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## EUROPEAN BISON (*BISON BONASUS*) IN THE CHORNOBYL EXCLUSION ZONE (UKRAINE) AND PROSPECTS FOR ITS REVIVAL

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**European bison (*Bison bonasus*) in the Chornobyl Exclusion Zone (Ukraine) and prospects for its revival.** — Gashchak, S., Gulyaichenko, Y., Beresford, N. A., Wood, M. D. — In 2012–2016 a European bison adult bull was observed (by camera traps) in the Chornobyl Exclusion Zone (CEZ, Ukraine), west of Tovsty Lis village. This is the first record of wild bison in Kyiv Polissya for over 300 years. The animal must have come from the Paliessie State Radioecological Reserve (PSRER, Belarus), having crossed the Pripyat river. The site where he was observed is 30–40 km from the locality where bison were introduced into the PSRER in 1996. The total area over which the bull has been observed is ca. 30–50 km<sup>2</sup>, and includes deciduous (oak, hornbeam, aspen) and mixed woodlands, and former grassy meadows now overgrown with birch, alder, aspen, pine. This constitutes the most favourable habitat type for bison available in the CEZ. The animal was only observed in February–March and August–October. Currently we are not able to judge how permanently the animal stays on this territory. Taking into account the amount of appropriate habitat in the region, size of the CEZ, protection regime and the fact that bison was a native species in the past, the CEZ could be the best area in Ukraine where a large free population of the European bison could be established.

**Key words:** European bison, Chornobyl Exclusion Zone, camera trap, reintroduction, habitats.

**Зубр (*Bison bonasus*) у Чорнобильській зоні відчуження (Україна) та перспективи його відновлення.** — Гащак, С., Гуляйченко, Є., Бересфорд, Н.А., Вуд, М. Д. — У 2012–2016 рр. за допомогою фотопасток спостерігали дорослого бика зубра у Чорнобильській зоні відчуження (ЧЗВ, Україна), західніше с. Товстий Ліс. Це перша реєстрація вільного зубра у Київському Поліссі за останні 300 років. Тварина мала прийти з Поліського державного радіоекологічного заповідника (ПДРЕЗ, Білорусь), перетнувши р. Прип'ять. Ділянка спостережень знаходиться у 30–40 км від місця, де зубрів інтродукували у ПДРЕЗ у 1996 р. Загальна її площа складає близько 30–50 км<sup>2</sup> і включає широколистяні (дуб, граб, осика) і мішані ліси та колишні вологі луки, що зараз поросли березою, вільхою, осикою, сосною. Це найсприятливіші для зубра угіддя у ЧЗВ. Тварину спостерігали лише у лютому–березні та серпні–жовтні. Зараз бракує даних, щоб судити наскільки тварина постійно тримається ділянки. Приймаючи до уваги кількість угідь, що відповідають потребам зубра, розмір ЧЗВ, охоронний режим та той факт, що колись це був адвентивний вид, ЧЗВ могла б стати найкращим місцем в Україні, де можна було б створити велику вільну популяцію зубра.

**Ключові слова:** зубр, Чорнобильська зона відчуження, фотопастка, реінтродукція, оселища.

### Introduction

In April 2012, during field studies assessing the environmental quality of the 'Tovsty Lis' site in the Ukrainian part of the Chornobyl Exclusion Zone (CEZ), some 'cow pats' (faeces) were found in a mature deciduous forest, 3–4 km westward Tovsty Lis village. These were definitely from some species of the bovine family (Bovidae). However in Lubyanka village, which was in 5–6 km away, some cows and a bull were kept by residents, and some of these animals could have roamed this far. As far as it was known at that time, there were no wild bovines in the CEZ and hence the possibility that the faeces were from a European bison seemed unrealistic. The nearest locality they were known to be was 30–40 km to the north, in Belarus. In 1996, European bison were introduced into the Pal-

iesie State Radiation and Ecological Reserve (PSRER) (Deryabina, 2008). Over 10 years their number grew, and in 2005–2011 they began to spread. However, their main territory was > 30 km from the ‘Tovstyi Lis’ site. Importantly this territory was on the opposite bank of the Pripjat river (Deryabina, 2012). Only a few individuals had been observed closer to the Ukrainian border, but again, these observations were all on the far bank of the Pripjat.

However, motion activated camera traps deployed in 2012–2016 at this site (westward Tovstyi Lis village) captured photographs of a European bison. The aim of this paper is to summarise records of bison in the CEZ in 2012–2016 and to discuss the status of the species in this area and the potential of the region for European bison conservation.

## Methodology

From November 2014 to July 2016, Chernobyl Centre for Nuclear Safety, Radioactive Waste and Radioecology (Ukraine) together with the University of Salford and the Centre of Ecology & Hydrology (UK) carried out an assessment of biodiversity of macrofauna in several areas of the CEZ using motion activated camera traps (see TREE project: <http://tree.ceh.ac.uk>).

The TREE project deployed 42 camera traps (Ltl Acorn 6210MC) at three sites in the CEZ, each of 5 km radius. One site was situated near the villages Tovstyi Lis and Buda about 25 km westward the Chernobyl Nuclear Power Plant. Within this site, 14 camera traps were deployed. Coordinates were calculated using a random number algorithm, the actual position used for each camera was the most appropriate place within 200–300 m of the random coordinate. Selection criteria for locating the camera included the presence of animal trails. Preference was given to the sites where the movement of animals was channelled by natural barriers (water, thickets etc.). The camera traps were run in one location for 7–8 weeks, then they were moved to new points within the overall study site. The cameras were moved six times (i.e. the cameras were each run at seven different locations). The main study ran from November 2014 to January 2016. Subsequently, until July 2016, four camera traps continued to be deployed, each camera being set-up at three additional locations. In total cameras were located at 97 locations in the study area, and the total duration of deployment was 6485 days. A more detailed description of the methodology used for the camera trap study can be found in article by S. Gashchak et al. (2016).

A further set of motion activated cameras have been in use at this site since May 2012. This was for a national project which was trying to identify areas of the CEZ of ‘valuable environmental status’ (Gashchak, Domashevsky, 2013; Petrov, Gashchak, 2013). A range of camera models (Ltl Acorn 5210A, Ltl Acorn 6210M, Bushnell 119437c, DLC Covert Red 40, Welta 8210A and Browning Strike Force) were used. The number of camera traps deployed varied from 3 to 7, and the duration of deployment at a given location was from two weeks to more than a year. The cameras were used at 35 points for a total duration of 3796 days. Between January to November 2016 the cameras were sited at points where it was considered most likely to observe European bison based on known habitat preference (Korochkina, 1969 a; Baskin, 1979; Kozlo et al., 1999; Deryabina, 2012).

At every point, during the setting up of the camera trap, a preliminary shooting of the site was taken (the study camera) with measurement poles in place. This was in order to be able to estimate animal size once photographs were obtained. Twenty 1-meter poles were placed in three paralleled rows, with 1 meter gaps, the first pole was located 3 m from the camera and the last at 8 m. The poles had markings at every 20 cm. Images of measurement poles and animals were overlaid using Adobe Photoshop to allow animal dimensions to be estimated (accuracy of estimation ca. 5 cm).

## Results

Since April 2012 European bison were recorded at the Tovstyi Lis/Buda site 25 times: ‘cow pats’ were found on five occasions at different locations; photographic records were obtained on 19 occasions from 7 points; and there was a confirmed oral report of a sighting at an additional point (tab. 1). All the observations were made in the same area: to the west and south of Tovstyi Lis village, inside woodland or close to its edge (fig. 1).

Table 1. Recorded cases of European bison or evidence of its presence in the CEZ in 2012–2016

Таблиця 1. Перелік випадків реєстрації зубра або ознак його присутності у ЧЗВ у 2012–2016 роках

No*	Point	Coordinates (WGS84)	Date (time)	Record	Duration (min:sec)	Light period	Direction of movement	Note
1	1	N51.3796, E29.7358	07.04.2012	Cow pat				
2	2	N51.3815, E29.7286	18.04.2012	Cow pat				
3	3	N51.3783, E29.7308	18.04.2012	Cow pat				
4	4	N51.3711, E29.7398	18.04.2012	Cow pat				
5	5	N51.3806, E29.7320	19.03.2015 15:44	Photograph	17:24	daylight	NE	Scratching on post
6	6	N51.3580, E29.8051	24.06.2015 11:27	Cow pat				
7	7	N51.3829, E29.7413	02.08.2015 20:58	Photograph	00:04	dusk	NE	Moving passed the camera
8	7	N51.3829, E29.7413	02.08.2015 21:45	Photograph	00:10	dark	SW	Grazing
9	8	N51.3565, E29.7665	03.11.2015	Oral report**		daylight		Scared by people and ran-off
10	5	N51.3806, E29.7320	07.02.2016 17:41	Photograph	00:24	dark	NE	Moving passed the camera
11	9	N51.3806, E29.7331	07.02.2016 17:44	Photograph	00:19	daylight	SE	Moving passed the camera
12	9	N51.3806, E29.7331	17.02.2016 15:41	Photograph	00:11	daylight	SE	Moving passed the camera
13	5	N51.3806, E29.7320	01.03.2016 23:57	Photograph	00:56	dark	NE	Moving passed the camera
14	10	N51.3869, E29.7128	02.03.2016 16:07	Photograph	00:06	daylight	NW	Moving passed the camera
15	11	N51.3663, E29.7300	09.08.2016 23:21	Photograph	00:03	dark		Moving passed the camera
16	5	N51.3806, E29.7320	15.08.2016 19:41	Photograph	01:21	daylight	SW	Scratching on post
17	5	N51.3806, E29.7320	24.08.2016 17:58	Photograph	06:22	daylight	NE	Scratching on post
18	12	N51.3576, E29.7984	31.08.2016 7:33	Photograph	05:28	daylight	W	Grazing
19	5	N51.3806, E29.7320	09.09.2016 16:38	Photograph	03:40	daylight	SW	Scratching on post
20	12	N51.3576, E29.7984	11.09.2016 18:35	Photograph	00:41	daylight	E	Moving passed the camera
21	13	N51.3615, E29.7896	13.09.2016 21:17	Photograph	00:19	dark	N	Moving passed the camera
22	5	N51.3806, E29.7320	17.09.2016 20:54	Photograph	01:37	dark	NE	Scratching on post
23	12	N51.3576, E29.7984	19.09.2016 20:32	Photograph	01:42	dark	W	Grazing
24	10	N51.3869, E29.7128	01.10.2016 11:45	Photograph	00:09	daylight	NW	Moving passed the camera
25	10	N51.3869, E29.7128	20.10.2016 15:58	Photograph	00:02	daylight	NW	Moving passed the camera

\* Identifies location on Fig. 1. \*\* confirmed report of Artur Kalmykov (photograph taken)

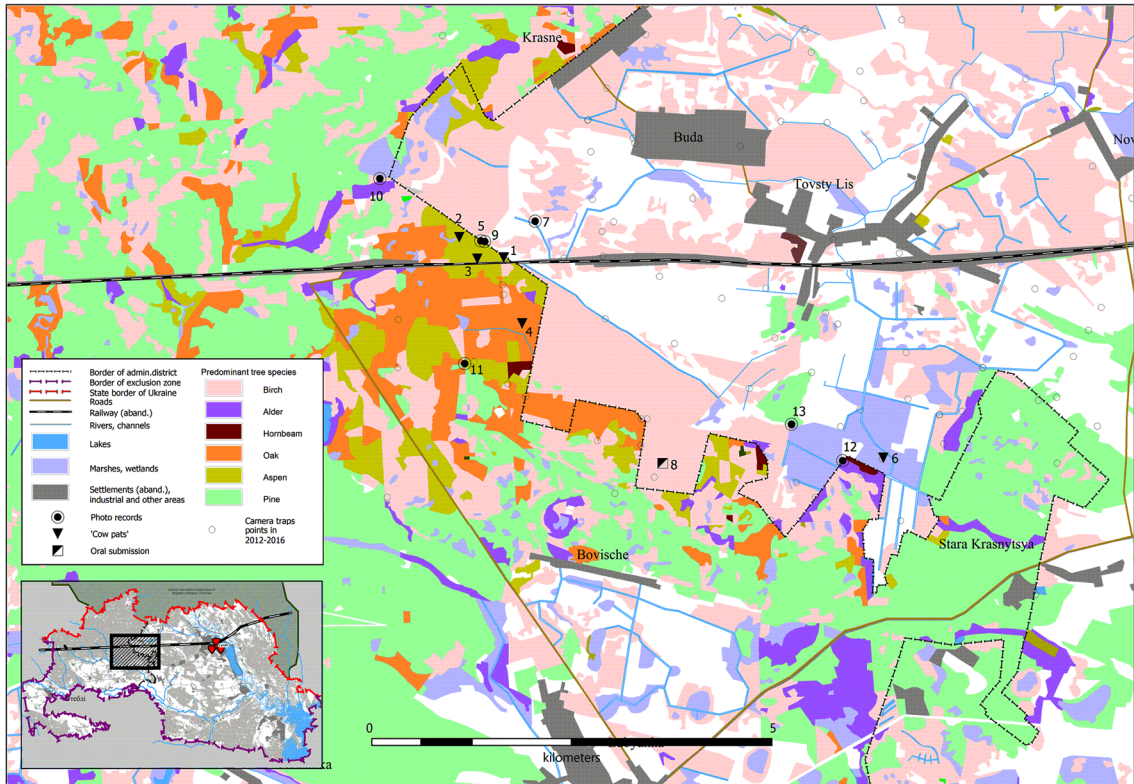


Fig. 1. Location of points where evidence of European bison was recorded in the CEZ in 2012–2016; forest type is also shown (on: Development project, 2006). Numbering of the points corresponds to that in table 1.

Рис. 1. Розташування місць, де зубра реєстрували у ЧЗВ у 2012–2016 рр., відносно лісорослинних умов (за: Проект..., 2006). Цифри біля точок відповідають номерам точок у табл. 1.

Almost all pictures were taken during the period 11:30 to 24:00, only one photograph was taken earlier in the morning. Mostly the animal was passing the camera and sometimes grazing grasses. At point No. 5 the bison came several times to scratch on a bridge side post, where he stayed for up to 17 min (fig. 2 and 3). Although the camera traps were deployed at the site for a long period, and the bison appeared in the same points several times, he was observed only during February–March and August–October. There were no data for other months.

It is not possible to comment on the animals' movement routes. However, between August and October 2016 the animal walked over the site at least three times from the north-west (point No. 5) to south-east (No. 12) and back, covering at least 5.3 km (straight line distance) over 2–10 days (5.5 d on average). Based on the photographs, there appears to be only one individual that has been observed to date. This is an adult bull; height at shoulder approximately 135–140 cm and about 120–125 cm on the rump. The animal looks in good condition (fig. 2 and 3).

## Discussion

### *Past history of European bison in Kyiv Polissya*

In the past European bison were common inhabitants of most regions of modern Ukraine (Kirikov, 1979 a) though it is not clear if it was present in the territory of the modern CEZ. Written evidence and fossils records suggest that the bison was abundant in different regions of Polissya (Kirikov, 1979 a). However, almost all written/fossil records originate from the forest-steppe zone (which is to the south of the CEZ) or in forest zone (as is the CEZ) but in north-west of Ukraine and in Belarus. Kirikov cited results from Volovich (in: Kirikov, 1979 b): in the 16th century, European bison undertook mass passages from forest-steppe areas near the Dnipro river to 'pripyat puscha' (dense

virgin forest). Regardless of their past distribution, bison had disappeared completely from most regions of Ukraine by the 18th century due to deforestation of lands and eradication by humans (Kirikov, 1979 a).

In the mid-1990's there was an attempt to return European bison back to the Kyiv Polissya. At that time, the programme of species conservation was failing because of a lack of available habitat where there would be no conflicts with man (Kryzhanovsky, 2007). Small isolated sub-populations still existed in Ukraine but these served to rescue the species from local extinction rather than being home to free populations, bison require large territories with the ability for contact between sub-populations. Social and economic crises contributed to a further reduction of the bison population in the Ukraine (Gerus, Kryzhanovsky, 2005; Kryzhanovsky, 2007; Parnikoza et al., 2010; Red Book of Ukraine, 2009). Consequently, the appearance of a large 'protected' territory in the north of Kyiv oblast, where there was no human population, opened up new prospects (Kryzhanovsky, 2007).

In 1998 two animals (a male and a female) were transported from the Askania Nova reserve (south Ukraine) and placed in an enclosure near Chornobyl town together with Przewalski horses (Program 'Fauna', 1998). Unfortunately, the female died within the first months as the result of an injury and the bull died of unknown reasons after 2.5 years.

Therefore, the first free bison (as reported here) must have come to Kyiv Polissya from Belarus, without the help of people. Favourable development of the situation in the PSRER fostered this.



Fig. 2. The bison photographed in the CEZ.

Рис. 2. Зубр сфотографований у ЧЗВ.



Fig. 3. The bison scratching on a bridge-side concrete post.

Рис. 3. Зубр чешеться об бетонний стовпчик огорожі моста.

### ***Reintroduction of European bison in neighbour territory of Belarus***

Sixteen animals (4 bulls and 12 females) were transported from Bialoweza Puscha National Park (Belarus) in 1996, and placed into an enclosure near the village of Babchin in the PSRER (Deryabina, 2008). One and a half years later they were released into the wild. Over 10 years their herd increased up to 116 animals in 2016 (Penkevich, 2016). Since 2005 the bison have begun to explore new territories, mostly in the north. A few individuals moved to southern areas of the PSRER but only on the left (east) bank of the Pripyat river (Deryabina, 2012). Growth of the herd and the number of mature bulls were main reasons for dispersion (Deryabina, 2012). It would appear that at least one bull swam across the Pripyat river and reached the Ukrainian part of the CEZ, with faeces being found in 2012. The width of the Pripyat river in this area is 100–200 meters, and the depth approximately 3–4 meters (State water cadastre, 1967). Such ‘swim passages’ of bison were well-known in the past and the site of river crossings used to be places for hunting (Kirikov, 1979 a). According to long-term studies in ‘Bialoweza Puscha’ (Korochkina, 1973) ‘distant roaming’ takes place periodically, and is provoked both by expulsion of males (competitors) from the herd and by the search for new territories when food is scarce.

### ***The observed facts referring to ecology of European bison***

Usually European bison have relatively small territories of 450–900 ha (Korochkina, 1973). A similar range was observed for ‘our’ bison, the area of forest and meadow habitats on which he roamed in August–October 2016 was approximately 500–700 ha.

Baskin (1979) reports that European bison that travelled far could come back to the same locations. However, the annual behaviour of the animal observed in the CEZ is difficult to comment on. Whilst, in the periods November to January and April to July there were no observations, it is in these seasons that bison are the most sedentary (Korochkina, 1973; Baskin, 1979). Distance and activity of movement increases at the end of winter — beginning of spring, in the period of poor food availability and again in the mating period (August–September). It is possible that the observed bison periodically returns to the Belarussian territory. However, it is also possible that during the periods of his ‘absence’ he is somewhere close by and that the most appropriate habitats with better food availability had no camera traps. Studies would be needed to clarify this.

The fact that observations of bison have been made in the same area for four years suggests that the site is not an occasional visiting place. The CEZ is a large area (2600 km<sup>2</sup>) but the animal came over tens of kilometres and appears to have settled at this particular site.

The site is between a large forests, spreading hundreds of kilometres to the west, and former agricultural landscapes that are now overgrown with trees and bushes. This site has a relatively high amount of deciduous and mixed forests on hygrophilous soils with rich mineral supply (Petrov, Gashchak, 2013). Near to 20–25 % of the forest is 80 to 150 years old or older, which is unusual for the CEZ where most trees are younger. Approximately 13 % of the total area over which bison activity has been observed are oak forest (*Quercus robur* L.), and up to 9 % aspen forest (*Populus tremula* L.); this area has a higher proportion of these habitats than much of the rest of the CEZ. Hornbeam (*Carpinus betulus* L.) is common in the understory layer of the area favoured by the bison and in some places it forms pure stands. There is a lot of ash (*Fraxinus excelsior* L.), maple (*Acer* sp.), rowan (*Sorbus aucuparia* L.) and spindle (*Euonymus* sp.). These species are reported as the most preferred among tree and bushes in the diet of bison, and are typical of the species’ main habitats in Europe (Korochkina, 1969 a; Baskin, 1979; Kozlo et al., 1999). The pine and mixed forests which are more abundant than deciduous in the study area grow in hygrophilic (moist) conditions and have a rich layer of grasses and herbs which are consumed by bison (Korochkina, 1969 b; Baskin, 1979; Kozlo et al., 1999). Up to 35 % of the study site is areas of natural reforestation of former meadows/agricultural land where 10–30 years old birch trees now predominate with abundant grasses.

The conditions at the study site are not uncommon in the CEZ, however there are not many places where these habitats occupy such a large area (30–50 km<sup>2</sup>). If we had wanted to re-introduce European bison into the CEZ, it would be difficult to find a more suitable area.

### *Prospects of European bison revival in the CEZ*

As a whole the CEZ has many localities of similar quality and habitat composition (fig. 4). The largest among them are forests with high component of oak in the south-east near the villages of Paryshev and Ladyzhychi. Suitable habitat also includes areas on the north of the Pripjat river's left-bank, between the villages of Usiv, Mashevo and Gorodchan. It is possible that bison have been there or are in these areas but that no observations have been made. These sites are closest to the Belarussian reserve and those localities where bison were observed (in Belarus) in 2005–2011 (Deryabina, 2012).

Bison prefer habitats with meadows and overgrown logging areas, avoiding residing in vast total woodland (Korochkina, 1973; Baskin, 1979). Much of the most appropriate habitat for bison in the CEZ is surrounded by dense woodlands (fig. 4), this is likely to make these areas less attractive to the bison though we speculate that they may be temporarily used during migrations or in winter.

Given its size, natural conditions and protection regime, the CEZ is a good prospective location for establishing a free (natural) population of bison (as opposed to the bison elsewhere in the Ukraine which are restricted to small areas). This is especially the case given that with the neighbouring PSRER (Belarus) the total area with very little human activity is up to 4760 km<sup>2</sup>. In the opinion of Kryzhanovsky (2007), the CEZ has the potential to be the largest Ukrainian reserve for bison, with a total herd of up to 500.

But currently a developing population exists only on Byelorussian territory. In theory, bison coming from Belarus to Ukraine could create a new herd (as was observed for Przewalski horses migrating to the PSRER from the CEZ (Deryabina, 2013)), but this is a future prospect taking into account territorial behaviour of maternal herds (rather sedentary) and the relatively low birth rate (Baskin, 1979). There is no governmental programme to support the reintroduction of bison in the CEZ (Parnikoza et al., 2010). There is also no organisation which could oversee the protection of bison in the CEZ. The recent decision to establish the 'Chornobyl radiation and ecological biosphere reserve' in the Ukraine (Decree of the President, 2016) should be positive for wildlife. However, only time will show if it will be helpful in returning the bison to 'Pripjat Puscha'.

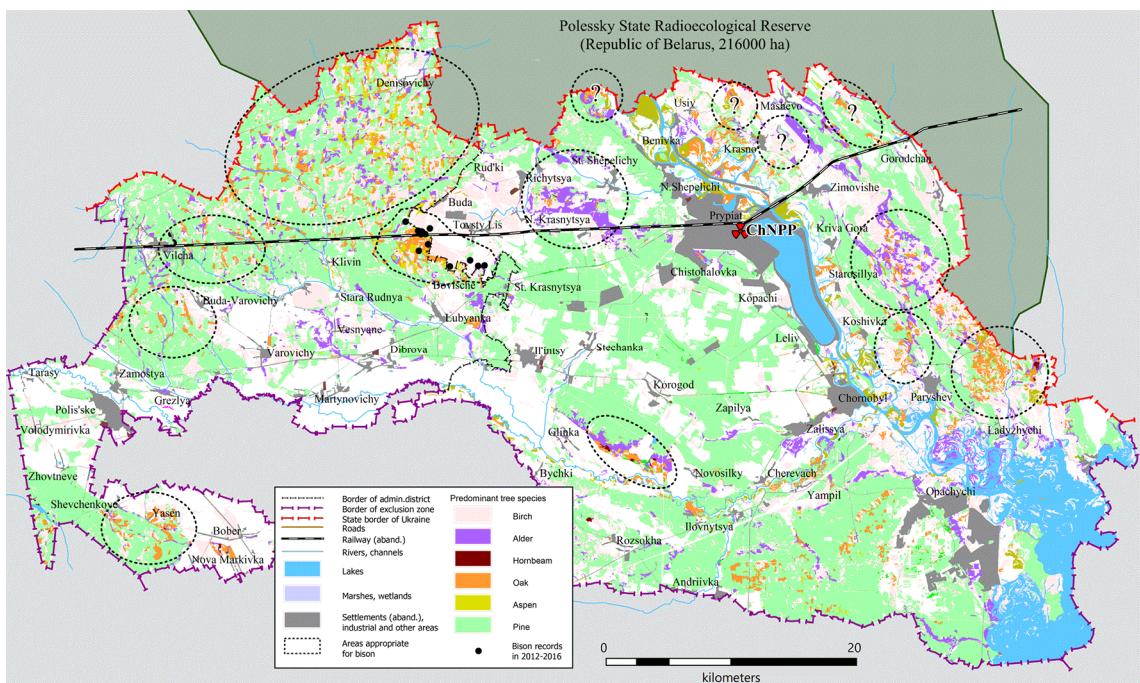


Fig. 4. Areas of CEZ corresponded to the needs of European bison on habitat conditions.

Рис. 4. Ділянки ЧЗВ, що найбільш відповідають потребам зубра за природними умовами.

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## References • Література

- Baskin, L. M.* Ecology and behaviour of European bison // European bison. Morphology, systematics, evolution, ecology / Ed. by V. E. Sokolov. Moscow : Nauka Publishers, 1979. P. 442–471. (in Rus.)  
[*Баскин, Л. М.* Экология и поведение зубра // Зубр. Морфология, систематика, эволюция, экология / Под ред. В. Е. Соколова. Москва : Наука, 1979. С. 442–471.]
- Decree of the President of Ukraine ‘About establishment of Chernobyl radiation and ecological biosphere reserve’, No. 174/2016, 26.04.2016. (in Ukr.)  
[Указ Президента України «Про створення Чорнобильського радіаційно-екологічного біосферного заповідника», № 174/2016 від 26.04.2016 р.]
- Deryabina, T. G.* Polissya population of European bison (1996–2011) // Wildlife of Belarus. 2012 (3.12.2012) <https://goo.gl/ILSHVg> (in Rus.)  
[*Дерябина, Т. Г.* Полесская популяция зубров (1996–2011 гг.) // Дикая природа Беларуси. 2012 (3.12.2012) <https://goo.gl/ILSHVg>]
- Deryabina, T. G.* Distribution and number of the large mammals (bison, bear, lynx, badger) included into the Red Book of Belarus Republic in the territory of Paliessie State Radiation and Ecology Reserve // Faunal studies in Paliessie State Radiation and Ecology Reserve: Proceedings / Ed. Antsipov G. V. Homel : RNIUP "Institute of Radiology", 2008. P. 19–35. (in Rus.)  
[*Дерябина, Т. Г.* Распространение и численность включенных в Красную книгу Республики Беларусь крупных млекопитающих (зубр, медведь, рысь, барсук) на территории Полесского государственного радиационно-экологического заповедника // Фаунистические исследования в Полесском гос. радиационно-экологическом заповеднике : Сб. науч. тр. / Под ред. Г. В. Анципова. Гомель : РНИУП «Институт радиологии», 2008. С. 19–35.]
- Deryabina, T. G.* Przewalski horse (*Equus przewalskii* Poljakov): results of observations for invasive species // Ecosystems and radiation: Aspects of being and development. Collection of scientific works / Ed. by Yu. I. Bondar. Minsk : Institute of radiology, 2013. P. 301–308. (in Rus.)  
[*Дерябина, Т. Г.* Лошадь Пржевальского (*Equus przewalskii* Poljakov): результаты наблюдений за инвазивным видом // Экосистемы и радиация: Аспекты существования и развития. Сб. науч. тр. / Под ред. Ю. И. Бондаря. Минск : БОРБИЦ РНИУП «Институт радиологии», 2013. С. 301–308.]
- Development project for the forestry of the state specialized integrated enterprise "Chernobyl Puscha" under the State department-administration of the exclusion zone and zone of absolute (mandatory) resettlement / Ukrainian State Engineering Forest Management Production Association. Integrated Expedition. Irpin, 2006. (in Ukr.)  
[Проект організації і розвитку лісового господарства державного спеціалізованого комплексного підприємства «Чорнобильська пуша» Державного департаменту-адміністрації зони відчуження і зони безумовного (обов'язкового) відселення / Українське державне проектне лісовпорядне виробниче об'єднання. Комплексна експедиція. Ірпінь, 2006.]
- Gashchak, S. P., Domashevsky, S. V.* Ornithocomplexes of site ‘Tovsty Lis’ as precondition for establishment of protection status // Problems of Chernobyl exclusion zone. 2013. Is. 11. P. 80–90. (in Ukr.)  
[*Гащак, С. П., Домашевський, С. В.* Орнітокомплекси ділянки «Товстий ліс» як передумова надання охоронного статусу // Проблеми Чорнобильської зони отчуждения. 2013. Вып. 11. С. 80–90.]
- Gashchak, S. P., Gulyaichenko, E. O., Beresford, N. A., Wood, M. D.* Brown bear (*Ursus arctos* L.) in Chernobyl exclusion zone // Proceedings of the Theriological School. 2016. Vol. 14. P. 71–84.
- Gerus, K., Kryzhanovsky, V.* The population of European bison in Ukraine today // Visnyk of L'viv Univ. Biology series. 2005. Is. 39. P. 110–113. (in Ukr.)  
[*Герус, К., Крижановський, В.* Сучасний стан популяції зубра в Україні // Вісник Львівського університету. Серія біологічна. 2005. Вип. 39. С. 110–113 с.]
- Kirikov, S. V.* Changes of Fauna in Natural Areas of the USSR (in the 13th–19th centuries.): Forestlands and Forest Tundra. Moscow : Publishing House of the USSR Academy of Sciences, 1960. 158 p. (in Rus.)  
[*Кириков, С. В.* Изменения животного мира в природных зонах СССР (XIII–XIX вв.): Лесная зона и лесотундра. Москва : Изд-во АН СССР, 1960. 158 с.]
- Kirikov, S. V.* Distribution of European bison on territory of Soviet Union in XI–XX centuries // European bison. Morphology, systematics, evolution, ecology / Ed. by V. E. Sokolov. Moscow : Nauka Publishers, 1979 a. P. 476–487. (in Rus.)  
[*Кириков, С. В.* Распространение зубра на территории Советского Союза в XI–XX вв. // Зубр. Морфология, систематика, эволюция, экология / Под ред. В. Е. Соколова. Москва : Наука, 1979 а. С. 476–487.]
- Kirikov, S. V.* Man and Nature in the Eastern European Forest Steppe in the 10th – Early 19th Centuries. Moscow : Nauka, 1979. 184 p. (in Rus.)  
[*Кириков, С. В.* Человек и природа восточноевропейской лесостепи в X – начале XIX в. Москва : Наука, 1979. 184 с.]
- Korochkina, L. N.* Home range and habitat distribution of European bison in ‘Bielowezha Puscha’ // Bielowezha Puscha: Studies. Is. 7. Minsk : Publisher house ‘Uradzhai’, 1973. P. 148–165. (in Rus.)  
[*Короочкина, Л. Н.* Район обитания и стациальное разме-



- шение зубров в Беловежской пушче // Беловежская пушча: Исследования. Вып. 7. Минск: Урожай, 1973. P. 148–165.]
- Korochkina, L. N. Wood vegetation in diet of European bison in Bielowiezha puscha // Bielowiezha puscha. Minsk: Uradzhai, 1969 a. Is. 3. P. 121–126. (in Rus.).
- [Корочкина, Л. Н. Древесная растительность в питании зубров Беловежской пушчи // Беловежская пушча. Минск: Ураджай, 1969 а. Вып. 3. С. 121–126.]
- Korochkina, L. N. Species composition of grass vegetation in diet of European bison in Bielowiezha puscha // Bielowiezha puscha. Minsk: Uradzhai, 1969 b. Is. 3. P. 204–221. (in Rus.).
- [Корочкина, Л. Н. Видовой состав лесной травяной растительности в питании зубров Беловежской пушчи // Беловежская пушча. Минск: Ураджай, 1969 б. Вып. 3. С. 204–221.]
- Kozlo, P. G., Yemelyanova, L. G., Deryabina, T. G., Kuchmel, S. V. Ration of European bison and assessment of food productivity of forest ecosystems in the National park 'Pripyatsky' // Biological diversity of National park 'Pripyatski' and other special protected natural territories: Collection of scientific works. Turov-Mozyr: Publisher House 'Bely Veter', 1999. P. 246–254. (in Rus.).
- [Козло, П. Г., Емельянова, Л. Г., Дерябина, Т. Г., Кучмель, С. В. Питание зубров и оценка кормовой продуктивности лесных экосистем в национальном парке «Припятский» // Биологическое разнообразие Национального парка «Припятский» и других особо охраняемых природных территорий: Сборник научных трудов. Туров-Мозырь: Белый ветер, 1999. С. 246–254.]
- Kryzhanivskyi, V. I. Roadmap for conservation of European bison (*Bison bonasus* L.) in fauna of Ukraine. Approved by an Order of Ministry of Nature and State Committee of Forestry of Ukraine in 8.05.2007, No. 231/163 // Myslyvstvo ta Poliuvannya v Ukraine (Game Farming and Hunting in Ukraine). 2007. Spec. is. P. 1–9. (in Ukr.).
- [Крижановський, В. І. План дій по збереженню зубра (*Bison bonasus* L.) в фауні України. Затверджено наказом Мінприроди та Держкомлігоспу України 8.05.2007, № 231/163 // Мисливство та полювання в Україні. 2007. Спец. вип. С. 1–9.]
- Parnikoza, I., Sesin, V., Boreiko, V. History, current state and perspectives of conservation of the European bison (*Bison bonasus* L.) in Ukraine // Proceedings of the Theriological School. Vol. 10 (Monitoring of Theriofauna). 2010. P. 137–149. (in Ukr.).
- [Парнікоза, І., Сесін, В., Бореїко, В. Історія, сьогодення та перспективи збереження популяції зубра (*Bison bonasus* L.) в Україні // Праці Теріологічної школи. Вип. 10 (Моніторинг теріофауни). 2010. С. 137–149.]
- Penkevich, V. A. European bison. 2016. <https://goo.gl/u5qMtx> (in Rus.).
- [Пенькевич, В. А. Зубр европейский. 2016. <https://goo.gl/u5qMtx>]
- Petrov, M. F., Gashchak, S. P. Radioecological, landscape and geobotanical conditions of Tovsty Lis site as preconditions for its reserved status // Problems of the Chernobyl Exclusion Zone. 2013. Is. 11. P. 102–128. (in Ukr.).
- [Петров, М. Ф., Гацук, С. П. Радіоекологічні, ландшафтні та геоботанічні умови ділянки «Товстий ліс» як передумови надання їй охоронного статусу // Проблеми Чернобыльской зоны отчуждения. 2013. Вып. 11. С. 102–128.]
- Program 'Fauna' of the exclusion zone and zone of absolute (mandatory) resettlement / Approved by First Deputy of Ministry of Emergency of Ukraine V. I. Kholosha, 17.10.1998. (in Ukr.).
- [Програма «Фауна» зони відчуження і зони безумовного (обов'язкового) відселення / Затв. Першим заступником Міністра МНС України В. І. Холошею, 17.10.1998 р.]
- State Water Cadaster. Main hydrological characteristics. Ukraine and Moldova. Middle and lower Podneprovie. Leningrad: Hydrometeoizdat, 1967. Vol. 6, Is. 2. 524 p. (in Rus.).
- [Государственный водный кадастр. Основные гидрологические характеристики. Украина и Молдавия. Среднее и нижнее Поднепровье. Ленинград: Гидрометеоздат, 1967. Том 6, Вып. 2. 524 с.]
- The Red Data Book of Ukraine. Wildlife / Ed. by I. A. Akimov. Kyiv: Global Consulting, 2009. 600 p. (in Ukr.).
- [Червона книга України. Тваринний світ / За ред. І. А. Акімова. Київ: Глобалконсалтинг, 2009. 600 с.]