2nd until 5th month after the reintroduction (Spearman rank correlation, $R=0.93$, $p<0.01$). Unfortunately, for Musyanya we could not conduct such comparisons, because her study period after the reintroduction almost hasn't overlapped with the analogous periods of the other females.

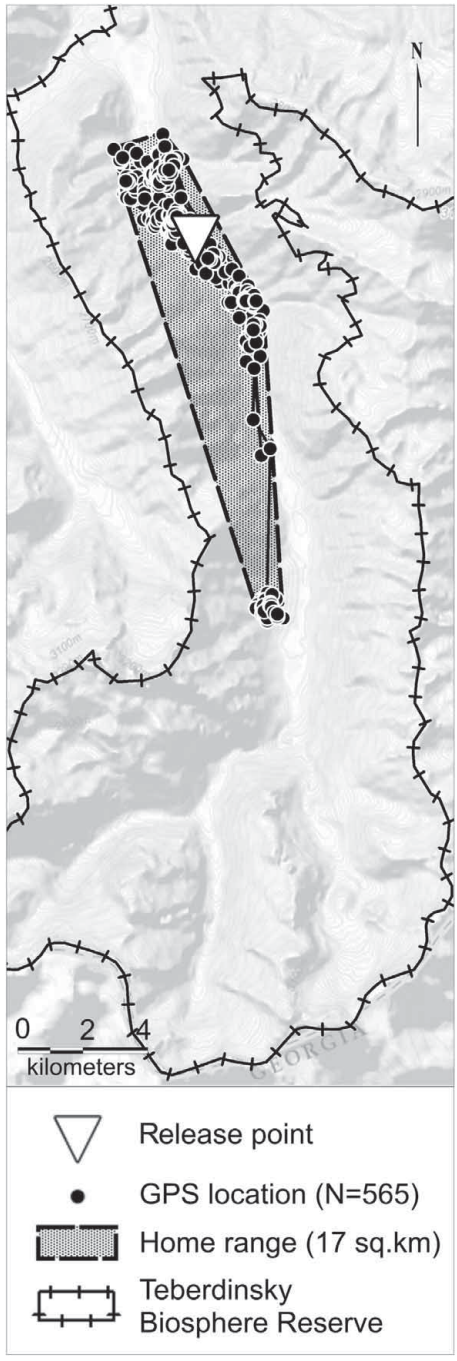

Fig. 4. Megida's home range from first until 6th month (January–June) after the reintroduction.

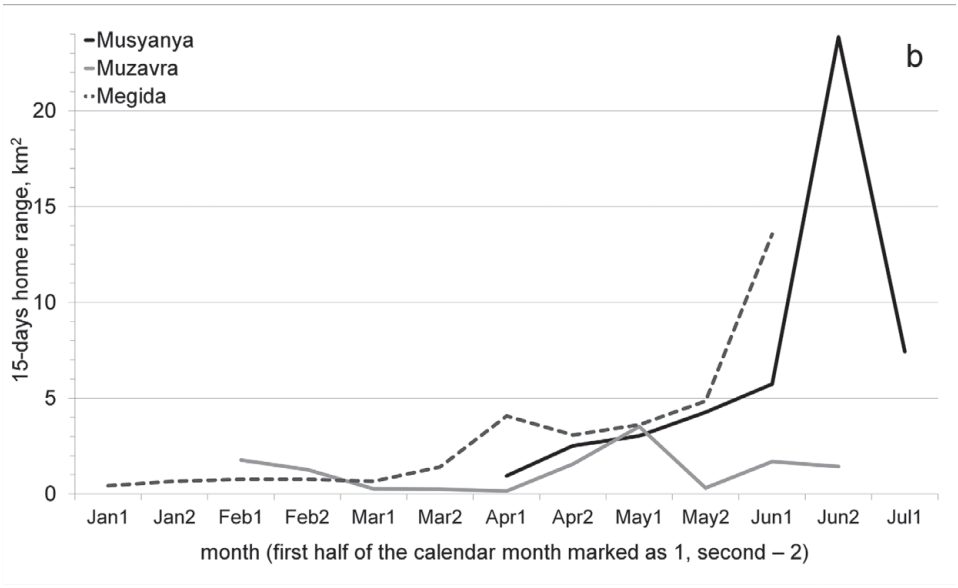

Figure 5. 15-days home ranges of E. bison females from January to July.

We also compared space use relative to the season pairwise for 3 females. Space use was the same for Muzavra and Megida from February until early June (Wilcoxon pair test, $T=7$, $p=0.07$). Space use for Musyanya from March until June differed significantly from the pattern of Muzavra's and Megida's space use. No correlations of changes of female home ranges relative to the season were revealed.

Table 1. 15-days home ranges of European bison female (Musyanya) and their changes (first half of the calendar month marked as 1,the second – 2, in bold font marked are intervals of change of home range).

Months after release	Month	Home range (HR), km^2	Overlap with the previous interval	Distance of HR shift from the previous, km
4.5–5	April1	0.9	–	–
5–5.5	April2	2.5	54%	0.4
5.5–6	May1	3.0	74%	0.3
6–6.5	**May2**	**4.3**	**22%**	**2.0**
6.5–7	**June1**	**5.7**	**12%**	**2.2**
7–7.5	**June2**	**23.9**	**1%**	**5.2**
7.5–8	**July1**	**7.4**	**0%**	**4.7**

Table 2. 15-days home ranges of European bison female (Muzavra) and their changes (first half of the calendar month marked as 1, second – 2, in bold font marked are intervals of change of home range).

Months after release	Month	Home range (HR), km^2	Overlap with the previous interval	Distance of HR shift from the previous, km
0–0.5	February1	1.8	–	–
0.5–1	**February2**	**1.3**	**39%**	**0**
1–1.5	**March1**	**0.3**	**34%**	**0.2**
1.5–2	March2	0.2	62%	0.1
2–2.5	April1	0.2	60%	0.1
2.5–3	**April2**	**1.6**	**29%**	**0.3**
3–3.5	**May1**	**3.5**	**44%**	**1.1**
3.5–4	**May2**	**0.3**	**16%**	**1.3**
4–4.5	**June1**	**1.7**	**37%**	**0.2**
4.5–5	June2	1.4	75%	0.3

Table 3. 15-days home ranges of European bison female (Feisha) and their changes (first half of the calendar month marked as 1, second – 2, in bold font marked are intervals of change of home range).

Months after release	Month	Home range (HR), km^2	Overlap with the previous interval	Distance of HR shift from the previous, km
0–0.5	February1	72.3	–	–
0.5–1	**February2**	**281.1**	**14%**	**23.5**
1–1.5	**March1**	**89.2**	**0%**	**12.4**

Discussion

All European bison groups were reintroduced in the protected areas, what is undoubtedly an important factor during such measures for conservation of rare and endangered species. All groups were kept together in one enclosure no less than 1.5 months before release, what is another factor necessary for successful reintroduction (Kleiman 1989). But nevertheless, the release to the nature was not successful in the case of one of four studied females. Despite the subdominant status in the established group, Feisha could take $^2/_3$ of the group from the dominant female and begin to migrate northwards. Maximal movement of Feisha's group measured along the straight line was 45 km. Natural migrations for so long distances are not characteristic neither for bulls, nor for mixed groups (Kowalczyk *et. al.* 2013). Extraordinary

Table 4. 15-days home ranges of European bison female (Megida) and their changes (first half of the calendar month marked as 1, second – 2, in bold font marked are intervals of change of home range).

Months after release	Month	Home range (HR), km^2	Overlap with the previous interval	Distance of HR shift from the previous, km
0–0.5	January1	0.4	–	–
0.5–1	January2	0.7	53%	0.1
1–1.5	February1	0.8	51%	0.1
1.5–2	February2	0.8	88%	0
2–2.5	March1	0.7	79%	0.1
2.5–3	March2	1.4	55%	0.5
3–3.5	April1	4.1	55%	0.4
3.5–4	April2	3.1	76%	0.4
4–4.5	May1	3.6	90%	0.3
4.5–5	May2	4.9	72%	0.2
5–5.5	**June1**	**13.6**	**50%**	**8.8**

occurrences of such migration were described only for bulls (Krasińska, Krasiński 2007). During the migration, Feisha showed aggressive behavior to humans and wounded a dog (Sitnikova 2012). Similar antagonistic behavior was showed by a bull transported to the Breeding Center of the Oksky Nature Reserve from Helsinki Zoo together with Feisha. Fortunately, Feisha and her herd were recaptured, and she successfully reared a calf followed by another one in next year. Thus, Feisha's spatial behavior after the reintroduction is untypical and couldn't be regarded as an example of space use by reintroduced E. bison.

Space use by Musyanya after the reintroduction in the Kaluzhskie Zaseki Natural Reserve differed from the pattern of space use by other two females. It can be due to two causes. Firstly, observed period fell on 5th–8th month after the release to the nature, whereas for two other females it fell on the first 5–5.5 months after reintroduction. Secondly, there was a resident group of European bison at the territory of the nature reserve. Most probably, released group was in the contact with the resident one prior to the release and, consequently, penetrated the available territory more actively (Chikurova 2014). The second reason, may also explain differences in space use and absence of correlation with other studied females in similar seasons. Probably, soon after release, the group joined several resident animals, and during the first year after the reintroduction its home range reached 60 km^2 by July, what is typical for resident mixed groups in snowless spring-summer season (Krasińska, Krasiński 2007).

Observations of Muzavra and Megida began immediately after their release from the enclosure and revealed many similar features in space use. Both were reintroduced

in winter. Gradual increase of home range by the end of spring is characteristic for both of them, but at the same time their home ranges remained small. It can be due to an increase of air temperature. Such correlation (independently of extra-feeding presence) was shown for reintroduced bulls in Białowieża Primeval Forest in Poland during the change of snow and snowless periods (Hotz 2006). Muzavra's and Megida's space use didn't differ during the first 5 months after the reintroduction (on the condition of extra-feeding), in spite of such factors as group size and different terrain. For Białowieska Primeval Forest it was also shown that home range size of the mixed group doesn't depend on its number (Krasińska *et al.* 2000). It can be concluded that type of the terrain doesn't play role during the first year after the reintroduction. Most probably, during the following years it will influence space use (Kuemmerle *et. al.* 2010) by Megida's group. Early in June, Megida's group moved up the ravine almost at 5 km. It can be due to the fact that only in this time the group met resident European bisons or Biological Signal Field (Naumov 1973) left by them. Resident animals always were observed at a distance of 7–10 km from the feeding site down the ravine. In turn, ceasing of extra-feeding could stimulate them to leave the feeding site. During that time Muzavra's group didn't move from the release site. Presumably it will remain there during the following years. Absence of home range shift is characteristic for resident mixed groups of European bison (Krasińska *et al.* 2000) and for other reintroduced hoofed mammals on condition that resident animals of the same species are absent (King 2002).

Conclusion

1. Home range of a reintroduced group remains small (15 ± 3 km^2) during the first half of a year under the condition that there is no stable (more than 10 animals) resident group within this territory.
2. Relief doesn't influence dynamic of space use during the first half of a year (under the condition that there is no stable resident group on this territory).
3. The presence of a stable resident group of European bison at the release site assures reaching a full size home range by the released group, already during the first year after reintroduction.
4. Not all adult females used for reproduction in the breeding centers are suitable as one of the adult leaders for the reintroduced group. It is desirable, that among the close relatives of the female were the ones who has successfully coped with this task.

Acknowledgement

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References

Chikurova E.A., 2014. Separation and schooling of herds of released European bison (*Bison bonasus L.*). Current problems of ecology and evolution in the studies of young scientists. KMK, Moscow: 214–215. [http://www.sevin.ru/ysc/Abstracts_23–25–04–2014.pdf].

Hayne D.W., 1949. Calculation of size of home range. J. Mammalogy 30: 1–18.

Hooge P.N., Eichenlaub B., 2000. Animal movement extension to Arcview. ver. 2.0. Alaska Science Center Biological Science Office, U.S. Geological Survey, Anchorage, AK, USA.

Hotz H., 2006. Space use of the European bison (*Bison bonasus bonasus*) in Białowieża Primeval Forest. B.Sc. Thesis. University of Applied Sciences, Eberswalde: 65 pp.

King S.R.B., 2002. Home range and habitat use of free-ranging Przewalski horses at Hustai National Park, Mongolia. Applied Animal Behaviour Science, 78(2): 103–113.

Kleiman D.G., 1989. Reintroduction of captive mammals for conservation. BioScience 39(3): 152–161.

Kowalczyk R., Krasińska M., Kamiński T., Górny M., Struś P., Hofman-Kamińska E., Krasiński Z.A., 2013. Movements of European bison (*Bison bonasus*) beyond the Białowieża Forest (NE Poland): range expansion or partial migrations?. Acta theriologica 58(4): 391–401.

Krasińska M., Krasiński Z.A., Bunevich A.N., 2000. Factors affecting the variability in home range size and distribution in European bison in the Polish and Belarussian parts of the Białowieża Forest. Acta theriologica 45(3): 321–334.

Krasińska M., Krasiński Z.A., 2007. European bison. The Nature Monograph. Mammal Research Institute Polish Academy of Science, Białowieża: 320 pp.

Minaev A.N., Purikov A.V., 2013. Universal GPS+GSM-radio-tag for large animals and its use specifics for European bison tracking. In: Formation prospects of European bison free-raging population in European Russia. GK "Desyatochka", Bryansk: 18–24 [in Russian].

Naumov N.P., 1977. Biological signal field and its importance for mammals. In: Successes of current theriology. Nauka, Moscow: 93–110. [in Russian].

Pucek Z., Belousova I.P., Krasińska M., Krasiński Z.A., Olech W., 2004. European Bison. Status Survey and Conservation Action Plan. Gland, IUCN/SSC Bison Specialist Group. IUCNSalman A.L. 2013. Basic principles of functioning Argos system and Pulsar radio-tag specifics In: Formation prospects of European bison free-raging population in European Russia. GK "Desyatochka", Bryansk: 25–33. [in Russian].

Sitnikova E.F., 2013. Creation of a free-roaming population of European bison in the Bryansk Region (Russia). European Bison Conservation Newsletter 6: 47–58.

White G.C., Garrott R.A., 1990. Analysis of wildlife radio-tracking data. Academic Press, San Diego, CA: 383 pp.

Areał bytowania żubrów w początkowym okresie po wypuszczeniu na podstawie danych telemetrycznych

Streszczenie: Analizowano wykorzystanie przestrzeni przez samice żubra (*Bison bonasus*), które wypuszczono w trzech regionach europejskiej części Rosji. Samice były wyposażone w obroże telemetryczne GPS w celu pozyskiwania danych o lokalizacji. Okres obserwacji obejmował pierwsze 8 miesięcy po wypuszczeniu samic do wolnych stad, od stycznia do połowy lipca. Dla każdej z samic wyznaczono areał bytowania w okresach 15-dniowych oraz zmiany tego areału w czasie. Dwie samice miały bardzo podobne wartości zajmowanego areału, który był niewielki. Inne warunki w dwóch regionach nie miały wpływu na zajmowany areał i zachowanie samic. Wykorzystanie przestrzeni przez trzecią samicę było pod wpływem stabilnej 10-osobniczej grupy żubrów bytującej w tym samym rejonie. Zajmowany areał przez tę samicę był charakterystyczny dla grupy mieszanej w pierwszym roku po wypuszczeniu.