forests

Article

The Reintroduction Analysis of European Bison (*Bison bonasus* L., 1758) in the North of Romania and the Identification of the Most Favourable Locations

Gabriel Dănilă [1], Sebastian Cătănoiu [2], Valerian Simioniuc [1,*] and Sanda Roșca [3,*]

[1] Forestry Faculty, University "Ștefan cel Mare" Suceava, 13 Universitatii Street, 720229 Suceava, Romania; gabidanila@usm.ro
[2] Vânători Neamț Natural Park, Zimbrului No. 2, 617500 Agaipa, Romania; catanoius@yahoo.com
[3] Faculty of Geography, Babes, Bolyai University, Clinicilor Street 4-7, 400006 Cluj-Napoca, Romania
* Correspondence: simisuceava@gmail.com (V.S.); sanda.rosca@ubbcluj.ro (S.R.)

Simple Summary: The European bison is the largest species of land mammal in Europe and was on the verge of extinction after the First World War. Through the efforts of scientists, wildlife managers, protected areas administrators, and environmental NGOs, the species has been saved from total extinction. All protective activities began in Poland, where the most bison survived, and the initiator of this undertaking was Jan Stanislaus Sztolcman. We aimed to analyse the possibility of reintroducing free-ranging wisents in an area in the north of Romania where the species existed until 1852. Near the analysed area, several wisents were released in the last decade, and now their number has increased to over 50 specimens. The study highlighted the ecological favourability of certain forests where reintroduction would be successful. Additionally, in order to connect the actual and future populations, certain ecological corridors were determined. The species is important for its ecological role as well as from scientific, educational, and sustainable development viewpoints.

Abstract: We analysed the possibility of reintroducing the European bison (*Bison bonasus* L.) in the north of Romania—in Suceava, Neamț, and Maramureș counties—as well as increasing the wild European bison population in Neamț county to improve the genetic quality of the existing population. Currently, there is a population of over 50 individuals in the wild in Vânători Neamț Natural Park, Romania. At the same time, an attempt was made to identify the connecting corridors between the free European bison in Neamț county and other populations through new nuclei of European bison released in Suceava and Maramureș counties. In this regard, the hunting grounds with the highest ecological potential for the analysed species were identified using GIS spatial analysis techniques. The aim was also to trace possible ecological corridors linking different reintroduction locations, taking into account the ecological claims of the species. The analysis also followed the size of the European bison groups to be released, the sex ratio of each group, and the periodicity of their releasing. In order to reach viable populations, scenarios and simulations were carried out depending on the age, number, and sex of the relocated specimens. In this regard, the dynamics and the minimum viable population that could survive without risk of extinction were highlighted. The analysis showed that the analysed area has a high potential for the reintroduction of European bison in the wild. The release and creation of new European bison nuclei in the wild creates the premises for natural contacts with the existing free populations in the wild, genetic improvement, and increasing fauna diversity with ecological, social, and economic implications.

Keywords: European bison; dynamics; hunting ground; reintroduction; sex ratio; GIS modelling

Citation: Dănilă, G.; Cătănoiu, S.; Simioniuc, V.; Roșca, S. The Reintroduction Analysis of European Bison (*Bison bonasus* L., 1758) in the North of Romania and the Identification of the Most Favourable Locations. *Forests* **2022**, *13*, 920. https://doi.org/10.3390/f13060920

Academic Editor: Todd Fredericksen

Received: 3 May 2022
Accepted: 9 June 2022
Published: 13 June 2022

1. Introduction

The European bison is the largest land mammal in Europe, and it lives in mixed herds, which are the basic units in the formation of European bison populations. It is an endangered species, being scientifically classified in the category of "vulnerable" species by the IUCN guidelines [1]. The species is of great importance for the conservation/restoration of biodiversity, especially in terms of vegetation, helping to maintain a mosaic structure of the ecosystem and landscape, by consuming excess vegetation in the glades, meadows, and afforested meadows [2–4]. This, together with its rare presence and impressive appearance, make the European bison a keystone species in nature conservation. In the Holocene, the species was widespread throughout Europe except for the southern extremities of the continent, namely Spain, southern Italy, and the southern Balkan Peninsula [2–4]; however, at high densities, it is problematic due to the damage it causes, as is the case in some regions in Poland.

Reintroductions in the case of the European bison species are based on the strategy [5] edited by the IUCN which is currently under review. According to it, the bison species can be saved from extinction as an element of wildlife in the forest and steppe ecosystems of Central and Eastern Europe only by reaching, for each genetic line, a target population of 3000 individuals in the wild. In 2019, there were 8461 bison, of which 1738 lived in captivity, 479 in semi-liberty, and 6244 specimens in the wild [6]. In 2019, there were 9112 European bison, of which 1792 lived in captivity, 501 in semi-liberty, and 6819 free-ranging. The total numbers of European bison with disregard to type of maintenance and genetic line (EBPB 2021) are high in Belarus (2356 individuals), Germany (609), Poland (2316), Russia (1798), Ukraine (387), and Romania (214).

Among the conservation measures recommended in the strategy mentioned above are:

- The continuous breeding of captive and semi-free individuals, as the populations of European bison in zoos and reservations constitute a valuable genetic reserve for this species;
- The continuation of reintroductions in the wild. These must be based on appropriate scientific data, requiring the identification of new reintroduction sites located mainly in the historical area of the species;
- Ensuring the natural transfer of the gene pool between free herds in the Carpathians.

The decline of the European bison's area followed by the bison's disappearance from today's territory in Romania took place from the end of the 18th century to the beginning of the 19th century. The last areas in which the European bison survived were the Călimani Mountains, the Bârgău Mountains, and the Rodna Mountains [7–9].

As in the rest of Europe, the extinction of the European bison in the wild was caused by a number of factors, including poaching, competition with domestic species, and habitat loss [10].

The existence of these reports regarding the presence of the wisent mainly in the western part of the Eastern Carpathians and in Transylvania can be explained by the belonging of this region to the Austrian Empire and by the existence, at that time, of an administrative system which was better developed than that in neighbouring Moldova. It is very possible that the European bison survived even longer in the eastern part of the Carpathian Mountains in the corresponding counties of Moldova (Suceava and Neamț; Figure 1).

The toponymic analysis can give additional information regarding the natural characteristics of the area. The highest toponymic concentration in Romania regarding the European bison is found in the so-called "European bison area"—the Carpathian area in the counties of Suceava, Neamț, Maramureș, and Bistrița—which is the subject of a serious argument regarding the presence of the species and the creditworthiness of habitats in this area. For the toponymic analysis, the Romanian word for wisent, i.e., "zimbru", and its derivatives were taken into consideration [7]. The restoration of the European bison herds in the Romanian Carpathians is vital for the success of the reintroduction programme for the entire area of the Carpathian Mountains. Now, there are three populations in the wild in Romania: one with over 50 specimens within Vânători Neamţ Natural Park, one with more than 100 specimens in the Țarcu Mountains (Caraș, Severin County), and one with 29 specimens in the Făgăraș Mountains [11,12]. The proximity of the Vânători Neamț population to the free-range herds in Ukraine creates a real opportunity to connect these populations and fulfil one of the goals of the European bison action plan [5].

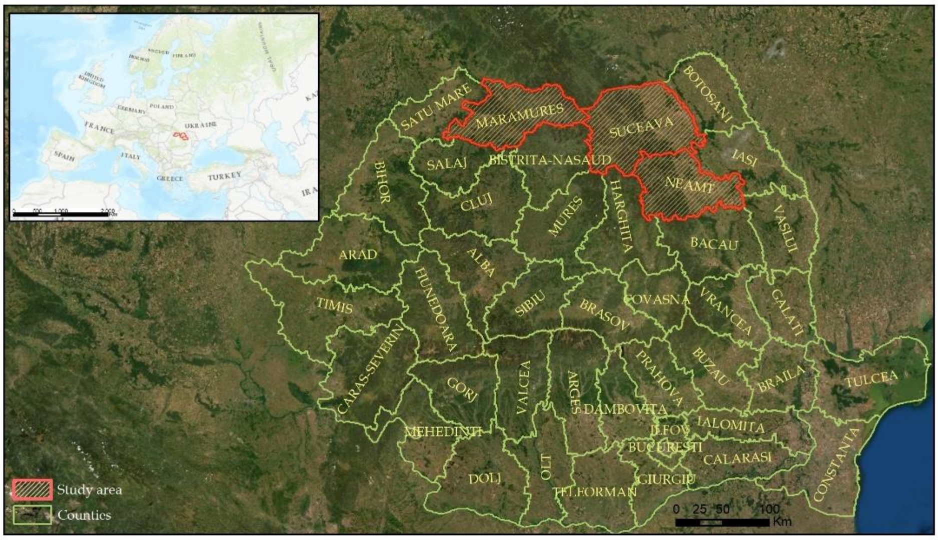

Figure 1. Geographical position of the study area.

The first specimens of European bison were released in 1952, and now there are 46 free living populations in Europe, located in 9 countries [6]. Despite this, the European bison remains a species whose behaviour in the wild is not fully known. For example, the wisent's dietary preferences are controversial. Some studies claim that, historically, the European bison is mainly a grazer [13]. As an ecological adaptation to forest habitats, the wisent's diet is now considered to be mixed herbivory, i.e., grazing enhanced with browsing, allowing utilization of a woody plant food base [4].

However, the ability to digest lignin, which is more developed than in other ungulates, is an adaptation to forest life [14]. The European bison can chew sprouts and even twigs, bark, vines, leaves, buds, etc. In general, older scientific works, under the influence of the theory that the European bison is mainly dependent on the consumption of the herbaceous layer, tend to underestimate the importance of tree and shrub species, while recent scientific works highlight a significant percentage of them in the European bison's diet [15].

Models made by GIS simulations have shown that, historically, the European bison has been spread in full-stocked forest massifs, suggesting that shoots, buds, etc., are an important part of its diet [16]. The European bison prefers deciduous and mixed forests, rarely being found in coniferous ones due to the lack of trophic conditions. In deciduous forests, wisents find food in abundance throughout the growing season. The mosaic forests are the most favourable for this mammal, as the wisent flocks have territories that include open areas, such as meadows or pastures in various stages of secondary succession—clearings, clear-cuttings, patches of natural regeneration, or stands of young trees up to 10 years old [17–20].

The attraction for open areas comes from the fact that more food is available there compared to full-stocked forests [4,10,21,22].

For this reason, some authors recommend that approximately 20% of the area intended for reinforcement be made up of open lands, stating that proximity to agricultural lands is not desirable [23].

Although in the Bieszczady Mountains of the Polish Carpathians and in the Eastern Carpathians (Vânători Neamţ Natural Park), the European bison in the wild reached their upper altitude limit (1200 m altitude), in the much higher Ţarcu Mountains, they also explored the alpine treeline at altitudes higher than 2000 meters. A similar behaviour is observed in the Caucasus region, where the European bison descend in the winter along the forested valleys, while in summer, they look for food in the alpine meadows, located at more than 2000 meters elevation [24]. Given the amplitude of its historical area, the climatic variables (average annual temperature, average temperature in winter, and annual rainfall) usually used to characterize the ecological niche of a species are not very important in the case of the wisent. The variables referring to vegetation cover and land use are important. Under normal conditions, where they can easily find food, free-ranging European bison avoid urban settlements and highways, while using forest roads or poorly trafficked roads as well as agricultural lands. European bison look for quiet areas with mosaic-type landscapes composed by meadows and deciduous and mixed forests with fragmented stands and low slopes [25–27].

At the landscape scale, European bison avoid areas with human influences, such as settlements, roads with higher traffic volumes, or areas where direct encounters with people are likely to occur [25,28,29].

In Romania, the hunting management is carried out on administrative units called "hunting grounds". In Romanian legislation, the bison is considered a fully protected game species [30]. The objectives of the analysis were to identify those hunting grounds in the analysed area that offer the best ecological conditions for the development of wisent populations. The aim was also to establish possible ecological corridors necessary for the natural exchange of individuals between free herds. Such studies have already been performed and successfully implemented for the conservation/reintroduction of the wisent in the wild [31].

2. Materials and Methods

2.1. Favourable Habitats

The work aimed to establish hunting grounds (HG) in the counties of Suceava, Neamț, and Maramureș, where new specimens of European bison could be released. The term "hunting ground" (HGs) shall not be taken as such, but for its ecologically protective meaning as network of nuclei and corridors able to increase and maintain the genetic diversity of these populations. For this purpose, favourable habitats were established on all hunting grounds in Suceava, Neamț, and Maramureș counties (Figure 1), and the analysis was carried out on a large scale using GIS spatial analysis techniques that allow mapping all the factors that influence both favourably and restrictively the studied species, allowing quantitative and qualitative definition of proper habitats as well as the classification of territories at different scales and details of analysis [32–36].

In the first stage, a complex database was created on a raster map (spatial resolution of 25 m) combined with vector databases (Landuses classes, hunting ground limits, road network, built area limits, etc.). CORINE Land Cover 2018 [37] and representative data of the environmental and anthropogenic factors influencing the studied species for the entire pilot area were used as cartographic materials. CLC is the most widely used land cover database in Europe, providing the accuracy needed for such research and ensuring a consistent projection over time (implementation began in 1990). CorridorDesigner ArcMap extensions were used to process data on the movement of the analysed species from one hunting ground to another.

Based on species requirements, as shown in the Introduction chapter, reflecting the specificity of the area, habitat favourability was measured by six variables: elevation, slope, distance from paved roads, distance from settlements, land use, and degree of fragmentation of forests. For each class of each variable, a specific suitability score was assigned depending on the influence that each category has on the European bison [38,39]. The range categories specified for the six variables have been established in accordance with the studies conducted for the reintroduction of the wisent into Europe.

The EU-DEM database raster, version 1.0, with a spatial resolution of 25 m was used for the elevation factor, which provides enough details to be included as a factor in the European bison favourability model.

The following thresholds were taken into account based on data provided by GPS collars worn by some individuals released in Vânători Neamţ Natural Park regarding movements, space use and resource selection, direct observations, and conclusions of other wisent reintroduction studies related to the Carpathians [31,38].

Considering the physical–geographical and ecological peculiarities specific to the Romanian Oriental Carpathians and the altitudinal distribution of forest formations, the following altitude categories were chosen: 0–300 m (30 points suitability), 300–500 m (50 points), 500–800 m (100 points), 800–1000 m (80 points), 1000–1300 m (40 points), 1300–1700 m (10 points) and higher than 1700 m (0 points).

Distance from paved roads was included in the modelling using the multiple buffer function. Then categories of distances were set up, assigning no suitability points up to 500 m (0 points), followed by 50 points (500–1000 m), and finally 100 points for buffers larger than 1000 m.

Larger thresholds were set up for settlements based on the fact that the European bison can occur near isolated settlements or scattered houses. The following categories were established: 0–500 m (0 points), 500–1000 m (75 points), and 1000–10,000 m (100 points).

Land use, according to CLC 2018, took into account the land cover classes. Given the multitude of uses, the classes were grouped into 7 categories (Table 1).

Table 1. Land use classes and their suitability points.

No. of Points	Land Use Classes
0 points	111—continuous urban areas, 112—Artificial areas, 121—Industrial, commercial and transport units, 122—Road and rail networks and associated lands, 124—Airports, 131—Mineral extraction sites, 132—Dump sites, 133—Construction sites, 141—Green urban areas, 142—Sport and leisure facilities, 331—Beaches, dunes, sands, 332—Bare rocks, 333—Sparsely vegetated areas, 512—Water bodies
20 points	211-non-irrigated agricultural land, 212—Permanently irrigated land, 213—Arable land, 221—Vineyards, 222—Fruit trees and berry plantations, 322—Moors and heathland, 411—Inland marshes, 511—Water courses, 512-Water bodies
40 points	312—coniferous forests
70 points	311—deciduous forests
80 points	231—pastures, 242—Complex cultivation patterns, 243—Land mainly occupied by agriculture, with significant areas of natural vegetation
90 points	321—natural meadows, 324—Transitional woodland shrub
100 points	313 mixed forests

Slope was measured by ArcMap software 10.7., being classified into the following categories according to the accessibility thresholds: <15 degrees (100 points), 15–20 degrees (70 points), 20–25 degrees (50 points), 25–30 degrees (20 points), >30 degrees (0 points).

For the forest connectivity, defined by the Morphological Spatial Pattern Analysis (MSPA), the following categories have been established: no forest—areas without forest vegetation (30 points); young forest, without patches of full-stocked forests, but connected at one end with a bridge, a link, or an inner or outer edge (50 points); island—a forest area without any patch of full-stocked forest, but isolated from full-stocked forest (40 points); the outer edge of the forest—the outer perimeter of a full-stocked forest (70 points); bridge—a forest area, thin, which does not contain a full-stocked forest and which connects at least two different full-stocked forest areas (70 points); loop—a forest area, thin, which does not contain full-stocked forest and which connects parts of the same full-stocked forest (50 points); inner forest—the inner part of a forested area, a certain distance from the forest–non-forest boundary (90 points); the inner edge of the forest—the inner perimeter of a full-stocked forest that is "perforated" (interrupted) by enclaves with uses other than forest use (100 points).

For the Ukrainian Carpathians, Deodatus, F. [38] took into consideration only five geodata sets in order to assess the suitability of habitats: land cover, forest/open aria ratio, altitude, terrain roughness, and human proximity. In one of their articles, Kuemmerle et al. [16] use for its model 14 predictors (land cover, forest fragmentation, distance to core forest, land cover diversity, road density, distance to settlements, population density, nighttime lights, elevation, slope, southernness, and latitude) without considering bioclimatic variables. In another article, the same Kuemmerle uses 10 predictors (land cover, forest fragmentation, distance to core forest, distance to forest, slope, aspect, terrain ruggedness, distance to settlements, distance to roads and railways, and distance to protected areas) [20].

Our model tried to provide a robust solution with only 6 variables, which could capture the specificity of the Carpathian area in northern Romania.

The habitat favourability model (HSM) allowed the reclassification and combination of the 6 habitat variables. In this regard, the habitat modelling menu was used. In order to obtain easily interpretable results, a reclassification was carried out according to Table 2. European-bison-friendly habitats are considered to be those that have obtained scores higher than 50 points.

Table 2. Reclassification of the score given, by habitat favourability categories.

Category	The Name of the Category	Score (*fv*) Points
0	non-habitat	0
1	limited habitat	0–25
2	moderate habitat	25–50
3	good habitat	50–75
4	excellent habitat	>75

The available food resources are the resources that adjust or determine the use of a certain territory by the European bison. In the specialized literature, the "areas suitable for breeding" stand for those areas large enough to allow at least one calving in freedom, while the "areas suitable for herd development" mean those areas large enough to allow, in conditions of freedom, the growth of the herd over 10 years [40].

For the European bison, the minimum area suitable for breeding (breeding patches) is about 2500 ha, representing the area required for a herd containing at least 5 females [41], while the minimum area suitable for herd development (population patches) is about 8000 ha [38].

For each of the hunting grounds in the study area, the following indicators were calculated:

$$F = \Sigma\ (Si \times fvi)/k \quad (1)$$

where:

F—the favourability,

Si—the area corresponding to each category of habitat, according to Supplementary Files S1;

fvi—favourability (score) of each habitat category, according to Supplementary Files S1;

k = 400,000—the favourability constant obtained by multiplying the minimum area for herd development (8000 ha) with the minimum score per hectare of a favourable habitat (50 points) resulting in the minimum score required at the level of the minimum area for the herd development (400,000 points).

Therefore, the F index is a quantitative index to describe the favourability, expressing the ratio between the total score of a hunting ground and the minimum score required at the level of the minimum area for the herd development. A ratio greater than one conveys that the hunting ground meets the conditions to ensure the development of the wisent population in the wild. A ratio smaller than one means that the hunting ground shall not be considered for the reintroduction of the European bison.

$$Fs = \Sigma\ (Si \times fvi)/S \quad (2)$$

where:

Fs—specific favourability,

Si—the area corresponding to each category of habitat i, according to Supplementary Files S1;

fvi—favourability (score) of each habitat category, according to Supplementary Files S1;

Fs is a qualitative index, which expresses the score of one hectare of the respective hunting ground.

The higher Fs is above 50 points, the more suitable the hunting ground is for reinforcement/population. The hunting grounds for which Fs is less than 50 points are not recommended to be considered for the reintroduction of the European bison species.

A hunting ground suitable for reinforcement with wisent must simultaneously meet both conditions related to the two indicators, namely F > 1 and Fs > 50 points.

For each hunting ground, the area of favourable habitats was calculated by summing the areas of categories 3 and 4 in Table 1 if their score was higher than 50.

The optimal number for a batch, as well as for the sex ratio, was established in accordance with the action plan developed at the European level [41].

The use of the corridor modelling menu allowed the tracing of ecological corridors that connect different locations, taking into account the ecological demands of the European bison species. During the menu run, the areas identified as having potential for reinforcement were combined so that they represented the terminus points of the corridors.

The methodology was tested within the Vânători Neamț Natural Park; the natural corridors used by the animals in the wild between the northern and southern areas of the Park overlapped with the corridors modelled in GIS.

2.2. The Dynamics of the Future Herds Released in the Wild

In conservation biology, the minimum viable population is the smallest population that can exist without the risk of extinction due to natural, demographic, or genetic threats [42]. The criteria for determining this number are arbitrary. For example, it is considered that a minimum viable population is possible if there is a 95% probability that it will exist in the wild for at least 100 years, or if 95% of the initial heterozygosity is maintained after 100 years [39,43].

Considering the aforementioned details, in order to be able to establish the minimum number of the herds to be released, the specialized software Vortex was used. In order to ensure statistical relevance, the simulations were replicated 500 times. The chosen period was 100 years, and a support capacity of 500 specimens was considered, a cover value for the threshold beyond which it is considered that an European bison population can be considered demographically stable [5].

3. Results

3.1. Determining the Favourable Habitats and Hunting Grounds (HG)

In the first stage, digital models were made for the six variables considered in calculating the favourability: altitude, distance from roads, distance from settlements, land use, slope, and the connectivity categories for the forest (Figure 2).

By considering all the factors, it was possible to create a digital image of the habitats by degrees of favourability (Figure 3) as well as a map that shows the favourability of each HG in the analysed area (Figure 4).

A very high favourability, which is an excellent habitat for the European bison, can be noticed in the forested mountain areas of Neamț and Suceava counties, to which large areas of Maramureș county are added (Figure 3). Thus, an extended area of 1796 km^2 (28.7%) within Maramureș county, 1175.6 km^2 (13.9%) in Suceava county, and 1161.7 km^2 (19.9%) in Neamț county are included in habitats with excellent favourability. To these figures, further areas of 3215.7 km^2 from Suceava county, 2013.4 km^2 from Maramureș county, and 1685.9 km^2 from Neamț county which offer good favourability for *Bison bonasus* are added (Figure 3). As shown in Supplementary Files S1 as well as in Figures 3 and 4, it appears that several groups of HGs could be considered for the reinforcement of the European bison population. The HGs taken into account have a favourability score of over 50 points. The groups were made in such a way that the HGs in a group have common borders that are easy to trespass.

Isolated higher-reliability HGs were not taken into account, i.e., neighbouring only with HGs with a favourability of less than 50 points. In doing so, the following groups of HGs were identified (number and name):

- Suceava county:

(a) 21 Rarău, 22 Botoșana, 23 Negrileasa, 24 Frasin, 47 Voroneț, 69 Râșca, 70 Suha Mare, 71 Suha Mica;

(b) 25 Dragoșa, 27 Moldovița, 28 Demacușa, 29 Brodina, 30 Nisipitu, 31 Straja, 32 Putna, 33 Codru Voivodeasa, 40 Sucevița, 41 Solca, 45 Humor Monastery;

(c) 5 Chiril, 9 Negrișoara, 11Teșna, 12 Coșna, 17 Botuș, 18 Măgura.

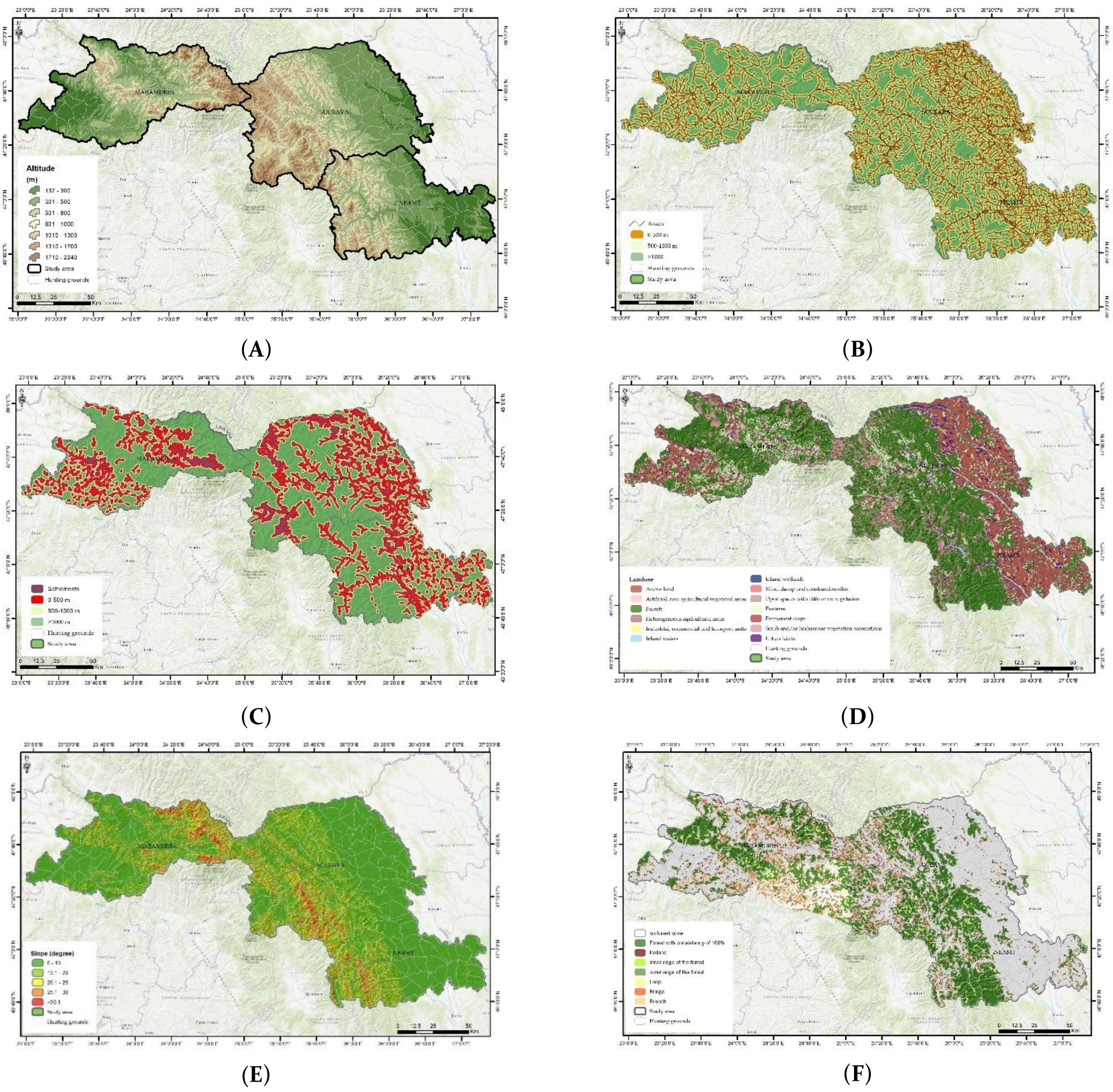

Figure 2. Map of altitude (**A**), distance from roads (**B**), distance from settlements (**C**), land use (**D**), slope (**E**), and the connectivity categories for the forest (**F**).

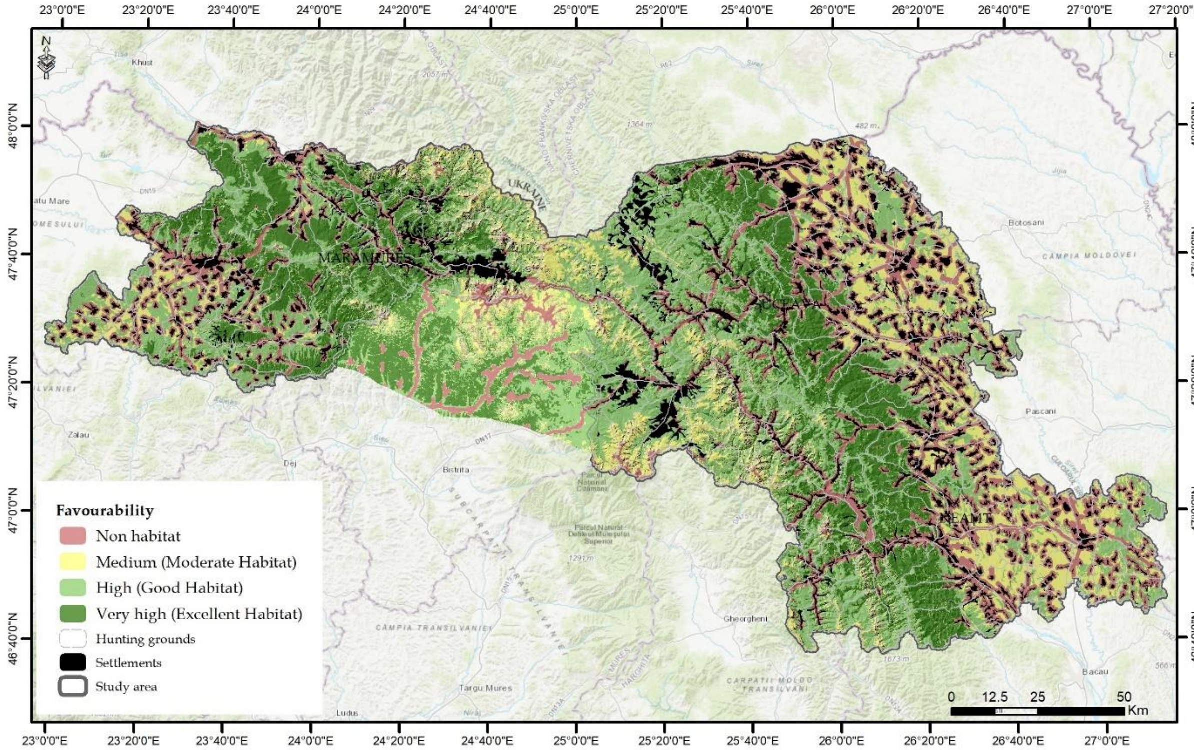

Figure 3. Favourability of habitats in Suceava, Neamț, and Maramureș counties for the European bison.

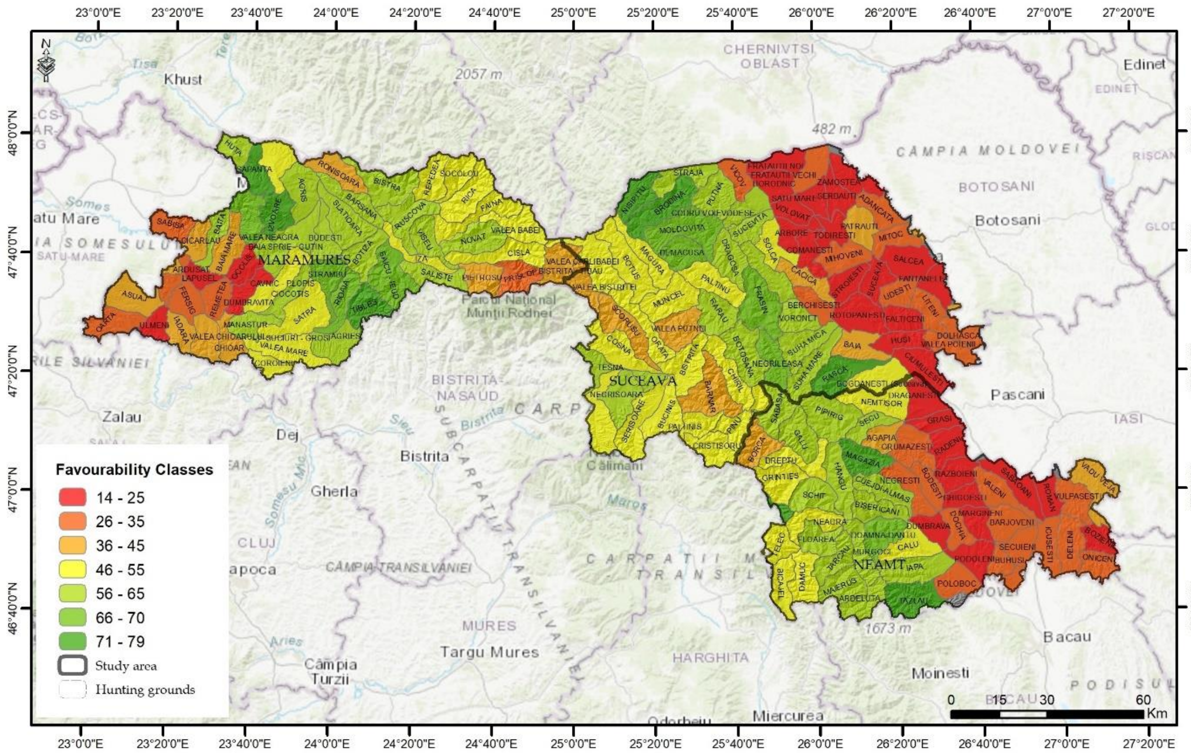

Figure 4. Favourability for the European bison at the level of the hunting grounds in the study area.

The first two groups can be considered for repopulation, in which case there is good continuity of favourable habitat. The third group is isolated in the southwest of Suceava county and has no connection with other areas with favourable habitats.

- Neamț County:
(a) 1 Tazlău, 3 Iapa, 4 Calu, 6 Doamna-Oantu, 8 Murgoci, 9 Ardeluța, 10 Maieruș, 11 Tarcău, 12 Floarea, 13 Damuc, 14 Bicajel;
(b) 7 Bisericani, 17 Schit, 19 Grinții es, 20 Galu, 21 Hangu, 23 Sabasa, 24 Pipirig, 25 Secu, 26 Nemțisor, 29 Magazia, 33 Cuejdi-Almas;

As for Neamț county, both groups are favourable and have good continuity in terms of favourability. In addition, they ensure continuity with the high-scoring HGs from Suceava county.

- Maramureș county:
(a) 21 Baia Sprie, 22 Izvoare, 23 Agriș, 24 Huta, 25 Săpânța, 26 Câmpulung Tisa, 31 Valea Neagră;
(b) 14 Salistea, 15 Baicu Ieud, 16 Botiza, 19 Slatioara, 20 Budești, 51 Strâmbu, 52 Rioaia, 53 Țibleș MM, 54 Suciuri-Groși;
(c) 2 Faina, 3 Novat, 4 Viseu, 5 Rica, 7 Repedea, 8 Ruscova, 9 Bistra, 18 Bârsana.

Of the three groups identified, the first one, located in the north-northwest of Maramureș county, is somehow isolated. The other two groups have higher potential and possible continuity with the favourable areas in Suceava county (Supplementary Files S1).

3.2. The Dynamics in Space and Time of the Future Herds Released in the Wild

For the analysis of spatial dynamics, as shown above, several groupings of HGs were identified as potential areas for the reinforcement of the European bison. In this sense, three such areas were established in Suceava and Maramureș counties, and two were established in Neamț county. Ecological corridors can be created between the release locations between the nuclei of the relocated European bison specimens.

Thus, the area made up of the hunting grounds 27 Moldovița, 29 Brodina, 31 Straja, 33 Codru Voivodeasa, and 40 Sucevița, has the advantage of being connected with the ecological corridor already identified in Ukraine [38], which could make a connection between the herds of free-range wisents from Ukraine and Romania. With a length of 26 km, this corridor starts from Vyzhnytsky National Park in Ukraine, passing through the localities of Lăpușna, Șipotele Siretului and Falcău in Romania (Figure 5).

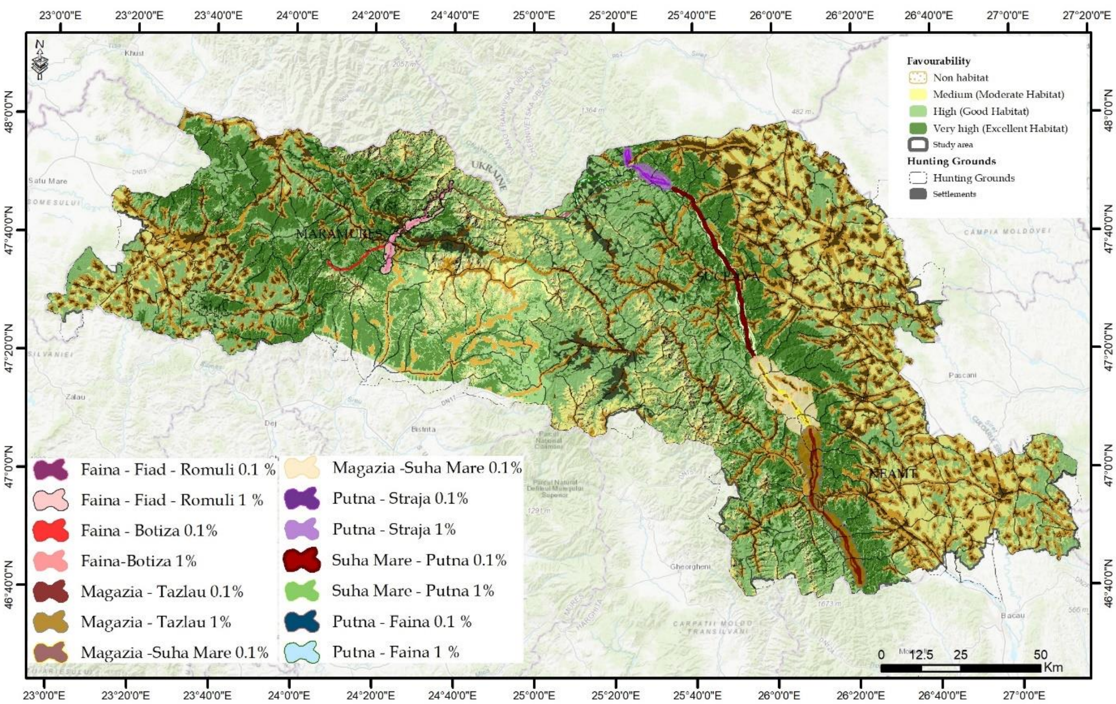

Figure 5. Connection ecological corridors for *Bison bonasus* L. species.

Running the corridor modelling menu, the areas identified as having potential for reinforcement were combined in order to reach the terminal points of the corridor. Figure 5 shows all the analysed corridors across the study area.

In the case of the Tazlău–Magazia corridor, there is a narrow section for crossing the DN15, caused by real estate development, on either side of this road. The Suha Mare–Putna corridor trespasses the national road between Bucșoaia and Gura Humorului and between Moldovița and Sucevița. Crisscrossing the Făina–Țibleș corridor implies using the Vaser Valley and trespassing another national road in the Vişeul de Sus area. The Magazia–Suha Mare, Putna–Straja (the border with Ukraine), and Putna–Făina corridors ensure the movement of the animals without any restrictions.

For the benchmark Bialowieza area, the minimum viable population was estimated at about 250 specimens (150 adult), considering the 95% probability of survival over a period of 100 years [44]. At present, in Bialowieza (Poland) there is a free herd of 770 specimens [6].

For the analysed area, the first scenario involved an initial herd of 5 adults (3 males and 2 females) which, without other later additions, would have at the end of the 100-year period a probability to survive of 34.6%, much lower than the probability of 95% necessary to keep the herd in the wild during this period.

A second scenario, which involved supplementing the initial herd with another 16 specimens (groups of four adults, two males and two females, released at 4-year intervals), increased the probability of survival to 99.4%. Based on this scenario, analyses were performed, and assumptions were considered regarding the proportion of the sexes and the age of the supplemented specimens. Thus, the simulation of hr4 (1) took into account, for the same number of supplemented specimens and for the same time intervals (four times, starting with year 4, at intervals of 4 years), a sex ratio of 3:1. The hr4 (2) simulation refers to a sex ratio of 1:3, and the hr4 (3) simulation analyses the supplementation with two females of 1–2 years old and two males of 1–2 years old (Table 3).

Table 3. The variables used for hr4 simulations associated with the wisent 2 scenario/simulation.

Scenario/Simulation	Wisent 2	hr4 (1)	hr4 (2)	hr4 (3)
Adult females—supplementation	2	1	3	0
Adult males—supplementation	2	3	1	0
Young females—supplementation	0	0	0	2
Young males—supplementation	0	0	0	2

where: wisent 2—scenario with supplementation; hr4 (1)—the number of females is the lowest; hr4 (2)—the number of females, regardless of age, is the highest; hr4 (3)—equal number of young females and males.

The sex ratio of the additional European bison is important, the most advantageous variant being the one where the number of females is the highest (simulation hr4 (2)), and the most disadvantageous being the one in which the number of females, regardless of age, is the smallest (hr4 simulation (1)). If the supplementation is carried out, each time with 1 adult male and 3 females, the probability of survival reaches 99.8% (Figure 6). It is also found that, in the long run, supplementation with young specimens has only a slight negative effect compared to that performed with adult specimens, mainly caused by their non-participation in mating for a short period of time.

The simulations showed that adding four adults shortly after the first release of four females brings the probability of survival to 99.8%, identical to the probability resulting from the gradual release of 16 specimens over 16 years in four trials.

In order to be able to compare the efficiency of herd supplementation in a single location (wisent 2 scenario) with the same number of specimens in two locations, a new scenario was considered (wisent 3). In order to maintain the same total number of supplemented specimens, in wisent 3 scenario, the supplementations of the herds in the two locations should be performed for each herd with one adult male and one adult female (compared to the two adult females and two adult males provided in the wisent 2 scenario). After

500 simulations, the probability of population survival in the wisent 3 scenario was 81.6% for the initial herd, 60.6% for the herd from the second reinforcement location, and of 87.0%, for the cumulative number of the two locations. In all three cases, the probability of population survival is lower than desired (95%).

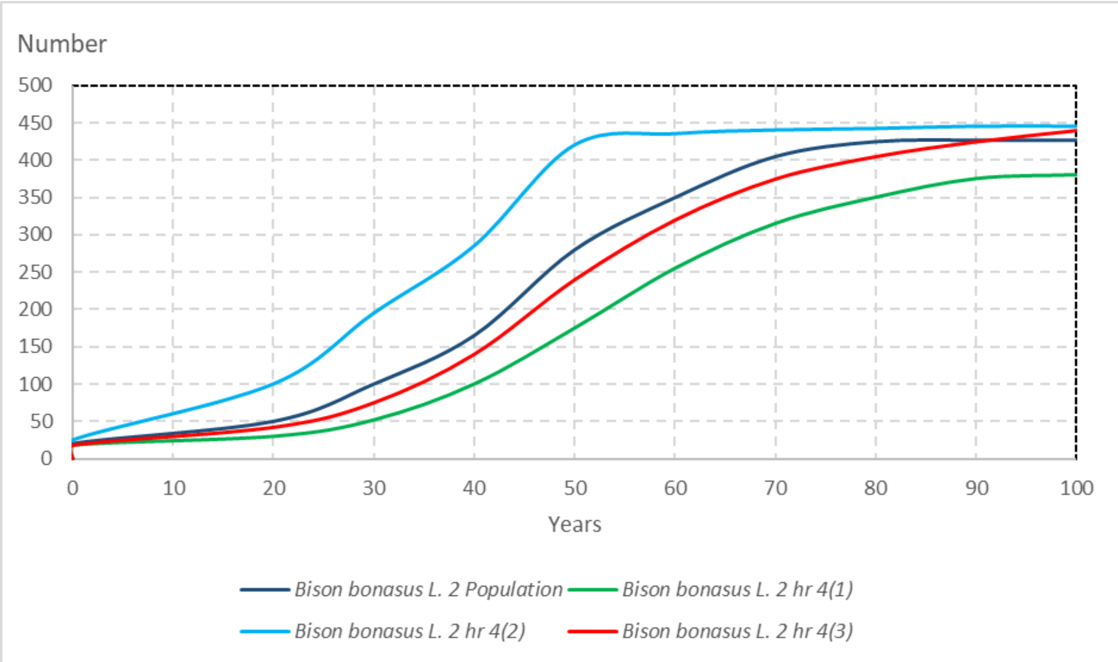

Figure 6. The number of specimens at the end of the time period for the scenario with supplementation (European bison 2) and hr4 (1), hr4 (2), hr4 (3) simulations.

For the wisent 2 scenario (a single reinforcement location), the survival likelihood was 99.4%, which confirms the conclusion that the latter scenario is the most favourable regarding the subsequent evolution of the herd (Figure 7).

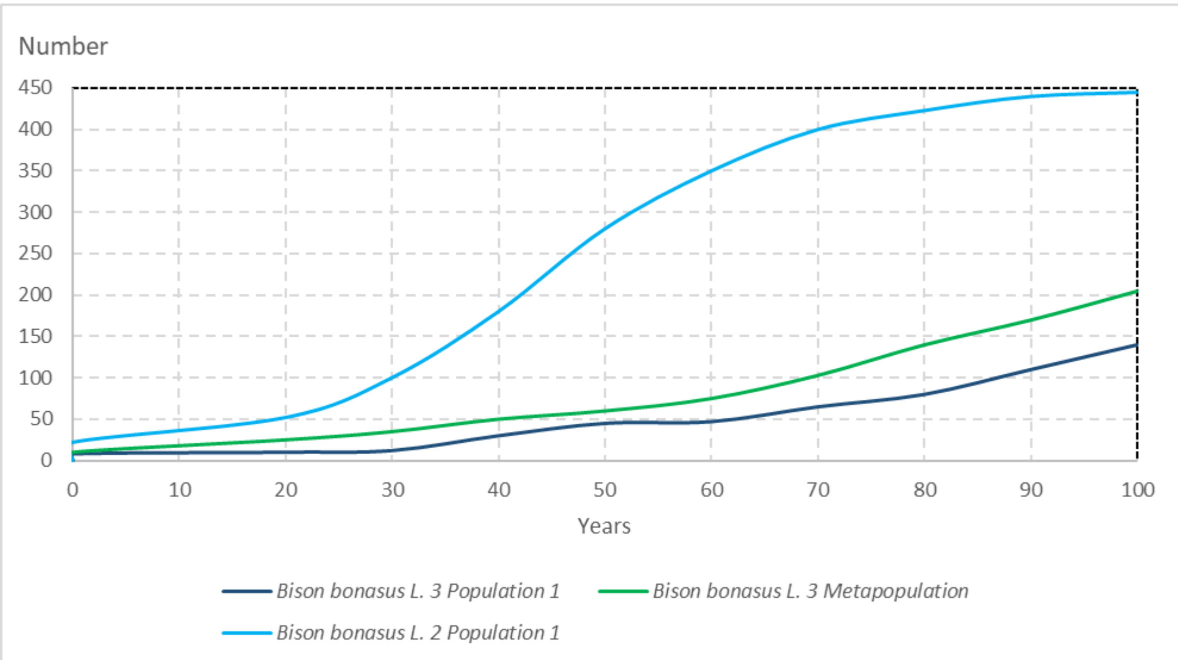

Figure 7. The survival percentage for wisent 2 and wisent 3 scenarios (the initial herd and the cumulative one).

4. Discussion

The analysed area—the HGs located in Suceava, Neamț, and Maramureș counties—is favourable as a whole to the reintroduction of European bison, especially in the case of the HGs located in the phytoclimatic floors FM2—the mountain mixture floor, FM1 + FD4—the montane–premontane floor of beech forests, and FD3—the hilly floor of durmast oak forests, beech forests, and oak–beech forests.

In the case of Suceava county, two potential clusters of HGs were identified for the release of wisent into the wild. These show continuity of favourability with the groupings of the HGs from Neamț county, but also with a corresponding grouping from Maramureș county. Both locations are suitable for reinforcement/repopulation with wisent because the indices that reflect favourability are appropriate; a natural communication is ensured between the existing wisent in the wild in Vânători Neamț Natural Park and these future reinforcement nuclei. A reinforcement/repopulation into these HGs is very important from the viewpoint of the conservation of the species in the northern part on the Romanian Carpathians, as is ensuring natural communication with the free-ranging European bison herds in Ukraine.

For the actual release action, the HGs with superior favourability will be chosen, but the possibility of moving the European bison into the neighbouring HGs that have suitable habitats will be considered.

It is desirable that the exchange of specimens between free herds occupying adjacent territories should take place naturally based on the use of the favourable habitats, as shown in Figures 3 and 4. The corridor modelling menu allowed the setting of ecological corridors, which can make connections between different locations taking into account the ecological demands of the European bison.

As for the carrying capacity for the European bison, it was determined only in particular conditions for some locations in Europe. In the case of the Bialowieza Forest, with a density of more than 5–6 specimens/1000 ha, the European bison require complementary food, which is associated with decreasing fertility [43].

The action plan developed at the European level [41], in conjunction with the continental analysis of the favourable areas for the European bison species, associates continuous areas larger than 200 km^2 [39], providing conditions for the existence of a herd of at least 50–60 specimens (thus resulting in a density of 0.3–0.4 European bison/km^2, the equivalent of 3–4 specimens/1000 ha). More detailed assessments have been made in the Bieszczady Mountains in the Polish Carpathians, where European bison have been reinforced since 1963. The most visited forests were those located at altitudes between 500 and 800 meters. In Bieszczady National Park, both in winter and summer, more than 90% of the wisent were found in areas covered with forest vegetation [22]. In the immediate vicinity, in Poloniny National Park in Slovakia, due to the existence of many abandoned lands, the percentage of forest use is only 50% in summer and 75% in winter [45]. A coniferous forest, to be visited by European bison, requires larger areas of meadows or pastures where the European bison can easily find food. In general, the mosaic habitat ensures the sustainability of the presence of European bison by ensuring various food sources throughout the year [29]. Taking into account the Polish experience, the carrying capacity in the Carpathians was estimated at 0.4 European bison/km^2 [28,39]. This coincides with the estimations made for the American bison herds in Yellowstone and Wood Buffalo National Parks [46] and with the suggested carrying capacity for the European bison in Central Europe [43]. In the analysed study area, in the case of Vânători Neamț Natural Park, the analysis of the areas used more intensely by the wisent, determined by the Kernell method (for the percentage of 95%), showed that a herd of 45 free specimens used 160 km^2, which represents approximately 3 specimens/1000 ha. This value is close to the one aforementioned in the literature. Therefore, at the level of the Romanian Oriental Carpathians, an average carrying capacity is about 3–4 specimens/1000 ha, with the specification that it may vary locally, depending on specific conditions.

Regarding the appropriate age for reinforcement, young specimens are less experienced and therefore prone to higher mortality. On the other hand, if they survive, juveniles can adapt more easily and are less affected by captivity or stress during and after release [47]. For mammals in general, although the number of reinforcement studies is low, the release of adult specimens increases the success rate of reinforcement [48]. The size and composition of the first group to be released (the founding group) is very important, especially if this is not followed relatively quickly by other groups. The smaller the initial group is, the more effort will have to be made later. Releasing a larger number of specimens increases the chances of success for reinforcement.

The calculations performed for large mammals show that the success rate is ensured by releasing, over time, 20–40 specimens [49].

For the European bison, it is recommended that the minimum initial group should be of five specimens, preferably 10 or even more. For example, in the Bialowieza Forest (Poland), 38 specimens (14M, 24F) were released gradually over 20 years, while in the Borecka area (Poland), 15 specimens (7M, 8F) were released over just 2 years [14]. In Vânători Neamț Natural Park (Romania), 30 specimens (14M, 16F) were released over 8 years in groups of 3–5 specimens, and in the Armeniș area (Caraș-Severin, Romania), within 5 years, 51 specimens (14M, 37F) were released in groups larger than 10 specimens. Even if, ideally, the M:F sex ratio for the wisent is 1:5, due to real conditions, it is desirable that it should be 1:2 or at least 1:1.5. In order to quickly establish a social hierarchy, the group must contain at least 2–3 males of different ages and a few adult females. For males, it is recommended that they be a mating male (6–12 years old), a successor (4–6 years old), and a young male (less than 4 years old).

Regarding the analysis area, there are natural predators of the wisent, mainly wolves and bears. In this respect, a small number of released animals can be affected until they develop skills to survive. In the wild, the animals have their first contact with predators in the presence of their parents, which provides them the necessary protection and thus provides them basic survival lessons. For the animals bred in captivity and released afterwards, these experiences with local conditions are lacking, so pre-release techniques must be developed in some cases. The problem can be solved by keeping the animals, for periods of time that can include the calving of the offspring, in large acclimatization pens located in the reinforcement areas in order to allow different levels of contact with predators [50].

There are two main release strategies that are used for reinforcements.

The "soft" strategy involves acclimatizing the specimens to the new environment by keeping them in the release area for a long time and providing them complementary food only when needed, while the "hard" strategy involves the relatively immediate release of the specimens into the new environment [51].

To ensure the success of the European bison reintroduction programme, it is necessary to release, at first, at least 3–4 groups of wisents so as to form and develop a stable, sustainable herd of at least 25–30—preferably 50—individuals. It would be advisable for the first group of wisents to include 6–10 specimens with a sex ratio close to 1:2. Depending on the chosen strategy, the groups of European bison that will be brought can be acclimatized for a period of 3–12 months. If desired, the last group can be kept as the queen herd. The European bison specimens that will be included in the reintroduction programme will be carefully selected from a genetic viewpoint and will be monitored through collars using UHF/GPS Iridium technology. In the case of small herds of 10–20 specimens, especially for those that are isolated from the other populations in the wild, it is necessary to improve the genetic structure of the herd and to avoid the loss of rare or underrepresented genes by new releases of specimens with known pedigree [11].

This total number of individuals must be released in small groups with a certain periodicity into the HGs with high favourability for the viability of the wisent.

In 2012, the first release of a group of wisents (five specimens) took place in the Vânători Neamț Natural Park (Romania). New releases were made in 2013 (five specimens), in 2014 (six specimens), in 2015 (two specimens), in 2016 (three specimens), in 2017 (four specimens), in 2018 (one specimen), and in 2019 (four specimens), totalling 30 specimens (14M, 16F). In Armeniș (Romania), the releases had a different dynamic, so that in 2015, 15 specimens were released; in 2016, 14 specimens; in 2017, 10 specimens; and in 2019, 12 specimens. The general proportion of the sexes was 14M, 37F; in general, the specimens were young.

In conclusion, the number of releases, their periodicity, the number of animals released will take into account the aforementioned aspects, stating that these elements eventually depend on the number of animals available, the proportion of sexes and ages, the carrying capacity of the release location, the movements of the animals, and the reaction of the local communities. The coordinating team, which must take decisions based on the reality on the ground, is essential for a proper reinforcement/release process. It should be understood that repopulating a large species with the aim of obtaining a viable herd in the wild stretches over a long period of time (decades).

5. Conclusions

Romania has good conditions for setting, conserving, and developing new free-ranging European bison populations. Given the success of the reintroduction of wisents in various forests in Europe, the initiative in the analysed area also has a high chance of success. Thus, possible areas for release were identified in the north of Romania. These areas are within the counties of Neamț, Suceava, and Maramureș, where wisents existed in the past. Additionally, in these areas, there are possible link corridors for European bison herds.

In this regard, the analysed forest ecosystems are favourable to the existence and development of viable European bison populations. There are also real chances for contact between different herds of wisent to increase genetic diversity and invigorate the species in the wild.

The setting of the final location for the European bison release will be performed by the local authorities, considering the following elements:

- Forest vegetation (composition, consistency, age, regeneration, grass cover, etc.);
- Additional areas not covered by forest vegetation (meadows, alpine barren zones, meadows, pastures, creditworthiness, property, etc.);
- Water sources and their availability throughout the year (relatively constant flow, frost, pollution, multiple use, etc.);
- Potential man-made or natural barriers (fences, precipices, deep rivers, roads, settlements, new infrastructure projects) and their permeability (traffic, fords, etc.);
- Existing infrastructure on the HGs (food lands, feeders, salt marshes, fodder depots/bailments, feeding places, hunting lodges, etc.);
- Social acceptance.

As one of the variants of the soft strategy involves the release of the European bison in a different location than the one where they were previously quarantined/acclimatized, the existing infrastructure can be used (pens, fenced areas, fodder depots, etc.) in different phases of reinforcement, even if these facilities are located on the HGs with low favourability according to annex no. 1. The use of the existing infrastructure will reduce the financial effort for the reinforcement, and if it is located in accessible places, it will be able to contribute to increasing social acceptance.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/f13060920/s1. Table S1: HG characterization from the viewpoints of favourability, specific favourability, and the area suitable for development ranged decreasingly, depending on the specific favourability, for each county.

Author Contributions: Conceptualization, G.D. and S.C.; methodology, G.D. and S.C.; software, S.R.; validation, G.D., S.C. and V.S.; formal analysis, S.R.; investigation, G.D., S.C. and V.S.; resources, S.R.; data curation, G.D. and S.C.; writing—original draft preparation, G.D. and S.R.; writing—review and editing, V.S. and S.R.; visualization, S.R.; supervision, G.D. and S.C.; project administration, G.D. and

S.C.; funding acquisition, G.D. and V.S. All authors have read and agreed to the published version of the manuscript. All authors contributed equally to this work.

Funding: This research was funded by University Ștefan cel Mare Suceava, Strada Universității nr. 13, 720229, Suceava, România, rectorat@usv.ro, +40 751 283087—robot, +40 751 283088—robot, +40 230 216147—operator.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. IUCN; SSC. *Guidelines for Reintroductions and Other Conservation Translocations*; Gland Switz Camb UK IUCNSSC Re-Introd Spec Gr.; IUCN: Gland, Switzerland, 2013; p. 57.
2. Bunzel-Drüke, M.; Drüke, J.; Vierhaus, H. Quaternary Park': Large Herbivores and the Natural Landscape before the Last Ice Age. *Grazing Grazing Anim. Vakbl. Natuurbeheer* **2002**, *41*, 10–13.
3. Benecke, N. The Holocene Distribution of European Bison-the Archaeozoological Record. *Munibe Antropol.* **2005**, *57*, 421–428.
4. Hofman-Kamińska, E.; Bocherens, H.; Drucker, D.G.; Fyfe, R.M.; Gumiński, W.; Makowiecki, D.; Pacher, M.; Piličiauskienė, G.; Samojlik, T.; Woodbridge, J. Adapt or Die—Response of Large Herbivores to Environmental Changes in Europe during the Holocene. *Glob. Chang. Biol.* **2019**, *25*, 2915–2930. [CrossRef] [PubMed]
5. Pucek, Z. *European Bison (Bison Bonasus): Current State of the Species and Strategy for Its Conservation*; Council of Europe: Strasbourg, France, 2004; ISBN 9287155496.
6. Raczyński, J. *European Bison Pedigree Book*; United Nations: Białowieża, Poland, 2020.
7. Vâlsan, G. Geographical Toponymy Distribution in Romania of Three Animals Now Extinct—Ox, Bison, Sheep. *Bul. Soc. Regale Române Geogr.* **1938**, *LVII*, 20–34.
8. Filipașcu, A. *Savages from the Time of Our Ancestors*; Stiintifica Publishing House: Bucuresti, Romania, 1969.
9. Geptner, V.G.; Nasimovich, A.A.; Bannikov, A.G.; Hoffmann, R.S. Mammals of the Soviet Union. v. 1. Artiodactyla and Perissodactyla. 1988. Smithsonian Institution Libraries and National Science Foundation. Available online: https://library.si.edu/digital-library/book/mammalsofsovietu11988gept (accessed on 16 December 2020).
10. Kuemmerle, T.; Hickler, T.; Olofsson, J.; Schurgers, G.; Radeloff, V.C. Reconstructing Range Dynamics and Range Fragmentation of European Bison for the Last 8000 Years. *Divers. Distrib.* **2012**, *18*, 47–59. [CrossRef]
11. Cătănoiu, S.; (Vânători Neamț Natural Park, Vânători-Neamț, Romania). Personal communication, 2022.
12. Dănilă, G.; Cheroiu, G.; Goicea, N. *Cynegetics Notions*; Mare, U.Ș.c.M., Ed.; Publisher Stefan cel Mare Publisher House: Suceava, Romania, 2022; ISBN 978-973-666-724-4.
13. Mendoza, M.; Palmqvist, P. Hypsodonty in Ungulates: An Adaptation for Grass Consumption or for Foraging in Open Habitat? *J. Zool.* **2008**, *274*, 134–142. [CrossRef]
14. Grzegrzółka, B.; Olech, W.; Krasiński, Z.A. The Genetic Structure of Lowland European Bison Free Ranging Herds in Poland. *Park. Nar. Rezerw. Przyr.* **2004**, *23*, 665–677.
15. Baraniewicz, M.; Perzanowski, K. Are Reintroduced Wisents a Threat to Mountain Forests? *Ann. Zool. Fenn.* **2015**, *52*, 301–312. [CrossRef]
16. Kuemmerle, T.; Perzanowski, K.; Akcakaya, H.R.; Beaudry, F.; Van Deelen, T.R.; Parnikoza, I.; Khoyetskyy, P.; Waller, D.M.; Radeloff, V.C. Cost-effectiveness of Strategies to Establish a European Bison Metapopulation in the Carpathians. *J. Appl. Ecol.* **2011**, *48*, 317–329. [CrossRef]
17. Gębczyńska, Z.; Kowalczyk, J.; Krasińska, M.; Ziołecka, A.; Bisoniana, L.V. A Comparison of the Digestibility of Nutrients by European Bison and Cattle. *Acta Theriol.* **1974**, *19*, 283–289. [CrossRef]
18. Bohn, U.; Neuhäusl, R.; Gollub, G.; Hettwer, C.; Neuhäuslová, Z.; Raus, T.H. Karte Der Naturlichen Vegetation Europas/Map of the Natural Vegetation of Europe. *Maßstab/Scale* **2003**, *1*, 500.
19. Augustyn, M.; Kozak, I. The Trends of Anthropogenic Pressure in Polish and Ukrainian Carpathians. In *Selected Ecological Problems of Polish–Ukrainian Carpathians Proceedings of the Scientific Session within the 2nd Annual Meeting of the International Centre of Ecology, Polish Academy of Sciences*; Polish Academy of Sciences: Warsaw, Poland, 1997; pp. 15–22.
20. Kuemmerle, T.; Perzanowski, K.; Chaskovskyy, O.; Ostapowicz, K.; Halada, L.; Bashta, A.-T.; Kruhlov, I.; Hostert, P.; Waller, D.M.; Radeloff, V.C. European Bison Habitat in the Carpathian Mountains. *Biol. Conserv.* **2010**, *143*, 908–916. [CrossRef]
21. Bocherens, H.; Hofman-Kamińska, E.; Drucker, D.G.; Schmölcke, U.; Kowalczyk, R. European Bison as a Refugee Species? Evidence from Isotopic Data on Early Holocene Bison and Other Large Herbivores in Northern Europe. *PLoS ONE* **2015**, *10*, e0115090. [CrossRef] [PubMed]
22. Kuemmerle, T.; Levers, C.; Bleyhl, B.; Olech, W.; Perzanowski, K.; Reusch, C.; Kramer-Schadt, S. One Size Does Not Fit All: European Bison Habitat Selection across Herds and Spatial Scales. *Landsc. Ecol.* **2018**, *33*, 1559–1572. [CrossRef]

23. Olech, W.; Perzanowski, K. A Genetic Background for Reintroduction Program of the European Bison (Bison Bonasus) in the Carpathians. *Biol. Conserv.* **2002**, *108*, 221–228. [CrossRef]
24. Kazmin, V.D.; Smirnov, K.A. Zimnee Pitanie, Kormovye Resursy i Troficheskoe Vozdeistvie Zubra Na Lesnye Fitocenozy Tsentral'nogo Kavkaza. *Byulleten'Moskovskogo Obs. Ispyt. Prir. Otd. Biol.* **1992**, *97*, 26–35.
25. Ziółkowska, E.; Perzanowski, K.; Bleyhl, B.; Ostapowicz, K.; Kuemmerle, T. Understanding Unexpected Reintroduction Outcomes: Why Aren't European Bison Colonizing Suitable Habitat in the Carpathians? *Biol. Conserv.* **2016**, *195*, 106–117. [CrossRef]
26. Ziółkowska, E.; Perzanowski, K.; Bleyhl, B.; Ostapowicz, K.; Kuemmerle, T. What Hampers European Bison's Movements? A Case Study from the Carpathians. In Proceedings of the IALE 2017, Ghent, Belgium, 12–15 September 2017.
27. Zielke, L.; Wrage-Mönnig, N.; Müller, J.; Neumann, C. Implications of Spatial Habitat Diversity on Diet Selection of European Bison and Przewalski's Horses in a Rewilding Area. *Diversity* **2019**, *11*, 63. [CrossRef]
28. Perzanowski, K.; Olech, W. A Future for European Bison Bison Bonasus in the Carpathian Ecoregion? *Wildlife Biol.* **2007**, *13*, 108–112. [CrossRef]
29. Balciauskas, L. Restoration of European Bison in Lithuania: Achievements and Problems. In Proceedings of the International Symposium:» European Bison, Yesterday, Today and Tomorrow, Šiauliai, Lithuania, 9–10 December 2000; pp. 8–15.
30. României, P. Legea Vânătorii Şi a Protecției Fondului Cinegetic Nr. 407/2006. *Monit. Of. Partea I* **2006**, *28*, 944.
31. Kuemmerle, T.; Radeloff, V.C.; Perzanowski, K.; Kozlo, P.; Sipko, T.; Khoyetskyy, P.; Bashta, A.-T.; Chikurova, E.; Parnikoza, I.; Baskin, L. Predicting Potential European Bison Habitat across Its Former Range. *Ecol. Appl.* **2011**, *21*, 830–843. [CrossRef] [PubMed]
32. Hooge, P.N.; Eichenlaub, B. *Animal Movement Extension to ArcView (Version 1.1)*; Alaska Biological Science Center, U.S. Geological Survey: Anchorage, Alaska, 1997.
33. Manel, S.; Berthoud, F.; Bellemain, E.; Gaudeul, M.; Luikart, G.; Swenson, J.E.; Waits, L.P.; Taberlet, P.; Consortium, I. A New Individual-based Spatial Approach for Identifying Genetic Discontinuities in Natural Populations. *Mol. Ecol.* **2007**, *16*, 2031–2043. [CrossRef] [PubMed]
34. Chabot, D.; Bird, D.M. Wildlife Research and Management Methods in the 21st Century: Where do Unmanned Aircraft Fit in? *J. Unmanned Veh. Syst.* **2015**, *3*, 137–155. [CrossRef]
35. Duffy, J.P.; Cunliffe, A.M.; DeBell, L.; Sandbrook, C.; Wich, S.A.; Shutler, J.D.; Myers-Smith, I.H.; Varela, M.R.; Anderson, K. Location, Location, Location: Considerations When Using Lightweight Drones in Challenging Environments. *Remote Sens. Ecol. Conserv.* **2018**, *4*, 7–19. [CrossRef]
36. Alexandru, C.; Rosca, S., IV. Hotspot analysis and human perception of Ursus Actos in the Romanian Carpathians. *Geogr. Napocensis* **2021**, *15*, 14–23.
37. EEA. Corine Land Cover (CLC). [WWW Document]. 2012. Available online: http://land.copernicus.eu/pan-european/corine-land-cover/clc-2012/view (accessed on 16 December 2020).
38. Deodatus, F. *Creation of Ecological Corridors in Ukraine: A Manual on Stakeholder Involvement and Landscape-Ecological Modelling to Connect Protected Areas, Based on a Pilot in the Carpathians*; State Agency for Protected Areas of the Ministry of Environmental Protection of Ukraine: Kyiv, Ukraine, 2010; ISBN 9079341053.
39. Boyce, M.S. Population Viability Analysis. *Annu. Rev. Ecol. Syst.* **1992**, *23*, 481–497. [CrossRef]
40. Beier, P.; Majka, D.; Jenness, J. *Conceptual Steps for Designing Wildlife Corridors*; CorridorDesign: Flagstaff, AZ, USA, 2007.
41. Allendorf, F.; Ryman, N. *The Role of Genetics in Population Viability Analysis*; University of Chicago Press: Chicago, IL, USA, 2002.
42. Miller, P.S.; Lacy, R.C. *Vortex: A Stochastic Simulation of the Extinction Process: Version 9.50 User's Manual*; Conservation Breeding Specialist Group: Apple Valley, MN, USA, 2005.
43. Krasińska, M.; Krasiński, Z.A.; Olech, W.; Perzanowski, K. European Bison. In *The Nature Monograph*; Mammal Research Institute PAS: Białowieża, Poland, 2007; p. 318.
44. Brook, B.W.; Tonkyn, D.W.; O'Grady, J.J.; Frankham, R. Contribution of Inbreeding to Extinction Risk in Threatened Species. *Conserv. Ecol.* **2002**, *6*, 16. [CrossRef]
45. Pčola, Š.; Gurecka, J. The Most Recent Information about the Restitution of European Bison (Bison Bonasus) to Poloniny National Park. *Eur. Bison Conserv. Newsl.* **2008**, *1*, 146–152.
46. Plumb, G.E.; White, P.J.; Coughenour, M.B.; Wallen, R.L. Carrying Capacity, Migration, and Dispersal in Yellowstone Bison. *Biol. Conserv.* **2009**, *142*, 2377–2387. [CrossRef]
47. Sebastian, C. Ecological Implications Regarding the European Bison (*Bison bonasus* L., 1758) Reintroduction in the Vânători Neamț Nature Park. Ph.D. Thesis, Transsylvania University, Brasov, Romania, 2012.
48. Ostermann, S.D.; Deforge, J.R.; Edge, W.D. Captive Breeding and Reintroduction Evaluation Criteria: A Case Study of Peninsular Bighorn Sheep. *Conserv. Biol.* **2001**, *15*, 749–760. [CrossRef]
49. Griffith, B.; Scott, J.M.; Carpenter, J.W.; Reed, C. Translocation as a Species Conservation Tool: Status and Strategy. *Science* **1989**, *245*, 477–480. [CrossRef] [PubMed]
50. McLean, I.G.; Lundie-Jenkins, G.; Jarman, P.J. Teaching an Endangered Mammal to Recognise Predators. *Biol. Conserv.* **1996**, *75*, 51–62. [CrossRef]
51. Lyles, A.M.; May, R.M. Problems in Leaving the Ark. *Nature* **1987**, *326*, 245–246. [CrossRef]