The Reintroduction of the European Bison (*Bison bonasus*) into the South-Western Carpathians (Țarcu Mountains)

BEST REWILDING PRACTICE GUIDELINES











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## **Executive summary**

The European bison, the largest terrestrial mammal in Europe (*Bison bonasus*) became extinct in the wild in the early 20<sup>th</sup> century and was brought back from the brink through long term conservation efforts. Despite successful reintroductions at the European level the bison population still only occurs in small, isolated herds scattered across the Central and Eastern parts of Europe.

Romania is one of the European countries considered to have available habitat of significant quantity and quality for bison reintroduction with 50% of The Carpathian Mountain range which is considered a stronghold of European bison and one of the only places where a viable metapopulation might exist, especially with recent trends of declining human pressure and reforestation of abandoned farmland. Also, it possesses a huge network of protected areas, including national parks, and Natura 2000 sites (23%) with large wild areas with little human activity, the largest area of old-growth forest from Europe and still wild rivers.

In Romania, the conservation initiative of this species started in 2012 with a first release into the wild in the Vânători Neamț Natural Park, in the Eastern Carpathians. Then two years later these efforts have been extended to the Țarcu Mountains, South-Western Carpathians where at first 17 animals were translocated as a part of a large reintroduction program initiated by Rewilding Europe and WWF Romania. At the end of 2019, a new reintroduction program has started in the Fagăraș Mountains by Foundation Conservation Carpathia. Nowadays, around 170 European bison roam freely in the Romanian Carpathians, with the largest population in Țarcu Mountains but none of these are yet considered to be a viable population, thus the conservation efforts must continue in the following years.

Establishing the first European Bison metapopulation in the Romanian Carpathians is a milestone in the Rewilding Europe and WWF Romania plan to conserve this species in the wild and demonstrate the ecological role of these large herbivores in human-dominated landscapes. To best serve the launch of the rewilding bison initiative the LIFE RE-Bison project began in 2016 with the assistance of national and international institutions, collaboration with the local communities, and co-funded by the EU through its LIFE Programme.



## 1. Introduction

#### 1.1. Purpose of these guidelines

These best practice guidelines were primarily designed to give practical guidance for reintroduction processes of the European Bison (*Bison bonasus*). Our recommendations are based among others on lessons learned during the almost 6 years of implementation of the LIFE RE-Bison project in the Southern Carpathians, Romania, as well as on the best available knowledge on bison biology, ethology and genetics, human-bison conflict management, legal and administrative aspects of reintroductions.

Bison rewilding initiatives are novel and experiences in this domain are still limited across Europe. In addition, the exchange of information between rewilding teams nationally as well as on a Pan-European level seems to be still hindered due to the lack of an internationally coordinated hands-on approach. It is hoped the lessons learned over the last 6 years and now consolidated in these best practice guidelines will help other Bison rewilding initiatives successfully reintroduce these magnificent animals into rewilded landscapes.



#### 1.2. Brief description of the LIFE RE-Bison project

The overall aim of the LIFE RE-Bison project was to start the rewilding process of the Țarcu and Poiana Rusca Mountains in southwest Romania by starting to enable the successful recovery of the European bison (*Bison bonasus*), a keystone species of this landscape. Both areas are part of the Southwest Carpathians, a region of great rewilding potential and one of the most favourable to initiate a large-scale European bison reintroduction. Its old growth forest and alpine meadows form a mosaic landscape that has very little fragmentation, medium to low human presence and vast no human intervention zones<sup>1</sup>. It is ideal for the establishment of a bison metapopulation with various subpopulations, interconnected through ecological corridors.

The LIFE RE-Bison initiative (2016–2021) is the first phase of a long-term effort by Rewilding Europe and WWF Romania, to rewild the Southern Carpathians. The objectives of this phase were:

- To establish one free-living, genetically and demographically viable population of the European bison with around 185 animals in the Țarcu and Poiana Ruscă Mountains, Romania.
- To create new economic activities in the area using the bison as the main focus.
- To reduce conflicts between free-living bison and rural economic activities.
- To stimulate a positive attitude amongst the local stakeholders in favour of the European bison.
- To increase the interest amongst the public in the conservation of the European bison.

<sup>1</sup> Strictly protected areas of national and natural parks

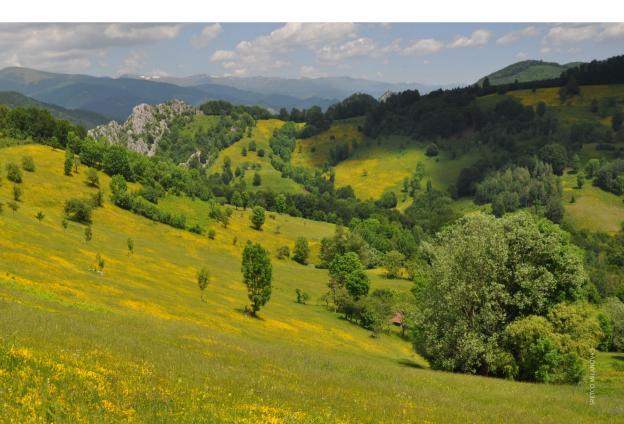
## 1.3. Rewilding Europe and WWF Romania contribution to the comeback of the European Bison

The Southern Carpathians Rewilding Area is part of a wider initiative of Rewilding Europe, which aims to create large, rewilded landscapes in at least 10 different regions across Europe. These 10 areas will demonstrate how Rewilding Europe's vision can be put into practice on a far larger scale across the continent. The same area is part of the Southwestern Carpathians Wilderness Network initiative of WWF Romania, which aims to ensure the maintenance of natural processes on a larger scale, and to create at the same time opportunities and benefits for the communities living in the proximity of these areas.

The work conducted during the LIFE RE-Bison project, the lessons learned during its course of action, and the resulting practice guidelines are therefore essential components of these plans.

The European bison reintroduction started in 2014 based on Rewilding Europe's Bison Rewilding 10-year Plan (2014–2024). The vision of the plan is a viable population of freeranging herds of bison established and restored across Europe and integrated into Europe's landscape alongside human populations, thereby improving the long-term conservation status of this species.

The program is implemented by Rewilding Europe in partnership with WWF Romania.



### 1.4. Challenges encountered in the LIFE RE-Bison project

The LIFE RE-Bison project is a pilot project due to its unique approach concerning selection of the animals (based on specific criteria), adapting the releasing method based on animal behaviour, applying innovative techniques for conflict management and non-feeding type of management. While many risks were identified prior to its implementation and successfully planned for and averted, due to the pilot nature of the project, unexpected realities arose in the course of implementation that resulted in substantial adjustments to the initial plans. This section presents a summary of those challenges and forms the basis of many of the lessons learned in the past 6 years.

The LIFE RE-Bison project foresaw the release of 100 bison in two areas: Țarcu Mountains (Armeniș site) and Poiana Rusca Mountains (Poieni site). The releases in the Armeniș site went as planned with adaptation actions derived from the issues encountered at the Poieni site listed below:

- **Unclear regulations regarding bison reintroduction.** The unclear regulation regarding species reintroduction resulted in the permits required for construction of the prerelease infrastructure taking 21 months to be issued. This postponement created a cascading delaying effect in the transportation and release of the bison.
- Artificial feeding of hunting areas. The Poieni site is located in an active hunting area where supplementary feeding during the year is a common management practice. There are a total of 28 artificial feeding stations across this area of 11 000 ha. Of these 28 stations, 9 are very close to the pre-release facilities, while others were located close to human settlements (i.e., 200 metres). The amount of food put out for the game species was significant, 12 tonnes during a six-month period (personal communication of the hunting manager overlapping with the Poieni site, 12 March 2019, at a meeting requested by the Forest Guard).

The location of the artificial feeding stations and the easy access to food, especially during the autumn, led to the bison coming into close proximity with people, either at the feeding stations or in nearby villages. They entered gardens, agricultural fields and enclosures; feeding on hay, corn and vegetables along the way leading to several conflicts with locals.

**Unclear regulations regarding the release of bison in an area overlapping a hunting unit/association.** The legislation regarding species reintroduction is vague with regard to the legal requirements of the hunting associations. As part of the permitting procedure, hunting associations were informed about the release of bison (Armeniş – 2016 and Poieni – 2018). However, a clear procedure to include the bison in the management plans of hunting units is not legislated, and therefore this was recognized as a risk in project design because it was not possible to address this aspect formally during its implementation.



This is a challenge that is not unique to this particular reintroduction exercise but to all those across Romania that overlap with hunting associations. Indeed, none of the existing bison populations across Romania are officially included into the management of their local hunting associations. The legislation also does not give any other options to safeguard the management of this species.

In this case, this legislative lack of clarity led to the management of the species being too dependent on partnership agreements that rely significantly on an alignment of institutional goals, instead of on agreed species management plans. If there had been the possibility to include bison in the hunting area management plan, some of the following challenges could have been averted:

Change of engagement regarding bison in the hunting area – as a consequence of unclear regulations. During the course of the project, there was a change in the hunting area leadership position and the presence of bison was no longer welcomed in the area.
Some of the issues raised related to the presence of bison rangers in the field as well as the fact that bison accessed the artificial feeding stations and fed alongside game species. Solutions were sought through extensive consultations and discussions with stakeholders in order to resolve the challenges of having the bison in the area, and make these stations inaccessible for the animals.

However, despite such efforts the unclear legislation concerning the management of the species in the wild and the lack of procedures for legally admitting the species into the management of the hunting unit resulted in the Hunedoara County Environmental Protection Agency (HD EPA) cancelling the environmental permit for the reintroduction of European bison in the hunting area with the following explanation: *"failure to clarify which institution is responsible for takeover of the species into the management"*. According to the existing legislation it is the role of the HD EPA, under Ministry of Environment guidance to clarify such aspects, and therefore, this feedback led to the matter not getting resolved. Cancelling the environmental permit led to several amendments of the LIFE RE-Bison project, such as (1) closing the Poieni site (2) managing the remaining bison population in Poieni and making sure that the animals were used for conservation purpose (3) focusing on Armeniş site and especially on the partnerships with hunting and forest units and management of the species into the wild.

• **Poieni pre-release infrastructure installed too close to settlements**. Due to the limited road access to this remote area, the options of where to build a pre-release site were limited from the start and therefore, a non-ideal location had to be selected. This resulted in the animals being released relatively close to settlement areas. Efforts were made to lead the animals away from settlements, those were not entirely successful. While the animals' natural behaviour in new areas was expected and planned for, the habitat suitability of the Poieni reintroduction site was overestimated, whereas the influence of certain hunting management practices was underestimated.

Under normal circumstances, when released into the wild, bison roam large areas to explore and understand the territory before settling into a more common pattern. In the winter, bison naturally migrate downhill where more food is available. They are attracted to shallow sided valleys that contain reasonable areas of open grassland and pasture but retain enough forest for shelter (LIFE RE-Bison, Armeniş site). This preference caused negative impacts in the Poieni reintroduction site because the valley areas ranging between the pre-release infrastructure and the human settlements are too steep and without enough open grassland and pasture.



# 2. Conservation efforts and threats concerning European bison

The European bison is the largest terrestrial herbivore in Europe, an ecosystem engineer that contributes towards maintaining a mosaic structure in the ecosystem by suppressing the overgrowth in forest openings and meadows with woody vegetation. A mosaic structure is analogous to diversity as it creates diverse ecological niches for other species to exist in, making the E. Bison an 'umbrella' species. A viable population of bison is also an effective tool for large-scale nature conservation.

Historically, E. Bison were widespread, inhabiting vast areas of the European continent, but after centuries of persecution and land use changes, the number of E. Bison was driven down to a point that by the 16<sup>th</sup> century, they only persisted in the wild through royal protection. The Lowland Bison and the Caucasian Bison were declared extinct in the wild by 1919 and 1927, respectively (Pucek et al. 2004).

The E. Bison has been making a remarkable comeback to Europe's landscapes. Their return, even if only to a minor part of their former European range, can be seen as a milestone in conservation. As a result of long-term conservation management, collaboration with local communities and international support, the E. Bison is no longer classified as 'vulnerable' according to the IUCN Red List Assessment, and it has recently moved up to the conservation status of 'near threatened' (Plumb et al. 2020).

At present, the species occurs in Belarus, Bulgaria, Germany, Latvia, Lithuania, Poland, Romania, Russian Federation, Slovakia and Ukraine (Plumb et al. 2020) with the largest wild population in the Bialowieza Primeval Forest between Poland and Belarus (Jaroszewicz et al. 2009).

The Carpathian Mountains are considered the stronghold of the E. Bison. In Romania, in the last decade the species was reintroduced in three different areas: Vânători Neamţ Natural Park, Făgăraş Mountains and Țarcu Mountains. The largest population of over 100 individuals now roams the Țarcu Mountains as a result of the reintroduction and management efforts of WWF Romania and Rewilding Europe.

Even though the European bison was declared in 2020 as a Near Threatened species by the IUCN, we consider that at the national level it is **'critically endangered'**, as the existing populations in Romania are below Minimum Viable Population<sup>2</sup> (MVP) and highly fragmented with hindered possibility to connect in the near future.

<sup>2</sup> According to IUCN, Red List (2021) the Minimum Viable Population (MVP) in a E. bison population is 150 mature individuals



Despite the recent come-back of the E. Bison, the need for protective management is far from over. The species continues to face serious threats against its survival and dispersal throughout the European continent:

- **Fragmented populations.** Currently, most free-living sub-populations exist in small numbers and are functionally isolated from the nearest neighbour sub-population of bison.
- **Insufficient habitat.** Recent scientific evidence has recharacterized the E. Bison as a refugee species, which has, through generations of natural selection pressures, adapted itself to exist in and use open and mixed habitats (Bocherens et al. 2015, Hofman-Kamińska et al. 2019). The challenge is that when an open-habitat species is confined to a forest habitat, it can intensify the need for intensive management, supplementary feeding, and conflict management when the animal attempts to move out of the forest to access human open-habitats that tend to be human dominated (Samojlik et al. 2019). Suitable habitat for the E. Bison generally coincides with regions supporting high human populations (Vlasakker 2014). Recent reintroductions in Romania and Bulgaria are focused in more suitable remote areas where open and mixed habitats are increasingly available for wildlife. This habitat is unlocked due to large-scale land abandonment in rural areas, which results in availability of habitat that was previously used as cattle pasture and for crop production (Castillo et al. 2021).

- **Diseases** such as blue tongue virus, balanoposthitis, bovine tuberculosis and other respiratory illnesses caused by viruses generally plague the E. Bison (Pucek et al. 2004; Larska and Krzysiak 2019), while parasitic infestation is also a growing problem. Supplementary feeding at fixed locations encourages unnatural aggregation and subsequent defecation at these aggregations which exacerbates the transmission of diseases (Pyziel et al. 2011; Kołodziej-Sobocińska et al. 2016). The limited genetic variability, lack of natural selection and subsequent low numbers have likely contributed towards lowering the species' resistance to diseases (Pucek et al. 2004).
- Other threats faced by the E. Bison can be attributed to its **low level of acceptance** by local communities due to the animal's propensity to cause agricultural and forestry damage. This makes it all the more difficult to gain acceptance for further reintroduction projects, which are invaluable to increase their overall numbers (Vlasakker 2014).
- Furthermore, there are still **policy inconsistencies** among countries in the E. Bison's historic range that may result in habitat loss, selective culling and practices that may negatively impact the survival of the species. These inconsistencies impact current populations and also limit chances of population expansion (Plumb et al. 2020).

In addition to the aforementioned threats faced by the E. Bison, there are some national level challenges in Romania that can severely impact the survival of the species:

- Lack of legal framework for the reintroduction and management of the European bison into the wild.
- Lack of compensation measures in case of human-bison conflicts.
- Lack of enforcement for human-bison conflict management.
- Habitat degradation due to forest logging in some areas in the Carpathians region.
- **Illegal hunting/Poaching** very poorly regulated in Romania and it can present a serious threat in the future.
- **Artificial intensive feeding** of the game species practiced on a large scale and already affecting ecological processes at a serious level.



# 3. Steps prior to the reintroduction activities

#### 3.1. Designing a species reintroduction initiative

Reintroduction with the aim to re-establish populations of threatened herbivores is an important global conservation effort. Designing and implementing a reintroduction initiative requires consideration of a range of aspects as:

- biological e.g., populations dynamics and genetics,
- ecological e.g., suitable habitat, interactions with other species,
- socio-economic e.g., attitude and values of local communities and key stakeholders, potential conflicts with people and land use,
- and financial e.g., costs of reintroduction efforts and monitoring thereafter/ costeffectiveness of establishing bison population.

Quite frequently, reintroduced European bison populations do not behave as envisioned. Release sites that were deemed suitable prior to release can become quickly abandoned for several reasons e.g., the reintroduced individuals could not adapt to the wild, the range expansion of the reintroduced population occurred towards different directions than expected, or the expansion rate was lower than prior expectations (LIFE RE-Bison project, Poieni site, 2018–2019; Gardner and Gustafson, 2004; Hirzel et al., 2004; de Barba et al, 2003; Hume et al., 2013; Müller et al., 2014). This can lead to the failure of reintroduction initiatives, even though apparently suitable habitat was assessed to be available.

The crucial conditions/aspects for a successful reintroduction are, however:

- Identification of suitable habitat within a species' 'former range' (Armeniş site, LIFE RE-Bison; IUCN/SCC, 2013; Seddon et al., 2007) based on statistical models.
- Low human presence (e.g., absence of roads, low traffic, few or no human settlements, absence of winter infrastructure, preferably no hunting and no harvesting zones) in the selected reintroduction areas plays an important role.
- Understand the factors affecting the dispersal of reintroduced European bison herds.
- Identify potential barriers to movement and thus provide starting points for conservation agencies to account for connectivity.

To be successful, reintroductions should be based on thorough feasibility analysis covering biological, ecological, and socio-economic factors prior to any funding request. The feasibility study should follow international standards established by IUCN Guidelines for Reintroduction and other Conservation Translocations (IUCN/SSC (2013).



The selection of reintroduction sites should take into account the functional connectivity of the whole habitat network in order to maximize dispersal opportunities after the animals are released. Fine scale habitat suitability modelling coupled with least-cost analyses, circuit models, and centrality analysis are effective tools towards such a goal.

### 3.2. Strategic partnerships and stakeholders' involvement

Strong partnerships and cooperation are key to successful species reintroduction programs, which are complex by nature and require efforts in the long-term. Each partnership/key stakeholder plays a crucial role in the species reintroduction process.

Raising awareness and getting support of the key stakeholders prior to the implementation of the project accounts for half of the work for successful species reintroduction/outcomes. In this way, the key stakeholders and local communities are involved from the early stages of designing the program and are aware of and in the best case already prepared for the changes and challenges which are to come.

During the implementation of the LIFE RE-Bison project, an international network of key stakeholders was created and long-term partnerships were built, which will last beyond the implementation of the project. The role and involvement of partners/key stakeholders prior to, during and after the implementation of bison reintroduction project is specified in Table 1.

		Role of the key stakeholder / partner			
Partnership	Scale of action	Prior to implementation	During implementation	Afterwards	
Ministry of Environment	National	National • Provide official support for the reintroduction programme	Setting the legal framework according to the needs of a successful species reintroduction	<ul> <li>Improvement of the legal framework</li> <li>Support the management decision</li> </ul>	
			Support the management decisions	<ul> <li>Set up the compensation measures for damages</li> </ul>	
			<ul> <li>Support on conflict management (derogation)</li> </ul>		
			Include the species in SDF of Natura 2000 site (if this is the case)		
National Agency for Protected Areas	National	<ul> <li>Support the reintroduction of the species in the Natura 2000 sites</li> </ul>	Release of the Agreement for each reintroduced group/or animal in the wilderness	<ul> <li>Ensure species is well managed</li> </ul>	
Environmental Protection Agency	County	Clarify the legal procedure for species reintroduction in the wilderness / protected areas	Release of the     Environmental Permit		
Sanitary, Veterinary and Food Safety Authority	County		<ul> <li>Release of the Veterinarian Authorization for the acclimatization facilities</li> <li>Necessary veterinarian analyses for TRACES</li> <li>Approve TRACES</li> <li>Intervene in case of diseases outbreak</li> </ul>	<ul> <li>Intervene in case of diseases outbreak</li> <li>Necropsy of dead animals and establishment of cause of death</li> </ul>	
			<ul> <li>Necropsy in case of dead animal and establishment of cause of death</li> </ul>		
Environmental Guard	County		Regular field monitoring of implementation according to Environmental Permit conditions	Regular field monitoring to verify bison management, complying with protected species status	
Forest Guard	County		<ul> <li>Hunting management decision</li> </ul>	<ul> <li>Hunting management decision</li> </ul>	
			<ul> <li>Establishment of damages due to bison – human conflicts</li> </ul>	<ul> <li>Establishment of damages due to bison – human conflicts</li> </ul>	
Hunting unit	Local	<ul> <li>Agreement to support project implementation, management of the species, management</li> </ul>	<ul> <li>Involvement in field monitoring, especially interactions between game species and bison</li> <li>Involvement in management of bison-</li> </ul>	<ul> <li>Management of bison- human conflicts</li> <li>Management of species in the wilderness</li> <li>Bison monitoring</li> </ul>	
		of bison-human conflicts	human conflicts <ul> <li>Support elaboration of management plan for the species</li> </ul>		

#### Table 1. Strategic partnerships/ key stakeholders prior, during and after project implementation

		Role of the key stakeholder / partner			
Partnership	Scale of action	Prior to implementation	During implementation	Afterwards	
National Forest Ad- ministration ROMSILVA/ Forest Unit	Local	<ul> <li>Agreement for building acclimatization / rewilding facilities (if the Forest unit is the owner of the property/forest)</li> </ul>	<ul> <li>Managers of the forest</li> <li>Managers of the hunting areas and game species management</li> <li>Support with access to acclimatization /rewilding facilities during bison transport</li> <li>Involvement on bison monitoring</li> </ul>	<ul> <li>Involvement on bison monitoring, including assessing impact on the forest</li> <li>Harmonizing the harvesting activities with conservation activities/management of the protected species</li> </ul>	
Local Municipality	Local	<ul> <li>Agreement to support project implementation, management of bison-human conflicts, education, and development of nature-based enterprises</li> </ul>	<ul> <li>To support communication with locals</li> <li>To help to identify likely properties/orchards prone to being damaged.</li> <li>To support management of bison-human conflicts</li> <li>To motivate locals to develop nature-based enterprises</li> <li>Support to implement educational program</li> </ul>	<ul> <li>To support management of bison-human conflicts</li> <li>To motivate locals to develop nature-based enterprises</li> <li>Educational project development</li> </ul>	
County Councils	County			<ul> <li>Defining the regional development strategy, initiating and supporting local initiatives/projects, influencing economic development;</li> </ul>	
Landowners	Local	Landowners need to be informed about the future project	<ul> <li>To help to identify likely properties/orchards prone to being damaged.</li> <li>To support management of bison-human conflicts</li> <li>To be involved in nature- based enterprises</li> </ul>	<ul> <li>To support management of bison-human conflicts</li> <li>To be involved in nature-based enterprises</li> </ul>	
Local farmers	Local	Need to be informed about the future project	<ul> <li>Central role at community level</li> <li>Maintaining good agricultural practices</li> <li>Providers of local goods and services related to hospitality</li> </ul>	<ul> <li>Central role at community level</li> <li>Maintaining good agricultural practices</li> <li>Providers of local goods and services related to hospitality</li> </ul>	
Shepherds	Local	<ul> <li>Shepherds needs to be informed about the future project</li> </ul>	<ul> <li>Involvement in bison monitoring e.g., interaction between bison population and livestock</li> </ul>	Involvement in bison monitoring e.g., interaction between bison population and livestock	

		Role of the key stakeholder / partner			
Partnership	Scale of action	Prior to implementation	During implementation	Afterwards	
Breeding centres /zoos /wildlife parks	Europe- an	<ul> <li>Agreement to provide proper animals for reintroduction based on selection criteria</li> <li>Agreement with large breeding centres/reserves to support the project with spaces and conditions necessary for the formation of non-habituated social groups prior to translocation to the reintroduction site</li> </ul>	<ul> <li>To provide proper animals for reintroduction based on selection criteria</li> <li>To provide support to form non-habituated social groups prior to translocation to the reintroduction site</li> <li>To make sure that all veterinarian requirements are fulfilled</li> <li>To collaborate with the team to improve immobilization and loading processes</li> </ul>	<ul> <li>To share the experience with other breeding centres to improve healthcare of the species</li> <li>To motivate breeding centres, zoos, animal reserves, wildlife parks to support /or become partners in conservation projects</li> </ul>	
EBCC (European Bison Conservation Centre)	European	Agreement to support project development and implementation	<ul> <li>To provide information about bison genetics (Origin certificate)</li> </ul>		
EBPB (European Bison Pedigree Book)	European		<ul> <li>To provide information about bison genetics (Origin certificate)</li> <li>To keep up the evidence of the free-living new bison population</li> </ul>	<ul> <li>To keep up the evidence of the free-living new bison population</li> </ul>	
Universities	Inter- national	Availability to be involved in research	<ul> <li>To study, monitor and support scientific publications regarding: population dynamics, habitat use, home range progress, parasitological and DNA monitoring, spatio- temporal behaviour etc.</li> <li>Education purpose</li> </ul>	<ul> <li>To study, monitor and support scientific publications regarding: population dynamics, habitat use, home range progress, parasitological and DNA monitoring, spatio- temporal behaviour etc.</li> <li>Education purpose</li> </ul>	
IUCN, BSG (Bison Specialist Group)	Inter- national	<ul> <li>Provide official support for the bison reintroduction project</li> </ul>	<ul> <li>Sharing knowledge about lessons learned in bison reintroduction projects across the world</li> </ul>		
International and national tour operators	National and interna- tional		<ul> <li>Raising awareness amongst general public</li> <li>Involved in a well- coordinated ecotourism programme</li> </ul>	<ul> <li>Raising awareness amongst general public</li> <li>Involved in a well- coordinated ecotourism programme</li> </ul>	
Local business and entrepreneurs	Local		<ul> <li>Support bison conservation by developing nature friendly businesses, support human-bison conflict management</li> </ul>	<ul> <li>Support bison conservation by developing nature friendly businesses, support human-bison conflict management</li> </ul>	
Local schools	local		• Education of the younger generation about the environment, civic duties and sustainable living	• Education of the younger generation about the environment, civic duties and sustainable living	



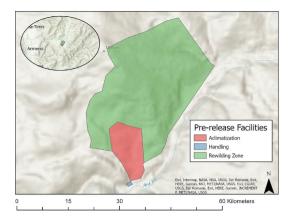
#### 3.3. Infrastructure development: pre-release enclosure

In the LIFE RE-Bison project, a 'soft-release' method was used for releasing the bison into the wild, instead of a 'hard-release' one. This method allows the animals a smooth adaptation to the new environment and the time for acquiring skills which captive animals are lacking, being crucial for survival in the wilderness. In contrast, a hard release would be releasing the animals directly into the wild. Therefore, the newly transported bison arrive in a pre-release facility specifically designed for the purpose of acclimatization, which also offers the bison recovery from the stressful transport.

The pre-release infrastructure used in the LIFE RE-Bison consists of the following zones: handling, acclimatization, and rewilding. Each zone has its specific role and technical characteristics. This setup worked well and therefore; it is hereby described as a good practice.

**Handling zone** is around 2000 m<sup>2</sup> and is easily accessible from the outside and inside of the acclimatization facility. This zone is used for handling of the animals, whenever strictly necessary. It is otherwise not accessible for the animals. The handling zone is electrically fenced and fortified by a wooden deer-fence that is around 2 metres high. It is recommended for the wooden fence to be solid (capable of handling 700 kg animals in stressed conditions) and to use an electrical wire mesh instead of only electric wires.

Acclimatization zone is around 16 hectares and accessible from the main road. We recommend at a minimum this area. The size of this area should be chosen carefully, as health monitoring should not be limited by a too large area. In some circumstances this area needs to sustain at once more animals (e.g., 28 individuals, in LIFE RE-Bison project) for a couple of months with no intensive care management (limited contact with people, limited supplementary food etc.). The function of the acclimatization zone is to "train" the animals to adapt to the



new environment and at the same time to allow the rewilding team to monitor them easily, without being in direct contact with the animals. The acclimatization zone should include a variety of habitats such as forest, meadows and shrubs and allow access to fresh water in several places. In the LIFE RE-Bison project, the acclimatization zone was fenced with electric wires and a 2-metre-high wooden deer fence.

The electric fence was marked with strips in order to be easily seen by the animals. The role of the electric fence is to keep animals inside the facility and to also teach them not to approach fences through electrical shocks (which do not harm the animal but create an uncomfortable sensation). Later, the European bison will recognize the electric fence marked with stripes on the private properties and this would provide the properties protection against possible damages.

**Rewilding zone** (semi-wild area) is around 130 ha and is electrically fenced. The role of this zone is to habituate the animals to wild conditions but still in a controlled manner. The management strategy is to gradually enlarge the habitat over a longer period of time, which helps the animals to get familiarized slowly to the novel habitat conditions. This zone is crucial for the first years of the reintroduction programme.

If the soft-release method is chosen for a reintroduction project, planning should take into consideration that pre-releasing facilities need to be **easily accessible** by car, truck, and heavy machines from the main road. In front of the main gate of the pre-releasing facilities, a large space is needed to manoeuvre trucks which transport the animals.

We recommend that the pre-releasing facilities be located as far as possible from villages, at a minimum of 15 km in order to avoid bison-human conflicts. At the same time, they should not be too far or at high altitudes, as it's preferable for the pre-releasing facilities to be located in a broadleaf forest which is an important determinant of bison distribution (habitat use analysis, LIFE RE-Bison). Further, it increases the probability that the location will be naturally included in the future home range of the species, and it will ease the release of the new groups, if a new reintroduction is needed.

### 3.4. Understanding Stakeholders and their Perceptions

Understanding people's perceptions of the reintroduction, before this takes place, as well as when it ends, is critical for a positive project outcome. Also, it highlights the key stakeholders that need to be engaged during and after the implementation of the project.

In the LIFE RE-Bison project stakeholders' perceptions were evaluated at the two target locations, Armeniş and Poieni.

The analysis of stakeholder perceptions suggests that the local communities should be informed frequently about the gradual hands-off model of rewilding by organizing more face-to-face information and consultation meetings where human-wildlife coexistence management, bison behaviour and community development are better explained. Moreover, involving the community in activities and consulting them often increases transparency, trust and the level of support for the return of bison to the landscape.

The analysis of stakeholders' perceptions is particularly valuable and therefore recommended to be completed before the start of a reintroduction project.



# 4. Selection of individual bison for reintroduction

The selection of bison for reintroduction is a critical factor for success, considering its history and the high level of inbreeding the species has experienced. During the implementation of the LIFE RE-Bison project, we learned that specific criteria are important to take into account when selecting the animals. In almost all situations, not all criteria can be met and it's difficult to make the decisions on what is more or less important.

### 4.1. The degree of inbreeding and genetic diversity

One of the main criteria taken into consideration in the selection process of individual bison for reintroduction, is the genetic diversity and degree of inbreeding in each individual.

Genetic diversity within and among European bison lines is considerably low, due to a historical population bottleneck of 28 potential founders, of which 11 were lost. The remaining 17 were represented through 12 genotypes which are called the founder animals3. Eleven of the 12 founder animals belonged to *B. b. bonasus* subspecies and one bull to *B. b. caucasicus*. So, the actual bison population is divided into two genetic lines: Lowland (LB), and Lowland-Caucasian (LC).

Starting in 1947 captive living bison have been registered continuously in the European Bison Pedigree Book (EBPB). The EBPB also monitors bison numbers in free-ranging herds. The pedigree data enables the procurement of parameters (e.g., inbreeding coefficient), which explain the genetic structure of populations, **so it's recommended to use this data when a bison population is established, if DNA analysis is unavailable or difficult to achieve.** 

During the LIFE RE-Bison project a total number of 91 animals were translocated in the project area (Armeniş and Poieni). All animals have been selected based on the Pedigree Book from different breeding centres across Europe (EU). During the selection process, we had to reject several animals because:

- some of the animals didn't have a clear pedigree (unknown father), or
- were too related and presented a high level of inbreeding (father x daughter or brother x daughter)
- also, for a few animals it wasn't clear to which genotype line they belonged to, if LC or LB line

<sup>3</sup> According to Olech, W., 2009

When the origin of the animals is arguable or the level of inbreeding is too high it is recommended to not select those animals for reintroduction, in order to avoid future negative consequences such as lowered fecundity, growth, breeding success and greater susceptibility to disease.

When a new bison population is established, it is advised to include as many as possible of the founder's genes, using captive animals for which the pedigree data are known. Once the founder population is settled up, special attention should focus on the whole gene pool and genetic variability in the next years, including the part of the genome underrepresented in the population. And in the case of the LC population, especially on the contribution of the five founders (100, 35, 46, 95, 96). DNA monitoring of the free-ranging population is highly recommended for management purposes.

#### 4.2. Availability of the Lowland-Caucasian genetic line animals

The recommendation of the European Bison Specialist Group (IUCN SSC) is to use the Lowland Caucasian (LC) genetic line for the reintroduction of European bison in mountain areas. However, this puts significant constraints on reintroduction efforts in mountain habitats because LC animals constitute less than 50% of the world's E. bison population and of those, less than 25% are located within the EU countries.

The LC line animals can be found in several breeding centres, with semi-free and free populations across the world, but we have learned that not all of them are easily available for a reintroduction program because of factors such as:

- Complicated bureaucratic procedures to transport animals from breeding centres outside the European Union
- Small breeding centres, with just a few animals, which are not suitable for reintroduction because of strong habituation to humans
- In some cases, the proposed animals that are available present high levels of inbreeding
- Zoological gardens that keep animals of only one sex for the purpose of demonstration and less so for the propagation of a threatened species
- Breeding centres with inappropriate healthcare systems
- Individuals coming from a free-living population are difficult to capture and may also entail a high risk of disease transmission such as Tuberculosis (TBC) or Brucellosis

During the LIFE RE-Bison project, we have been in contact with many breeding centres or zoos, but only around 35% were considered suitable sources of animals due to adequate healthcare standards and very clear evidence of the pedigree.

The LC animals from a few semi-free-living and free-living populations can be considered for reintroduction, but due to an unknown pedigree and risks of translocating highly inbred animals, it is not recommended unless DNA analysis is performed beforehand.

#### 4.3. Sex-ratio of reintroduced groups

The male to female sex ratio of the founder group depends mostly on the availability of animals, but it shouldn't exceed 50% in favour of males. A ratio in favour of more females is preferred as it results in a greater rate of population increase (Vlasakker, J. van de, 2014).

When a large bison reintroduction project is implemented, we have learned that each newly released group and its gender ratio should be considered based on analysis which include:

- Gender ratio of previously released groups
- Mortality of the females and males in the previously released groups, and:
- If possible, gender of born bison into the wild in order to keep a balanced ratio of the entire population.

In the LIFE RE-Bison project, we have observed a high rate of mortality amongst the young males, especially in the first years of the project (2016–2018). After 2019, when we started translocating just pre-formed stable social groups, the rate of mortality decreased amongst both genders.

In conclusion, it is recommended that the gender ratio of the first translocated group be 1:2 or even 1:1 due to high mortality amongst males (especially young ones) in the first few years of reintroduction when the bison are adapting to their novel habitat. The gender ratio of subsequent translocated groups should depend on the sex ratio of the surviving group already released into the wild.

Year	No. of the animals released / year	Gender ratio at the moment of release into the wild
2016	29	1:1,6
2017	9	1:3,5
2018	9	1:1,25
2019	12	1:3
2020	8	1:3
2021	26	1:2,5

<sup>4</sup> The groups translocated in 2014 and 2015, were released in the wilderness at the same time with the group translocated in 2016.



### 4.4. Age structure of reintroduced groups

The age of the bison reintroduced into the wild might strongly influence their ability to adapt to the new circumstances. In the case of the LIFE RE-Bison project, while factors such as sex ratio and social structure of reintroduced groups certainly affected the survival rate, bison mortality was also strongly connected to their age.

The Best Practice Manual for Protection of European Bison (Wanda, O., & Perzanowski, K., 2004) recommended that the size of the founder group should be of 6 to 8 individuals, comprising bulls aged 3 to 4 (capable of breeding), young cows aged 2 to 4 and one older cow that could act as a leader of the group. In the Rewilding Europe Bison Rewilding Plan, it is recommended to reintroduce young animals of 2 to 4 years of age because of easier availability, greater ease in handling and managing, and their ability to adapt to the local circumstances (Vlasakker, J. van de, 2014).

During the LIFE RE-Bison programme, animals between 1 to 8 years old were translocated. Availability of the animals was a determinant factor.

We have observed a strong correlation between the rate of mortality and the age of the animals as well as the way in which they are translocated in the reintroduction area: individuals separately acquired and put together in the acclimatization zone or in preformed social groups before transportation (see more details on chapter V).

In the case of separately acquired individuals, we have observed after the release into the wild that the highest rate of mortality was amongst the males, regardless of age. In general, amongst males, the lowest rate of mortality was of individuals over 4 years and the highest of those between 1 to 2 years. However, amongst the females, the rate of mortality was not related to a specific age category.

In the case of translocation of pre-formed social groups, no casualties were registered amongst the released groups into the wild. This protocol was implemented in 2019.

Of course, further data on optimal age structure of selected animals needs to be gathered, but based on our experience, we advise in the case of separately acquired animals that the selected bulls should be of at least 2.5 years old in order to avoid a high rate of mortality. Older animals (over 4 years old) present the lowest rate of mortality, but they are inclined to create more conflicts. All of these facts were considered in the selection process. Further research should be done to correlate the rate of mortality with the age, gender and translocation mode.

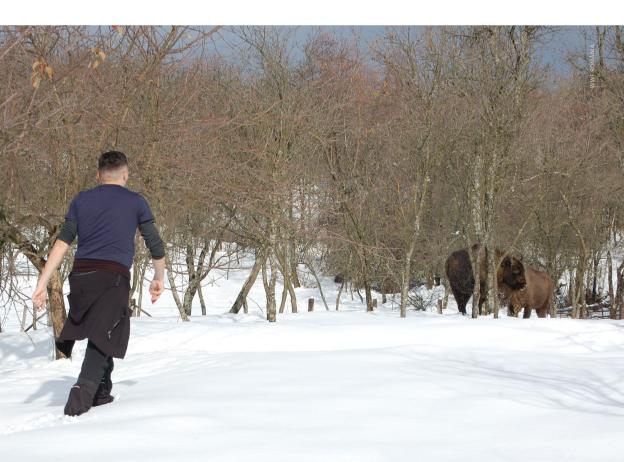
#### 4.5. Health condition

The health condition and the phenotype features of the selected individuals are of utmost importance for the success of a reintroduction effort. The selected individuals should be able to cope with the stress of the handling procedure (i.e., immobilisation), the translocation journey and their release into a new environment. Following the release, they should also be able to withstand the stress of exploring the new environment, integrating in the existing free-living herds, and interacting with other wild species, including predators and domestic ones as livestock.

If, after selection, diseases are detected, the infected animals may have to remain in quarantine in the breeding centres until they are healthy enough for translocation or, in case of no recovery, be euthanized (1 case in the LIFE RE-Bison project).

#### 4.6. Habituation to humans

During the LIFE RE-Bison project, we asserted a direct relationship between the level of habituation of the bison to people and occurrence of conflicts. The level of habituation is directly dependent on the place of origin.



In the case of captive animals, their habituation happens prior to translocation, because the animals are in constant contact with caretakers and visitors. Animals coming from zoological gardens are more habituated than animals coming from large breeding centres or wild parks, especially if these have a mixed feeding management (natural and artificial food). Habituated individuals once reintroduced into the wild are more prone to create conflicts, than individuals which had limited contact with human beings prior to release.

In the first 3 years of the LIFE RE-Bison project, almost all translocated animals originated from breeding centres or zoological gardens where the animals had been in close contact with people, including visitors. As a result, there were several conflicts. From 2019 onwards, we had mainly reintroduced pre-formed social groups which were kept away from human contact (except caretakers) as much as possible, for several months, before the translocation. This pre-translocation protocol significantly contributed towards the decrease of the conflicts after release into the wild. **For this reason, we strongly recommend** that habituation of the animals to humans before translocation into the new reintroduction site is kept at a minimum.

A fast integration of the newly released groups within the free-ranging ones may also decrease conflicts with people. Calves born into the wild are not used to human contact or artificial feeding, so the natural behaviour is to avoid human presence and this behaviour is embraced by the whole herd for the protection of offspring.

## 4.7. How big should the founding group of the European bison population be?

Over the years, there have been different perspectives on the size of the recommended founding group. In the Best Practice Manual for protection of European bison (Wanda., O & Kajetan Perzanowski, 2004?), it's recommended that the size of the founder group to be 6 to 8 individuals. On the other hand, Frankham et al. (1998), recommends a minimum of 50 animals to avoid inbreeding depression in a shorter perspective, and more than 500 animals are required to retain evolutionary potential and ensure overall resilience in genetic variability, in the longer perspective (>100 years). A third perspective is that of the Rewilding Europe Bison Rewilding Plan which recommends starting a bison reintroduction programme with an initial founder group of 10–20 animals, followed with yearly group supplementation, of a minimum of 10 animals per year, over a 10-year period (Vlasakker, J. van de, 2014).

Based on our experience, we recommend Rewilding Europe's phased and feasible approach, because it allows a better control of the genetic diversity of the population and each new translocated group, during the 10-year period, can be selected in direct connection with the composition and structure of the free-roaming herds.



## 5. Preparation of animals for reintroduction into the natural environment

as mentioned before, we used the "soft-release" method, where animals are given time to acclimatize to a novel area, in order to reduce the stress of adaptation to an unfamiliar environment, such as:

- Social stress, from being taken out of their 'safe' social structure.
- New habitat stress, especially for those coming from small enclosures.
- **Food stress**, as the diet of the bison is changing and the bacterial flora in their rumen and intestines need to adapt.
- New interspecific interactions, including predators.
- **New parasitological load:** the animals are exposed to and getting in contact with new parasites which are coming from wild fauna and local livestock.
- **Climatic stress,** as the climate may be quite different from their original location.
- Immobilisation and transport stress.

As a result, the animals often drop weight and become immunosuppressed which could lead to a high rate of mortality amongst the new reintroduced groups. For this reason, all efforts need to be made to reduce **stress factors prior to the actual translocation.** The major factors which can be reduced are those related to **social, and immobilisation stress.** 

**Immobilisation stress** can be reduced by eliminating the chemical immobilisation and using specific "capturing" facilities to take biological samples and to load the animals in the vehicle. Not all breeding centres have such "capturing facilities" due to a low budget or low numbers of kept animals. If the method of pre-formed social groups would be implemented, then this kind of "capturing" facility might be built as part of the conservation projects ensuring financial aid for construction and maintenance.

When chemical immobilisation is used, the stress can be considerably diminished through a well-organized team, by reducing the time of immobilisation and by avoiding any excitement for the animal before and after chemical restraint. Also, the type of drug used can influence the level of stress e.g., use of diprenorphine as an antidote to etorphine, it gives a slower, smoother, more gradual recovery than naltrexone, which gives a quicker, more sudden and explosive recovery and can determine unexpected behaviour such as running into fences, etc. before calming down. Social stress. In the LIFE RE-Bison project, we have translocated animals that were:

- separately acquired and put together in the acclimatization zone and:
- introduced to each other and established a pre-formed social group before transportation

In the first case we observed a high rate of mortality after the release, even among those animals that were kept in the acclimatization zone for 3 months. The reason could be that the animals are not bonding properly because of other related stress factors (e.g., unfamiliar habitat, new food, parasite load etc.) and once released into the wild the social instability led to separation of the animals from the groups and subsequent death. On the other side of the spectrum, the animals translocated in pre-formed groups with a clear social structure registered the lowest rate of mortality (2 mortalities in 4 years).

It seems that strengthening the social bond of the groups before translocation increases the rate of survival and facilitates a smooth transition to the new environment.





# 6. Preparation for relocation and transport

## 6.1. Transportation of bison

During the LIFE RE-Bison project implementation, we have learned that even with careful planning each transportation can come along with new challenges.

When a bison reintroduction project involves transportation from many countries, it is recommended to start with:

- Making a list of available transporters from several countries.
- Checking if the selected companies have the expertise to transport wildlife species, and ideally, bison.
- Verifying the capacity of the transport company, if large transportations are planned.
- Ensuring if the transporter meets all the legal requirements<sup>5</sup> for trans-boundary translocations.

<sup>5</sup> The transportation of the live animals needs to respect the EU Regulation (EU1/2005) on the protection of the animals during transport and related operations.



Once this prevenient process is established, it becomes much easier to organize yearly transports as a routine activity, especially in the case of a long-term project. Ideally, negotiations with a transport company and planning should be done at least 6 months before the date of transportation.

Technical characteristics of the transport vehicle are directly related to the specificity of the project. In our case: a big animal of at least 300 kg to 700 kg, transportation of a wild animal and of groups comprising sometimes up to 12 animals, remote location of the release area (unloading location) and difficult access.

Based on the specificity of the project we have required the following technical characteristics of the vehicle:

- Sufficient floor area and height of the vehicle appropriate to the size of each animal and the intended journey. If possible, the compartments should be adaptable to each animal size and weight. Too much space allows the animal to gain momentum, potentially injuring itself as well as being thrown against the compartment wall during sudden braking of the truck.
- The means of transport to be designed, constructed, maintained, and operated to avoid injury and ensure the safety of the animals.



- To have access to a small opening in order to replenish water and food, and for personnel to be able to clearly see the animals during transport in order to check their condition.
- A short truck with a trailer for special manoeuvring due to the limited space at the unloading location and narrow, twisty roads. Also, a high ground clearance of the vehicle is needed to easily pass the forestry road, which sometimes can be degraded by the unfavourable weather conditions.

Essential qualities and conditions recommended for animal welfare:

- Adequate qualifications of the personnel involved in transportation, which do not use violence or any method likely to cause unnecessary fear, injury or suffering of the animals.
- To be able to provide clean water for the entire journey.
- To make sure to feed the animals with the food provided by the breeder and according to the received instructions.
- To provide bedding (if not provided by the breeder), ideally straw or pellets and saw dust, which is placed in the trailer in order to provide traction, warming during cold weather, absorption of urine and faeces, and to reduce abrasions.
- To avoid and reduce ambient noise during the journey.
- Patience, as the unloading of the bison can sometimes take hours.



Challenges overcome during LIFE RE-Bison project when selecting a transport company:

- Lack of expertise with wild species transportation, especially with bison.
- Lack of adequate capacity and vehicle characteristics (e.g., separated compartments) for large transportation (over 10 animals).
- The disposition of the transport company to "not to stop during the journey", as the European bison is not used to being handled and needs immobilisation or specific facilities to be loaded and unloaded. For the wild animals, the stopover is not demanded, but not all transport companies are aware of that, and they can either reject the transportation or ask for an official declaration from the certifying veterinarian.
- At least one of the drivers should be an English speaker as the transportation of captive bison involves several countries and communication is essential for the loading and unloading process to be safe and easy for the animals.
- Availability to change the date of transport if weather conditions are not appropriate. Transportation of bison in either hot or cold extremes must not happen.

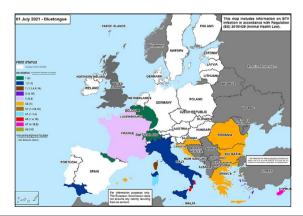
## 6.2. Animal health and veterinary requirements

Live animals' transports, including European bison fall under the EU Regulation 2016/429 on transmissible animal diseases and amendments and repealing acts in the area of animal health ('Animal Health Law'). This Regulation lays down rules for the prevention and control of animal diseases which are transmissible to animals or to humans. It is therefore necessary to work with a veterinarian, preferably one with experience in wildlife veterinarian medicine. The main role of the veterinarian is to work with the Veterinarian Authority and the team to make sure that all veterinarian requirements are fulfilled, amongst other tasks e.g., health and parasitological load monitoring etc.

During implementation of the LIFE RE-Bison project, the mandatory veterinarian tests according to the legislation were for tuberculosis (TBC), brucellosis and leucosis diseases. All individuals of European bison translocated to the Armeniş site were tested for these diseases before transportation.

Beside the requested mandatory tests, a few months before the translocation of the animals, it is recommended to check the EU Animal Diseases Information System (ADIS) which is designed to register and document the evolution of the situation of important infectious animal diseases as identified in the framework of the 'Animal Health Law' (AHL). ADIS lists all disease outbreaks across the EU and based on this, Member States or zones of the European Union are declared disease-free or restriction zones. Consulting the website allows to prepare in time if extra required veterinarian tests or vaccination of the animals is needed, as happened in 2019, when we have been obliged to test and vaccinate some of the selected animals against Bluetongue disease (BTV) as the individuals had come from BTV restriction zones.

Infection with bluetongue virus is a non-contagious, insect-transmitted, viral disease that affects domestic and wild ruminants. Bluetongue can cause widespread disease outbreaks and is OIE<sup>6</sup> listed. If not controlled efficiently and quickly it can decimate a vulnerable bison population in a very short time.



6 The World Organisation for Animal Health – https://www.oie.int/en/what-we-do/animal-health-and-welfare/animaldiseases/

## 6.3. Immobilization, loading and unloading of the bison

Bison reintroduction projects require immobilization of the animals for different purposes, such as fitting GPS collars, translocation to new areas, veterinarian tests, procurement of biological samples etc. During the LIFE RE-Bison project two types of immobilisations were used:

- physical, which involves the capturing of the animal in a specific facility, and
- chemical, which involves using drugs

Chemical immobilisation was mostly used, and in only one particular breeding centre was physical immobilization applied when loading the animals – Zweckverband Donaumoos. Usually, the immobilisations were done several days before the transport with the purpose to test the animals for required diseases (for TRACES) and ultimately for loading the animals in the truck for translocation.

Although bison are considered physically robust mammals, sometimes they can react negatively to chemical immobilisation. Therefore, there are some basic rules which are recommended to be followed:





- Immobilization should be performed as quickly as possible and efficiently with a short induction time.
- Only absolutely necessary medicines should be administered.
- Adequate antagonist/antidotes should be used to allow a speedy reversal and recovery and thus avoid undesirable and harmful effects of drugs.
- Animals should be observed closely for evidence of any undesirable reactions throughout all the procedures, in order to act fast and avoid negative consequences which can lead sometimes to death.
- The animal's vital signs should be monitored throughout the entire procedure.
- Bison should be placed in a safe position when immobilized and as a ruminant must never be "turned over on its back" as its rumen contents can become regurgitated in the lungs and cause serious, sometimes fatal, pneumonia. Right lateral recumbency is generally preferable.
- The eyes should be covered by fabric cloth and surrounding noise kept to a minimum.
- The journey shouldn't start before full recovery from the immobilization of all animals.

During the LIFE RE-Bison project implementation, around 75 bison were chemically immobilized before transportation to the reintroduction site. Based on the input from breeders, we observed that there is a difference in the type of drugs used for immobilization,

because of clearance differences in each country. There are different opinions on the effectiveness of drugs, so maybe a large-scale study is necessary regarding the effects of chemical immobilisation of the European bison in order to determine what kind of drugs are more efficient in relation to time recovery (to reduce the tranquilization stress), and possible negative reactions.

Loading is preferably done without any immobilisation, if possible, which is a practice adopted by some breeders. This can be achieved by constructing a special infrastructure: divisions (and hallways) in which the animals can be gradually ushered through onto the trailer.

Before loading the animals, the disposition of the bison in the truck according to their hierarchy, should be established in advance. Leading individuals must have the possibility to come out from the transporter prior to their conspecifics. In an ideal case, the dominant animal is followed by the others. A non-dominant bison might show resistance and therefore hinder a soft release of all the individuals from the truck.

The immobilisation when animals are unloaded must be avoided. This extreme step can easily be done by thorough planning in consultation with the breeders and the respective veterinarians who are acquainted with the animals. Hence, the field team should be patient at the release site since bison unloading can take up to several hours and requires calmness. In any case, the animals arrive after a long and burdensome drive of sometimes up to two days, therefore disturbance caused by public presence should be completely avoided.



# 7. Management of the European bison in pre-releasing facilities

### 7.1. Release of the bison into the wilderness

In the LIFE RE-Bison project, the animals have been released based on the 'soft-release' strategy, in the first phase, into the acclimatization zone before they were allowed to enter the rewilding zone. As a last step, the animals have been set free into the wild. The animals are kept for at least 21 days (mandatory quarantine period) and up to one month in the acclimatization zone whereas in the rewilding enclosure they spend approximately two months. This management strategy, the gradual enlargement of the habitat over a longer period of time, helps the animals to slowly familiarize themselves to the novel habitat conditions. On the one hand, the bacterial flora of the gastrointestinal tract has to adapt to natural food as a primary food source (versus easily digestible pellets used in the reservations/zoos) and on the other, the fencing offers protection against predators and gives them the feeling of comfort and safety they have been accustomed to in their former homes for years.

In this enclosure period, the animals learn how to forage naturally, they usually gain weight, and establish final group hierarchies. To make it easier for the bison to adapt, it is recommended to feed the animals in the first 4–6 weeks to ensure a smooth transition from the previous diet to a natural one. Pellets and salt licks should be offered at various sites on different days in the acclimatization zone in order to minimize their contact with humans and to gradually decrease supplementary food. Bison should not be fed in the rewilding zone anymore.

The optimum timing to release bison into the wild is much debated. It depends very much on the geographic and climatic conditions of the region and the management practices that are applied to the free-roaming groups. Since the free-roaming bison in the South-Western Carpathians are not regularly fed throughout the year (only in harsh winters), the time of release should be no later than late summer/early autumn. In this way, the animals have enough time to discover their new home ranges and to adapt to local conditions before the winter sets in. Until then they have the chance to fatten up under controlled conditions, so that they receive an optimal start for surviving in the wilderness.

During the pre-release phase, the bison needs to be monitored closely. The new group will only be released if all of the animals have adapted well to the new environment, show a strong bonding, natural behaviour and are in a good health condition. This period is additionally very suitable to verify if the GPS collars are transmitting properly. If problems with the



technical devices appear, there are good chances to find the animal in the enclosure and to remove it. This kind of operation is more difficult in the wild because primarily the animal has to be located.

The 'soft-release' method can be adapted to specific situations such as the one described below, especially if the outcome is better.

In the fourth year of the project (2019) two of the translocated groups of European bison (preformed social groups) were 'naturally released' from the enclosure by a 6-year-old bull, which broke the fence of the acclimatization zone. The most probable cause was the interest of the bull towards females. These groups stayed with the bull for a few days and after that joined the free-living herds, which happened to be near to the acclimatization zone. These groups adapted well to the novel habitat, as they had guidance from free-living herds.

Since this incident we have released the new bison groups right after the acclimatization period when free-living herds were close to the pre-release infrastructure. The bonding, behaviour and good health condition were nevertheless taken into consideration. All groups had adapted perfectly to the new environment conditions with no casualties so far. It seems that the location of the pre-release infrastructure can play a key role in the release process, if it's incorporated in the home range of the bison.

## 7.2. Health monitoring during pre-release period

During the pre-release period, health monitoring of the newly translocated animals is extremely important in order to increase the survival rate of the bison into the wild. This needs to be done constantly and under veterinary supervision. The aim of the health monitoring in the acclimatization period is to ascertain whether the animals are:

- **physically fit (body condition)**, prior to release into the wild. Due to high levels of stress during and after the transportation, extra care is often needed to help the animals adapt to the new environment, by providing supplementary food or vitamins.
- medically healthy, prior to release into the wild. Broadly speaking, the baseline knowledge of medical and husbandry information for domestic cattle applies to bison. This includes non-infections as well as infectious diseases such as; black leg, necrobacillosis, paratuberculosis, tuberculosis, brucellosis, blue tongue, malignant catarrhal fever etc. Even though all the animals were intensively screened for bovine diseases prior to transport, the 'screening' should be continued during the acclimatization period, in order to minimize the risks. Besides that, blood samples collected during immobilisation of animals before the transport should be tested for the parasites.

When an animal dies of unknown causes in a pre-release area, a thorough necropsy (postmortem protocol) must be undertaken in order to provide information about cause of death. Sometimes the standard veterinary necropsy is not enough to identify the exact cause of death and it is recommended to work with universities which have proper laboratories to do an extensive morpho-pathological examination of the carcass.

Besides health monitoring during the acclimatization period, the behaviour of the animals is followed closely, especially regarding the social structure. For this, camera traps can be used for the entire period of acclimatization.



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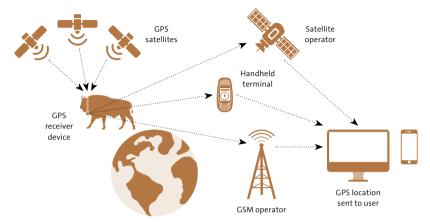
# 8. Monitoring of the new free-living European bison population

Monitoring is essential for keeping track of the bison's movement patterns, habitat utilization, population demographics, poaching incidents, disease breakouts etc. A reliable monitoring system will influence management decisions such as the need to regulate numbers of a given population, the need to increase genetic variability, developing efficient tools for conflict management or to tackle habitat fragmentation in a certain area and create ecological corridors which will help the population to spread.

The monitoring of the E. bison population in the Armeniş site was established as part of a comprehensive research programme, and based on that, the following methods are recommended to be taken into account when a reintroduction programme is established:

- (1) Direct observation is a time-consuming method, but a very important one as it gives the observer several data such as number and structure of the herds, number of new-borns, animal health information etc. Combined with innovative technologies, it can bring new information about behaviour of the animals, dynamics of the social structure, habitat use and how human activities can influence behaviour and movements of the species. In the long-term, it's recommended to develop close cooperation with universities (for student internships) and key stakeholders such as hunters and foresters for monitoring the E. bison population.
- (2) Indirect observation (e.g., faeces, tracks, browsing signs) can offer valuable additional information about:
  - bison diet, during different seasons,
  - impact on the habitat,
  - resting and bathing places,
  - mortality,
  - interaction with other species,
  - use of ecological corridors,
  - population distribution and densities.
- (3) GPS monitoring is a process which allows you to remotely observe relatively finescale movement or migratory patterns in a free-ranging wild animal using the Global Positioning System (GPS). Ultimately, GPS tracking devices are sophisticated gadgets that contribute to wildlife conservation management.

With the aid of this real-time monitoring technology, **bison distribution**, **individual home ranges and spatial-temporal movement patterns can be mapped.** Moreover, it gives information about **how the bison uses resources and landscape**. Optional environmental sensors can be added in order to gather information about **ambient temperature**, activity, mortality data etc. The mortality event message helps to detect possible injuries or a dead animal that might have fallen victim to an illegal poaching event. Another very useful option is the **Virtual Fence**, which is a user-defined, invisible fenced area (polygon feature), which can help to **prevent human-bison conflicts**.



Remote data transfers for GPS-based tracking systems use a GSM link, a satellite-based link, or a handheld terminal. (Mongabay 2015)

(4) Bison health monitoring is of high priority after the release into the wild. The results can determine or influence the management of the animals in the short and long-term. The health monitoring of the free-living population focuses on the same two aspects as during the acclimatization period: body and health (medical) condition.

The **body condition** of free-ranging bison can be difficult to follow, so a relatively simple method should be used for the assessment. In this case we recommend the Body Condition Score Scheme (BSC) which can be applied by a large category of specialist and non-specialists (e.g., rangers, veterinarians, biologists, hunters and foresters (Zielke, L., Wragge-Mönnig N. & Müller J., 2018). The BSC follows the five-point scale from 1 to 5, giving to the body the following qualifications: 1- emaciated, 2 – thin, 3 – good, 4 – fat and 5 – obese. To our knowledge this method wasn't yet applied to any free-living E. bison population.

E. Bison **health (medical) condition** should be monitored constantly, in order to discover in time any signs of disease. Key stakeholders such as hunters and foresters, should be trained to recognize the signs of main diseases. An alert system should be developed and

available for all key stakeholders in order to act as fast as possible to prevent any disease outbreak within the bison population. If any sign of disease is discovered, then under veterinary supervision, the course of actions and treatment should be decided.

(5) Parasitological monitoring. It is known that domestic ruminants have a detrimental effect on bison health and significantly influence the process of adaptation and survival. In this case, a parasitological study is necessary to follow the load of the parasites from livestock, but also other wildlife to bison, and thereafter the spread of diseases which can become a pressing concern. Based on the results, management actions can be taken to reduce the pressure of infection such as prophylactic actions on domestic ruminants as well as a scientific management of grazing.

It is also recommended that the pre-release infrastructure be carefully planned and not located near livestock breeders. This approach should give bison time to adapt to the new parasites.

- (6) DNA monitoring. In 2019, a SNP (Single Nucleotide Polymorphisms) approach for rapid and cost-effective genetic bison monitoring based on non-invasively collected samples was developed by Wehrenberg, G., Tokarska, M., Nowak, C., and Cocchiararo, B. The first practical implementation of the SNP panel was done in 2021 in the LIFE RE-Bison project. This newly developed method tackles several questions in conservation of the European bison with low error rates such as:
  - **Individualization** which allows to assign non-invasive samples to any European bison worldwide and therefore monitoring of individual migration and recognition.
  - **Parental assignment** if parental genotypes are available. This allows to assess the reproductive success of individuals and genetic exchange between herds.
  - **Sex determination,** allowing sexing of wild born without direct observation and future evaluation of sex-ratio.
  - Assessment of genetic diversity which allow relevant issues like inbreeding in reintroduced populations and changes in genetic diversity after reintroduction (genetic erosion, genetic drift., etc.) to be monitored.
  - **Breeding line discrimination** facilitating to assign an individual to one of the breeding lines of European bison, LB or LC.
  - **Cross-species detection** now is possible by detecting non-invasive samples from non-target species erroneously collected in the field.

The E. bison populations are still threatened by extremely low levels of genetic variability and high inbreeding, so **it is highly recommended to implement a DNA monitoring programme and create a DNA database for each newly free-living E. bison population** in order to monitor genetical evolution and therefore to plan the management of the population accordingly.











- (7) Photo trap camera monitoring has become a popular way to collect wildlife data and in the case of a bison reintroduction project, can be used to collect information before and after the release into the wild of the species about: behaviour, health, dynamics of the social structure, interaction with other species and information about wildlife in the reintroduction area. The data can be used to improve our understanding of the species' ecology and biology, its adaptation to the new environment, how it's changing the landscape as an umbrella species, and of course it helps to make better management decisions.
- (8) Human-bison conflict monitoring. The necessity of multidirectional monitoring of the free-range E. bison population is not just to understand their condition, distribution, home range or habitat use, but also essential to manage possible threats these animals can pose in inhabited areas. A human-bison conflict monitoring programme should include:
  - GPS tracking technology especially in the first years of the reintroduction programmes, until animals define their home range, and their behaviour is better understood. During wintertime more frequent GPS location transmission can be scheduled in order to get information on the whereabouts of the bison and alert of unexpected movements. Of course, not all animals can be fitted with GPS collars and in this case:
    - good cooperation with the state forest and hunting units and locals is recommended and a volunteer network can be set up to monitor and manage the conflicts,
    - a mobile application which includes an alert system (such as in Earth Ranger database) should be developed so the information can be transmitted in real time to the intervention team.
- (9) Wildlife monitoring. Knowledge about biodiversity in an area where bison are reintroduced is very important. As a keystone species, European bison once reintroduced would have a vital ecosystem-level function. Gathering information about biodiversity, since the beginning of the reintroduction programme is of high priority, in order to understand how the E. bison population will influence the existing fauna in the area. For this reason it is recommended to focus mainly on collecting information about key species such as large carnivores, other herbivores and some bird species which are habitat quality indicators. The monitoring can be done by using direct and indirect observations, and camera traps.



# 9. Management of the free-roaming European bison population

the management of free-living E. bison population depends on the size of the herds, genetic structure, the structure and characteristics of its home range, habitat fragmentation, carrying capacity of the area, and potential for human-bison conflicts. Aside from that the management can be highly influenced by the overlapping with protected areas and the type of these (e.g., Natura 2000 site, natural or national parks). In this matter we consider that the management system must be adaptive and indicate specific tools for achieving particular goals. Nevertheless, whatever management system is actually applied, it is also influenced by the legal situation at the national level, as well as local social constraints.

At this moment there is no official management plan for any of the existing European bison population in Romania, or a National Action Plan for Conservation of the species. Thus, the bison population from the Armeniş site is managed and monitored by the WWF Romania, one of the LIFE RE-Bison project beneficiaries. We think the conservation management of the bison should be based on the following principles:

#### (1) Maintain genetic diversity and integrity

Building genetic integrity and maintaining genetic diversity within a bison population is important for resistance to diseases, maintenance of reproductive health, long-term adaptability, and a host of other biological traits. In order to fulfil this, we agree that the management of the free-ranging population should focus on:

- allowing the natural evolution of a viable population, without any unnecessary interventions,
- maintaining and monitoring genetic diversity,
- new translocations should be planned based on DNA tests,
- new reintroduction sites should be started in areas with high potential for connection to allow genetic exchanges in the future.

#### (2) To maintain a balanced age and gender structure of the population

A natural diversity of age classes creates various forms of competition (e.g., for food resources, breeding, social hierarchy) and social interaction that favour natural selection instead of human-driven selection. Also, the sex ratio, interactions between age classes, and herd size is affecting the population's genetic health. A constant monitoring programme following the evolution of this structure should be implemented in order to establish an appropriate management to maintain a healthy herd of diverse age classes and sexes, which in theory should avoid systematic removal (harvest or culling).

#### (3) To allow the bison to play its ecological role

Traditional forms of European bison management are based on zootechnical practices, rather than ecosystem ecology. Supplementary feeding during winter, which increases parasite infestation and encourages more sedentary behaviour, is slowing down the ability of European bison to naturally adapt and fulfil their niche within the ecosystem to create positive impacts on ecosystems and biodiversity.

We consider that in sites where accessibility of ground flora in winter is severely limited, the home range of the population is small, the settlements are closed and the habitat is not fully suitable (e.g., lack of the open areas), seasonal supplemental feeding should be considered as an option. In this case management techniques that avoid seasonal mass congregations are necessary to avoid parasitic transmission and disease risk, such as: supplementary feeding conducted simultaneously in multiple locations, removal, composting or disinfection of excrements in these unnatural aggregations can be successful in containing the spread of parasites.

But in large enough areas, such as South-Western Carpathians, that have huge suitable habitat to sustain large bison populations within a continuous range, with no human settlements present, the supplemental feeding should be avoided in order to let the species play its role, to boost biological diversity and abundance. Of course, this won't exclude conflicts, but we should rather focus on enhancing co-existence by providing efficient preventive measures and a compensation system which are long-term solutions<sup>7</sup>.

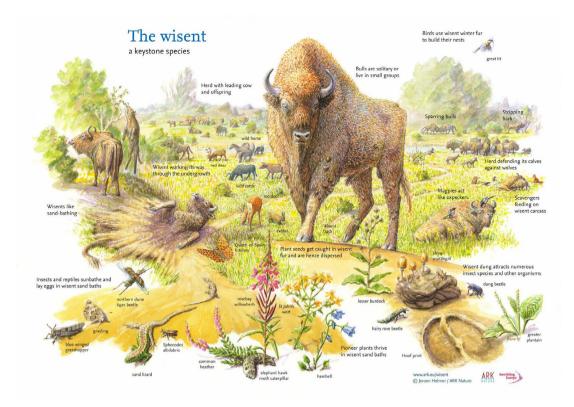
#### (4) To minimize human intervention

Ideally, bison should be allowed to survive by themselves without any interventions. This will minimize negative behavioural impact, injuries and mortality. Exceptions should be in cases of parasites management, disease outbreaks, and other unexpected or urgent management needs which are related to the health of the population.

#### (5) To manage health of the bison population

The health of the European bison population determines the viability and resilience of the species, and it is closely related to the environmental and genetic factors. The environment provides the necessary components for the proper development and functioning of an animal, but also is a source of threats which can create difficulties for the functioning of the species, populations and individuals. The limited genetic heterogeneity, low numbers and lack of natural selection might all have contributed to

<sup>7</sup> According to IUCN Red List assessment across the world just Belorussia (1 population), Ukraine and Russia are applying no-feeding management for free-roaming E. bison population. E. bison population from Tarcu Mountains (Armenis) is the only one across the European Union which is not supplementary fed.



the species' weak resistance to diseases (Pucek 2004, van de Vlasakker 2008). So, diseases remain a serious threat to the present European bison population across their range. Thus, it is vital to:

- monitor health of the population,
- strictly adhering to the rule of epidemiology investigating the carcass of every dead animal,
- extend parasitological research to the livestock in the area, as a preventive measure of diseases spread or outbreak,
- gain a better understanding of how the environment and the presence of infectious agents can influence the evolution of the E. bison population and how negative consequences can be prevented and efficient prevention and protection measures can be implemented.

#### (6) Restore and maintain biodiversity and ecosystem functioning

Bison are considered ecosystem engineers, contributing to the maintenance of biodiversity and ecosystem functioning. So, our management aims are not just about a healthy population, but also a healthy ecosystem; such as maintaining habitat structural diversity, enhancing natural patterns and processes which is balancing natural environmental forces such as fire, flooding, native seed dispersal, predators, parasites and ecological succession and sustainable human activities.



# 10. Management of bison-human coexistence

### 10.1. Bison-human competition for resources

"Local communities are key to the survival of the European bison"

The return of Europe's largest land mammal into human-dominated landscapes is inevitably linked to potential conflicts which are one of the main threats to the survival of this species and are also a significant problem to local human populations. The conflicts result from both humans and bison sharing the same landscape and aiming for the same resources such as forest, grasslands, meadows, water, and a safe place to live and survive.

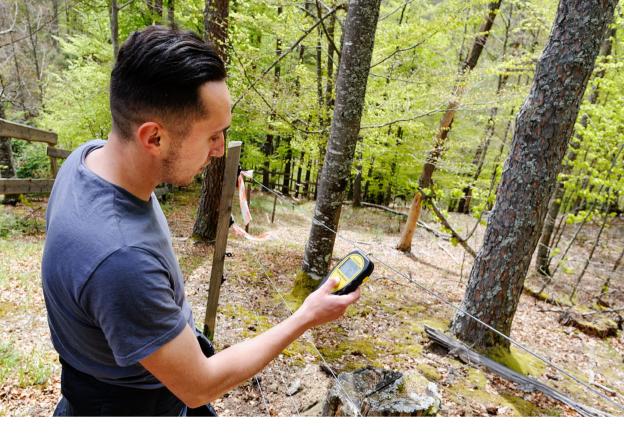
Efficient human-bison conflict management can reduce losses and risk to local communities, creating direct, positive impacts on safety, livelihoods, and the social life of communities sharing the landscape with wildlife. **The goal of HWC (including human-bison conflict)** management is to enhance the safety of people and wildlife and to create mutual benefits of coexistence, by enhancing ecosystem services.

To help those affected by bison-human conflicts achieve some level of coexistence, holistic and integrated approaches are needed. A holistic management leads to greater stakeholder involvement, better communication and conflict resolutions. The key is to enable humanbison conflict management through protocols, principles, provisions, and measures stipulated in legislation and undertaken by authorities. Lack of proper policy framework can lead to the situation such as those encountered in the LIFE RE-Bison project – Poieni case –, mentioned at the beginning of this guidance.

Unfortunately, at this moment there are no legal provisions or protocols which includes human-bison conflict management. In this context, the proposed guideline offers transferable solutions to reduce and prevent conflicts between humans and bison to ensure sustainable coexistence, until a legal framework for human-bison conflict is in place:

#### (1) Understanding the context of the conflict by researching all aspects of its profile:

- identify the root cause of the problem and plan how to eliminate or reduce that (e.g., reintroduction of habituated animals, feeding places close to villages),
- to fully understand bison-human conflicts and determine the best way to address it,
- understanding the community attitudes towards bison conflicts.



#### (2) Prevention of conflicts

- applying preventive methods to protect human livelihoods (e.g., fence, early detection tools such as GPS collars, photo-trap cameras etc.)
- ensure food supply in remote areas during extreme weather conditions to avoid foraging close to settlements,
- eliminate all artificial feeding places for game species close to villages,
- progressive awareness among locals to implement preventive measures for protecting their goods,
- the perception of wildlife can also improve locally, leading to higher tolerance towards bison.

#### (3) Response to ongoing bison-human incident

- developing a standard operating procedure adapted to the species' biology/ behaviour and to the local needs,
- involving local stakeholders (e.g., hunters, farmers) in the Intervention Units,
- reporting mechanism (e.g., system alert),
- use of innovation technology for nuisance individuals (e.g., high-tech non-lethal ammunition, EDM-product Vienna, Austria),
- professional training of the intervention units and local hunting association to improve practical and theoretical knowledge and to increase "ownership" over the bison.

#### (4) Mitigation

 Local revenue as a result of conflict prevention such as: buying hay for the bison, get agreements from landowners to let bison access old orchards (not used) etc. until compensation measures, insurance and alternative livelihoods will be in place

#### (5) Monitoring

- mapping sensitive areas and monitor spatial dynamics of bison herd's distribution towards these,
- mapping and monitoring artificial feeding sites to understand better interaction between bison and game species,
- using modern tracking technology and spatial conservation monitoring systems,
- to monitor and evaluate the deterrent efficiency of each repellent on the bison for the application in conflict management.

#### Human-bison conflict are:

- of forestry interests
- of agricultural interest (crops, orchards)
- supplementary feeding of game species which can be a driver for human habituation
- property damages, such as fence or storehouses damages
- bison presence in settlement posing risk to human health/safety

#### What the LIFE RE-Bison Project has faced in context of HWC:

- Unclear legislation to manage HWC
- Lack of state-established intervention procedure
- Weak control system related to damage assessment
- No state-aided compensation system
- No responsibility on the part of authorities

# What are the recommendations in the context of human-bison conflict in a short and long-term?

- Developing an efficient fast intervention procedure at regional and national level
- Working with Ministry of Environment for proper compensation measures (including Natura 2000) to keep human tolerance towards bison high
- Establishment of professionally operating intervention units that reacts quickly and eliminates risks that affect human and animal safety
- Cooperation with the administration of State Forest and hunting units for conflict management
- Amendment of the legislation concerning management of the species











### 10.2. Bison-human mutual benefits

"Human-bison coexistence is an inspiration for unlocking solutions and identifying opportunities"

Managing and minimizing Human-Wildlife Conflict (HWC) **offers multiple benefits** for communities, including saving lives and preventing losses from crop and livestock damage or destruction of other assets. Empowered, trained, and well-equipped communities can effectively manage HWC at the local scale. In many cases, community-led HWC management not only is better for the local community – as it offers sustainable income generation – but also has a better chance of success, as the local community members know the area, know what they need to sustain their livelihoods, and know the species' behaviour. In many places, people and wildlife have a common history, making protecting local species important to local communities. Encouraging people to reconnect with traditions, tales, and beliefs concerning their history with wildlife opens opportunities for communities to develop pride in living with a species (Gross E., Jayasinghe N., Brooks A., Polet G., Wadhwa R. and Hilderink-Koopmans F., 2021).

We consider that the most important steps towards human-bison coexistence are:

- Community engagement for professional response.
- Creating bison-safe communities.
- To build consensus around management actions.
- Reconciliation processes involved in human-bison conflict management have the potential to bring together various interest groups and transform hostility into partnerships.
- Mainstreaming human-bison conflict management into landscape-level conservation and sustainable development endeavours create benefits for both sides.

Well-planned sustainable development should consider and manage the drivers of humanbison conflict to realize several benefits such as: reducing environmental risk; improving household economies, education, and basic infrastructure; and providing conservation benefits such as increased knowledge about species and ecological processes, and increased tolerance. An environmentally and socially responsible economy can play a vital role in developing enterprises and businesses that not only are conflict-free and beneficial for wildlife and people, but also channel revenues back into coexistence systems and equitably distribute costs and benefits of living with wildlife.

#### Bison-related businesses can support conservation and local communities through:

• Increase of revenues from forestry, agriculture and free-ranging livestock production, as these commodities are particularly prone to damage by bison, as they may serve as alternative food sources or shelter.

- Certification can be used along the supply chain to regulate production, processing, and distribution of local products. Labels will affirm that the final product contributes to the coexistence of bison and people and that the development of their product has resulted in the improved survival of a threatened species' population. Connecting them to growing markets would advance conservation and development.
- Harmonizing commercial operations with bison conservation such as ecotourism. Community-based ecotourism structures can play an important role in correcting the unequal distribution of benefits and cost of living with wildlife. Sustainable ecotourism can channel income generated from people visiting wildlife-rich areas and unique species such as bison to those people who bear the costs of living with wildlife. For sustainable development programmes to succeed, those involved must have a thorough understanding of the socio-economy and culture of the target groups.
- By addressing the needs of both bison and people (integrated HWC management) the area can become an interesting field for international corporations and business. Their investment helps to ensure the survival of wild species, maintains ecosystem functions, and enhances the safety of communities that share their neighbourhoods with wildlife. This can be the foundation for sustainable regional development by supporting economic growth, and education through the establishment of mutually reinforcing economic development and wildlife/biodiversity conservation.

Investing in human-bison conflict management and coexistence means not only doing good for people and wildlife but also unlocking synergies between wildlife conservation and local development.

#### What the LIFE RE-Bison Project has faced during the business identification process:

- Lack of confidence to start new businesses.
- Lack of infrastructure for commercialising local food products.
- Lack of skills and knowledge to run a business.
- Lack of skills to maintain a good standard of hospitality essential for the sustainability of ecotourism experiences.
- Lack of dedicated capacity on the local level to support improvement on all of the above.

#### What we have focused on:

- Product development (all aspects of tourism experience design and delivery).
- Human resource requirements.
- Training requirements.
- Target markets and all related marketing/promotion opportunities and activities.
- The financing requirements of the business.
- The management/governance structure of the business.
- The various ways in which the business will directly and indirectly support the bison conservation objectives.

# 11. Earth Ranger, an efficient management platform for a freeliving European bison population

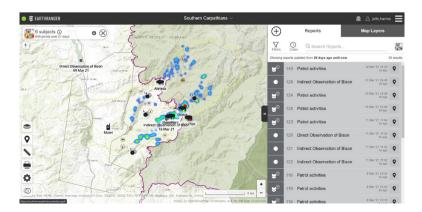
Earth Ranger is an easy-to-use online software solution developed by Vulcan Inc. to help protected area managers, ecologists, and wildlife biologists stay informed and make operational decisions for wildlife conservation (ER website). It meets conservation needs in providing solutions for real-time monitoring and storing incident reports of your project. In a broader sense:

- it provides a force multiplier for security operations (Security);
- supports and monitors the health of the project's ecosystem (Ecological Management),
- promotes sustainable coexistence with wildlife (Human Wildlife Conflict).

Earth Ranger collects, integrates, and displays all historical and available remote sensing data and combines it with reports from the field to provide one unified view of monitoring, patrolling or other operations. The ER system is a fully integrated mobile, desktop and web solution and provides the ability to manage a nationwide protected area network.

ER allows analyses for animals and incidents (Heatmaps) or temporal analysis to monitor how situations have changed over time. A very useful tool is the custom alert that sends an immediate notification of high priority issues via WhatsApp, text message or email. That could be the case if an animal enters a virtually geo-fenced area which is a predetermined area of interest, e.g., of potential human-wildlife-conflict.

The system is very flexible and gives room for customized models. In the LIFE RE-Bison project ER and its applications have been used for all kinds of data entry from the field in a structure that met the special requirements of bison data collection.



# 12. Legal framework and necessary amendments

The existing national legislative framework regarding the reintroduction and management of the European bison are:

- Hunting Law (Law No 407/2006). European bison is listed in the Annex 2 of the Hunting Law as a protected species not allowed for hunting.
- Natural Protected Areas Law (OUG no 57/2007). European bison is listed in the Annex 3 and 4A. According to the OUG no 57/2007 European bison is a strictly protected species and its presence in an area leads to Natura 2000 site designation.
- Minister Order No 979/2009 on the introduction of allochthonous species, species interventions on invasive species as well as the reintroduction of indigenous species contained in Annexes No 4A and 4B to the Government Emergency Ordinance No 57/2007.

## 12.1. Challenges and obstacles

The challenges and obstacles encountered during the implementation of the Life project revealed significant gaps in the legislation regarding species introduction and their management. There are inconsistencies regarding:

- the procedure to be applied for species reintroduction
- split responsibilities regarding biodiversity conservation and game/hunting management among two different ministries (Ministry of Environment and Ministry of Forest and Water)
- the integration of conservation measures in the case of a spatial overlap of protected areas and hunting units, especially if both lack management plans
- the roles and responsibilities of the managers of hunting units
- the compensatory mechanisms for conflict mitigation
- the overall responsibility of the authorities at national level

For the reintroduction of bison in the Armeniş and Poieni sites, an Environmental Permit/ Authorization was issued according to the existing legal framework, based on the directives of the the Minister Order No. 979/2009. The permit does not include clear reference to the responsible institutions for managing the species after the release in the wilderness, assuming that they become part of the national natural capital. Integrated management of game species in areas where Natura 2000 sites overlap with hunting units should be implemented, at least through simple procedures. Especially for Natura 2000 sites without a management plan, the responsible authority (National Agency for Protected Areas) should ensure that other users of the area are aware of conservation actions. Intensive artificial feeding and inappropriate management of the feeding places in the hunting areas have a negative impact on the behaviour of the species (reintroduced or existing). According to Romanian legislation for all hunting areas which overlap with a Natura 2000 site, an addendum to the hunting concession contract is necessary. The addendum would clarify the responsibilities and necessary measures to ensure favourable conservation status of protected species. To date, this was not yet implemented in Romania.

The Hunting Law (Law No 407/2006) is outdated regarding definitions and interpretation of species reintroduction, generating confusion of terms and the requirements imposed (e.g. feasibility study approved by a scientific body with expertise on game management) are simply not feasible.

Therefore, a clear procedure/regulation for species introduction (listed in Annex 1 of Habitat Directive) that takes into consideration all the above-mentioned aspects have to be jointly developed by the National Environment Authority. Considering some negative outcomes in the LIFE RE-Bison project and specifically suspending the bison reintroduction at the Poieni site, and other potential initiatives for species reintroduction, the regulation is urgently needed.

Besides, the environmental and hunting management aspects it is critical to elaborate:

- The National Conservation Strategy for the European bison
- The National Action Plan for the Conservation of European bison in Romania

In 2016, a national working group for the conservation of European bison was established by representatives of the Ministry of Environment, WWF Romania and other experts involved in bison reintroduction initiatives. The working group had the mandate to develop the National Conservation Strategy for the European bison. Unfortunately, the working group was not formalised by a Ministerial Order and in the absence of a formal framework the few informal meetings did not bring more clarity or concrete solutions. In 2019, there was a new attempt to revitalise the working group and give it a new start and a refreshed combination of experts. After several meetings with the Ministry of Environment to discuss and agree on the structure and functions of the group, still, there is no progress on this initiative. Over the last years there were frequent changes in the Ministry of Environment and in the Ministry of Water and Forest causing delays in addressing the issues related to bison reintroduction. The departments have recently become merged.

## References

- Bocherens, H., Hofman-Kamińska, E., Drucker, D. G., Schmölcke, U., & Kowalczyk, R. (2015). European bison as a refugee species? Evidence from isotopic data on Early Holocene bison and other large herbivores in northern Europe. PloS one, 10 (2), 0115090.
- Benecke, N. (2005). The Holocene distribution of European bison-the archeozoological record. Munibe Antropologia-Arkeologia, (57), 421-428.
- Castillo, C. P., Jacobs-Crisioni, C., Diogo, V., & Lavalle, C. (2021). Modelling agricultural land abandonment in a fine spatial resolution multi-level land-use model: An application for the EU. Environmental Modelling & Software, 136, 104946.
- Demiaszkiewicz, A. W., Pyziel, A. M., Filip-Hutsch, K., Januszczak, M., Olech, W. (2020). Parasitological monitoring of European bison in Bieszczady Mountains. Med. Weter., 76 (2), 111 114.
- Hartway, C., Hardy, A., Jones, L., Moynahan, B., Traylor-Holzer, K., McCann, B., & Plumb, G. (2020). Long-term viability of Department of the Interior bison under current management and potential metapopulation management strategies. Fort Collins (CO): National Park Service.
- Hofman-Kaminska E. and Kowalczyk R. (2012). Farm crops depredation by European bison (*Bison bonasus*) in the vicinity of forest habitats in North-eastern Poland. Environmental Management, 50, 530–541.
- Hofman-Kamińska, .E, Bocherens, H., Drucker, D.G., Fyfe, R.M., Gumiński, W., Makowiecki, D., Pacher, M., Piličiauskienė, G., Samojlik, T., Woodbridge, J. and Kowalczyk, R. (2019). Adapt or die – Response of large herbivores to environmental changes in Europe during the Holocene. Global Change Biology V29 (9), 2915-2930.
- Grimm, K.A., Lamont, L.A., Tranquilli, W.J., Greene, S.A., Robertson, S.A. (2015). Comparative Anesthesia and analgesia of Ruminants and Swine. Veterinary Anesthesia and Analgesia: The Fifth Edition of Lumb and Jones, Chapter 38.
- Gross E., Jayasinghe N., Brooks A., Polet G., Wandhwa R. and Hilderink-Koopmans F. (2021) A future for All: The Need for Human-Wildlife Coexistence. WWF, Gland, Switzerland, 45 89.
- Jaroszewicz, B., & Piroznikow, E. (2008). Diversity of plant species eaten and dispersed by the European bison *Bison bonasus* in Białowieża Forest. European bison conservation Newsletter, 1, 14-29.
- Jaroszewicz, B., Pirożnikow, E., & Sagehorn, R. (2009). Endozoochory by European bison (*Bison bonasus*) in Białowieża Primeval Forest across a management gradient. Forest ecology and management, 258 (1), 11-17.
- Klich, D., Olech, w., Cielniak, K. (2017). A complex project for conservation of European bison in Poland by State Forest (2017 – 2020). European Bison conervation Newsletter. Vol. 10, pp: – 11-20.
- Kołodziej-Sobocińska, M., Pyziel, A. M., Demiaszkiewicz, A. W., Borowik, T., & Kowalczyk, R. (2016). Pattern of parasite egg shedding by European bison (*Bison bonasus*) in the Białowieża Primeval Forest, Poland. Mammal Research, 61(3), 179-186.

- Kowalczyk, R., Wójcik, J.M., Taberlet, P., Kamiński, T., Miquel, C., Valenti, A., Crainec, J.M. and Coissac,
   E. (2019). Foraging plasticity allows a large herbivore to persist in a sheltering forest habitat:
   DNA metabarcoding diet analysis of the European bison. Forest Ecology and Management 449:
   DOI: 10.1016/j.foreco.2019.117474.
- Krasinska M., Krasinski Z. A., Bunevich A. (1999). Free-ranging populations of lowland European bison in the Bialowieza Forest. Parki narodowe I Rezerwaty Przyrody 18, 23-75.
- Krasinska M. and Krasinski Z. A., (2008). Der Wisent. Die Neue Brehm-Bücherei Bd. 74, Westarp Wissenschaften, Hohenwarsleben, Germany.
- Krasinska M., Krasinski Z. A., Perzanowski K., Olech W. (2014). European bison *Bison bonasus* (Linnaeus, 1758). Ecology, Evolution and Behaviour of Wild Catle: Implications for Conservations, ed. M. Melletii and J. Burton. Cambridge University Press.
- Kreeger, T. J., and Arnemo, J. M., (2018). Handbook of Wildlife Chemical Immobilization, 5th Edition
- Larska, M., & Krzysiak, M. K. (2019). Infectious disease monitoring of European bison (*Bison bonasus*). In Wildlife population monitoring. IntechOpen.
- Lammers, D. J., Ogorzalek, K., Olson, T., Flocchini, J., Forrest, S., Anderson, B., Grajal, A., Jørgensen, D., Kremer. C., LeFaive, T., Majerus, J., Montanye, D., O'Brien, D., Sarver, S., Stone, J. (2013). Bison Conservation Management: Guidelines for Herd Managers. World Wildlife Fund, Inc.
- LIFE RE-Bison. (2021, June 30). Unique European bison transport just arrived in the Southern Carpathians, Romania [Press release https://life-bison.com/news/new-bison-release-to-enhance-genetic-diversity-in-the-southern-carpathians-2/]
- Melis C., Selva N., Teurlings I., Skarpe C., Linnell J.D.C. and Andersen R. (2007). Soil and vegetation nutrient response to bison carcasses in Białowieża Primeval Forest, Poland. Ecol. Res., 22, 807-813.
- Olech, W. (2009). The changes of founder's number and their contribution to the European bison population during 80 years of species restitution. European Bison Conservation Newsletter Vol. 2. pp: 54-60
- Olech, W., Perzanowski K. (2004). Best Practice Manual for Protection of European Bison. Best for Biodiversity, CCEP, Warsaw, Poland.
- Plumb, G., Kowalczyk, R. & Hernandez-Blanco, J.A. (2020). *Bison bonasus*. The IUCN Red List of Threatened Species 2020: e.T2814A45156279. Downloaded on 27 July 2021.
- Pucek, Z. (Ed.). (2004). European bison: status survey and conservation action plan. Gland, Switzerland and Cambridge: IUCN.
- Pucek, Z., Belousova, I.P., Krasínska, M., Krasínski, Z.A. & Olech, W., (2002). European Bison Bison bonasus: Current state of the species and an action plan for its conservation. Mammal Research Institute, Polish Academy of Sciences, Białowieża, Poland
- Pyziel, A. M., Kowalczyk, R., & Demiaszkiewicz, A. W. (2011). The annual cycle of shedding Eimeria oocysts by European bison (Bison bonasus) in the Bialowieza Primeval Forest, Poland. Journal of Parasitology, 97(4), 737-739.

- Samojlik, T., Fedotova, A., Borowik, T., & Kowalczyk, R. (2019). Historical data on European bison management in Białowieża Primeval Forest can contribute to a better contemporary conservation of the species. Mammal Research, 64(4), 543-557.
- Sobczuk, M., Wanda O. (2016). Damage to the crops inflicted by European bison living in the Knyszyn Forest. European Bison Conservation Newsletter. Vol. 9, pp: 39-48.
- Sontakke, S., Dr. Umapathy G., Kumar, D., Singh D. N., (2017). A Manual on the Chemical Immobilization of Wild Animals. Published by Central Zoo Authority and the laboratory for Conservation of Endangered Species, Centre for Cellular and Molecular Biology, Hyderabad.
- Stachurski A. and Raczynski J. (2003). Bison, AFW "Mazury".
- The European Bison, Ecological value. (2015) Retrieved from https://life-bison.com/life-bison/ european-bison/
- The IUCN/SSC (2013). Guidelines for Reintroductions and Other Conservation Translocations. Version 1.0. Gland, Switzerland: IUCN Species Survival Commission,
- The IUCN Red List of Threatened Species. (2020). Supplementary information https://www.iucn. org/resources/conservation-tools/iucn-red-list-threatened-species
- Tokarska, M., Pertoldi, C., Kowalczyk, R., & Perzanowski, K. (2011). Genetic status of the European bison *Bison bonasus* after extinction in the wild and subsequent recovery. Mammal Review, 41(2), 151-162.
- Vlasakker, J. van de (2014). Rewilding Europe Bison Rewilding Plan, 2014–2024. Publication by Rewilding Europe, Nijmegen, The Netherlands.
- Zielke, L., Wragge-Mönnig N., Müller J. (2018). Development and Assessment of a Body Condition Score Scheme for European Bison (*Bison bonasus*). Animals 2018, 8, 163; doi:10.339/ani8100163.
- Wehrenberg, G., Tokarska, M., Nowak, C., and Cocchiararo, B., (2020). Bullshit makes sense now: A reduced SNP panel for non-invasive genetic assessment of a genetically impoverished species, the European bison, 4th Annual Meeting in Conservation Genetics (ConsGen20).
- Wójcik, J. M., Kawałko, A., Tokarska, M., Jaarola, M., Vallenback, P., & Pertoldi, C. (2009). Postbottleneck mtDNA diversity in a free-living population of European bison: implications for conservation. Journal of Zoology, 277(1), 81-87.
- WWF CEE. (2021, January 13). The European Bison is no longer a vulnerable species [Press release]. https://wwfcee.org/our-offices/romania/the-european-bison-is-no-longer-a-vulnerablespecies
- https://news.mongabay.com/2015/06/real-time-monitoring-how-timely-location-data-cankeep-wildlife-out-of-danger-zones/
- https://www.lotek.com/technology/satellite/











