Rewilding Europe®

Rewilding horses in Europe

Background and guidelines – a living document

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Foreword

Symbols of freedom

Wild horses speak to our imaginations. Songs are written about these symbols of freedom and enduring legends exist in many regions of our continent. Their cultural value is beyond doubt, but also their impact on the European natural landscape cannot be overestimated.

In a sense we know this animal very well, but this is when we talk about horses as livestock; forgetting that domestication covers only a small part of European horse history. Long before humans and horses became companions, wild horses were roaming the European plains in large numbers, shaping conditions for thousands of plants and animal species. In a domestic context this co-evolution of horse and other species continued in a slightly different way, but still existed.

However, for the last few decades, this herbivore-related biodiversity is at risk. With the abandonment of marginal areas by farmers, their livestock also disappears. After millions of years of natural grazing and some 10,000 years of domestic grazing we see large parts of Europe lacking this important natural process. Bringing back large herbivores in these landscapes is therefore one of the key activities of Rewilding Europe, and the wild horse is one of the key species in this context.

The European wild horse is officially extinct, but at the same time still present in many different types of (feral) horses. From Exmoor in the west to Hucul in the east, several primitive horse types still have many characteristics of the original wild horse and are suitable for rewilding and regaining their place in European ecosystems.

This document guides the reader through the rich world of European horse types, makes a first selection of horses suitable for rewilding and gives guidance on how rewilding of horses should be done, according to the latest scientific and practical information. Since this knowledge is developing rapidly, this document must first and foremost be seen as a live document and this is also how Rewilding Europe will use it.

Revealing our practical experiences with rewilding horses in different parts of Europe and at the same time using the latest scientific information, we hope to contribute to the ultimate goal: well-functioning European ecosystems with the wild horse as one of the defining species. Adding a new chapter in our special relationship with this noble animal.

Frans Schepers

Managing Director
Rewilding Europe

Wild Bosnian mountain horse in Malo Libinje, near the Paklenica National Park, Velebit mountains, Croatia

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Konik horses with bison in Kraansvlak, The Netherlands

Executive summary

Once upon a time, wild horses were present all over Eurasia. Together with other wild herbivores they had a large impact on the landscape. Improved hunting skills and an increasing human population resulted in an overexploitation of wild horses and other large herbivores. Some of them like the rhinos and elephants largely disappeared during the Pleistocene epoch, but others survived in ever-dwindling populations up to modern times.

However, the wild horse did not really disappear. Once domesticated on the central Asian steppes, tame horses spread quite quickly over Europe. Genetic evidence suggests that while domesticated herds spread, wild mares were added, causing the locally adapted horses to integrate with the domesticated ones. This inbreeding resulted contrastingly in the conservation of local variations of the European wild horse and was the origin of many locally adapted, domesticated, horse types.

The tradition of semi-feral breeding of these horse types made sure that wild survival gene variants were kept intact. Predator avoidance, free partner selection, competition between stallions, winter hardiness, rain and ice resistant coats were all preserved. These breeds may even be direct descendants of wild horses carrying few domesticated horse gene variants. Irrespective of the amount of domesticated gene variants, the absence of strong human selection and the presence of natural selection have kept them fit for rewilding. These old breeds, especially when living feral or semi-feral, are therefore an important gene pool for a new wild horse in Europe. Unfortunately, land abandonment in rural areas has caused a sharp decrease in semi-feral kept herds, urging us to advance rapidly and start rewilding horses as soon as possible. Fit for living in the wild, this new wild horse can reclaim his lost role of grazing landscape manager on Europe's vast areas of abandoned, extensive agricultural lands. Once again, wild horses will facilitate many other species' survival in this new wilderness.

Although a lot of scientific knowledge has been built up recently, there is still a lack of clarity on the genome of the European wild horse and its variation. Also, the genetic background of modern 'rewildable' horse breeds and especially their relation to the extinct European wild horse is very often heavily disputed. By unravelling one ancient horse genome, the knowledge on this subject has recently increased enormously. Nevertheless, there is still a lot to be studied and clarified, like the original DNA variation in wild horses, the variation in the stallions Y-chromosome, the original coat colour variation, etc. Broader DNA studies are highly recommended to further unravel the mysteries that surround the original European wild horse.

Fit for rewilding

Rewilding horses means using current and future scientific knowledge to select and conserve the best descendants of the original European wild horse and to re-adapt them to modern natural environments. These new wild horses are not necessarily exactly identical to the extinct European wild horse, but are very capable of surviving without help and regaining their lost role in Europe's ecosystems.

Rewilding horses also means moving from domestication towards wildness, from tame to wild, from human care to self-sustainability. When choosing horses for rewilding, it is best to use regional and well-adapted individuals that are still used to living in the wild. Often several local breeds are quite alike and share an ancient common background. Mixing these breeds is therefore no problem and helps to broaden the genetic diversity and therefore their fitness for survival. When selecting individuals from several breeds, care must be taken that all individuals do appear like the original type, thus avoiding an artificially mixed appearance.

The following set of horse breeds are considered best suitable for rewilding:

- Exmoor pony for Northwest Europe and England, with possibilities to add the Dartmoor and Welsh pony to restore genetic diversity or the Eriskay pony in harsher climates (e.g. Scotland);

- Yakoet pony for harsh climates in Northernmost Europe and Siberia;
- Konik Polski from Latvian or Dutch/Belgium free ranging herds in the lowland areas of Northern / Central Europe (Netherlands, Belgium, Northern France, Germany, Poland and the Baltics);
- Hucul in the Central and Eastern-European mountains, ranging into the Alps;
- Pottoko can be used in the mountains of South-Western Europe, such as in France, Spain and Portugal. Asturcon, Losiño, Monichino, Cabalo Galego/Faco or Garrano/Minho/Géres can be mixed to improve genetic diversity as they have equal rewildable qualities and comparable characteristics. The long-legged Retuerta should be used in more or less flat open steppe areas of Central and Southern Spain;
- Przewalski's horse for large Eastern European continental steppe area's;
- In the Balkans a number of horse types are suitable, such as the Karakachan horse, the Bosnian and Serbian mountain ponies, the Myzegea horse and the Pindos pony/Thessalier. The differences between these horse types are often minor and all horse types are adapted to mountainous terrain and often have experience with predators such as wolves or bears. For rewilding, a mixture of these breeds would be preferred to improve genetic diversity.

Locally, several other horse types are available for rewilding:

- In mountainous areas in Italy; Pentro, Esperia or even Bosnian mountain ponies can be used;
- In Sardinia and other Mediterranean islands the Giara/Achetta can be used;
- In Mediterranean deltas, the Camargue horse can be used.

As indicated before, breed standards are of no further use after rewilding and the new wild horses should not be considered as belonging to a certain breed. Unwanted colour morphs or white markings can be selected out at first, but for the most part, nature should do the selection process. Although our interpretation may turn out to be subjective, for rewilding purposes the proof is always in the practice. After rewilding, wolves, bears, harsh winters and dry summers will harden the new wild horses and, as konik did in the Oostvaardersplassen, height and other traits will slowly adapt to the new environment and standard of living. What will appear is a range of new wild horses, based on hardened old breeds, but evolved into a set of new wild horse types, all adapted to living in the wild in their own regional environment.

The process of rewilding

Rewilding takes time! It is a process, combining both (epi) genetic and cultural changes. Rewilding is a radical transition from an ethical domain of individual care to a concern for the ecological whole, where individual suffering is insignificant. How best to deal with this transition, is the responsibility of the project's wildlife manager and depends on the circumstances. In smaller areas animals are approached at the individual level, in larger areas at the species level, while in unlimited

Konik horses in Oostvaardersplassen, The Netherlands

wilderness at the ecosystem level. Rewilding is about respect for the authentic wildness of wild animals and thus respect for the potential wildness of rewilded animals. Management of a rewilded herd means consideration at a population level, thinking at herd level, acting at social sub-group level and keeping a watchful eye for the individual animal. Bearing in mind that reduced welfare for individuals will, over time and over generations, bring better survival for the species.

It is best to start rewilding with a herd of 3 socially integrated harems and one stallion group, containing 6 genetically distinct adult stallions and 12 genetically distinct adult mares and their offspring. As a herd of at least 150 genetically diverse animals is considered to be a self-sustaining population, this should be the goal of a rewilding herd. There should be enough food and water in both summer and winter and places to shelter from adverse weather conditions. This results in a minimum area requirement for the final herd ranging from at least 450 hectares in a nutrient rich delta to at least 4,500 hectares or more on poor soil. Such a large area does not need to be present at start-up, but can be gradually added to it as the herd grows in size.

While selecting individuals, care must be taken to select animals that:

- live nearest to the area,
- are well adapted to the terrain type, local climate and other circumstances,
- are used to living in the wild,
- form a social herd with all ages represented [Meissner 1997, Nieuwdorp 1998, Vermeulen 2012],
- have no white markings or unnatural colours,
- are within the height range,
- are readily available,
- do not upset the local opinion. A second option may have to be selected.

Rewilding often means translocation of horses from their current habitat to their new rewilding area. This means that horses have to get to know their new territory. Translocation is best done with existing social groups, or when only young animals are involved, with at least two individuals that already know each other. This will improve their integration in an existing herd. Also give newcomers ample opportunities to learn how to cope with the predators around; especially if they have no previous predator experience.

When starting with rewilding, make sure to have a communication plan and local action plan [IUCN/SSC 2013]. Wildlife managers of horse rewilding areas should inform themselves about all laws and rules relevant for their work. Rules and regulations can be complicated, especially in border situations. More information about releasing and managing the newly wild horses can be found in Vermeulen[2012]. Rewilding horses in rewilding areas brings the need for recognition of the wild status for the newly rewilded horses. This should include appropriate legislation and perhaps also a separate official subspecies name. Rewilding Europe is currently working on a separate status for rewilded horses in the European Union, i.e. wild versus domestic. If this project succeeds, rewilded horses will no longer have a responsible owner and become truly wild.

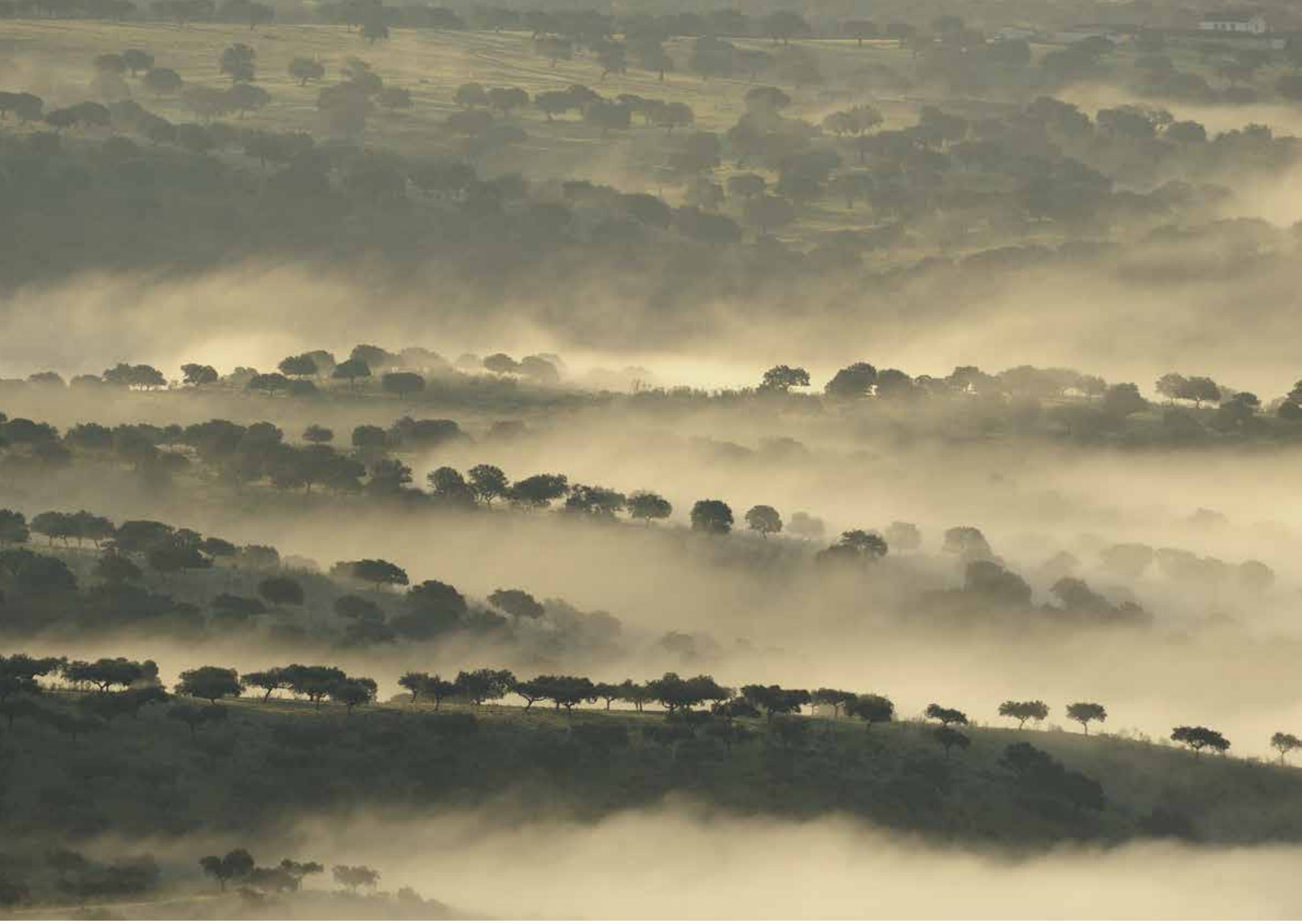
1. Rewilding horses

All across Europe, land use is changing rapidly. Where possible, good quality agricultural land is intensified, whichh boosts food production and diminishes biodiversity at the same time. Simultaneously, poor quality or less accessible land is being abandoned at a very high rate of many thousands of hectares per year. This land no longer has agricultural value. Villages are left to disintegrate or are only inhabited by a few elderly people, unable or unwilling to move. This rapid change of land use is not only a burden. Land abandonment today offers also new opportunities for bringing back the wild fauna and developing an economy based more on wild nature and wildlife, in which wild horses can be a flag species. Rewilding Europe wants to grasp these opportunities and improve the future for a European wild living horse.

By restoring natural processes, such as natural grazing by large wild herbivores, floods and natural wild fires, original European biodiversity can reappear in its full magnitude. Wild horses used to play an important role in grassland and semi-open forest ecosystems. Together with other mega-herbivores they can revitalise the natural process of grazing, browsing and debarking. At the same time natural processes such as wallowing, treading, transporting seeds are restored as well. Wild horses played an important role in the European ecosystems, a role which can be restored by rewilding modern day descendants of the European wild horses. The need for restoration is appreciated in the recent IUCN guidelines: "Where species are extinct, consequent changes in the ecosystem can indicate a need to restore the ecological function provided by the lost species; this would constitute justification for exploring an ecological replacement" [IUCN 2013]. Rewilding means moving from domestication towards wildness, from tame to wild, from human care to self-sustainability. Rewilding also implies we should release the concept of breed or race, both being human invented artefacts that have increased the differences between horse types by selecting and breeding. Once upon a time these differences were only driven by natural selection and adaptation to local circumstances. "Those that are rewilded have had their history ruptured, but their wildness has been restored" [Norton 1995].

Rewilding horses means working towards a future wild horse and should not be mistaken with rebuilding extinct wild horses from the past. Our knowledge of the ancient European wild horse is still very incomplete. New research regularly results in more information which builds on existing research. The growing knowledge about the extinct wild horse can be used to choose the right breeds and characteristics of existing horses for rewilding purposes. Future scientific knowledge can and should be used to improve the rewilding process and end product, such as adding or excluding certain gene variants from the rewilded herds. Furthermore, rewilding can start now and will result in the conservation of the identified best descendants of the original European wild horses while re-adaptating them to modern natural environments. Rewilding also fulfils human demands for recreation in natural environments and enables ground breaking scientific research on e.g. the ecological role of the newly wild horses in wilderness nature areas. Therefore, the emphasis of this document is currently on rewilding, not on back breeding.

Wild Retuerta horse in the Campanarios de Azaba Biological Reserve, Spain



Dehesa landscape in the Monfrague National Park, Spain

2. The role of wild horses in European ecosystems

2.1. Prehistoric landscapes

Some 40 million years ago horse-like animals started to appear and slowly evolved into the horses we know today. 5 million years ago Equus species roamed the plains of North America and Eurasia. During the last Ice Age, wild horses were present in Europe and co-existed with a wide range of mega fauna we now only know from Africa: elephants (mammoth), (woolly) rhino, spotted hyena and (cave) lions. Pictures of these horses and other animals are still visible in ancient cave paintings [Chauvet 1995]. At the end of the Ice Age much of the mega fauna disappeared from Europe and North America. There are strong indications that modern man and their ever-improving hunting techniques – like the use of dogs [Shipman 2014] and later bow and arrow – were the main causes. At the end of the Ice-Age temperatures increased and mega fauna members of the cold steppes moved to the north (reindeer), northeast (mammoth) or east (Przewalski's horses). Temperate flora and fauna that survived in the warm southern and eastern refugia returned to Central Europe. Among them were fallow deer, aurochs, wild ass and horses adapted to warm climates. Others, such as saiga and red and giant deer remained widespread. While many of them roamed the new grassy plains and open savannah woodlands in early-Holocene Northwest Europe, many others were not able to recolonize these new habitats. A growing human population and mounting hunting pressure kept them from recolonizing the new grasslands and open woodlands. The continuously growing human population depleted the herds of mega herbivores. The larger the animal, the more vulnerable it appeared to be [Crees 2013]. One by one, species started to disappear from large areas and retreated to less hospitable areas in order to escape hunting pressure. Without the constant high grazing pressure, forests started to dominate over grasslands [Sandom *et al.* 2014].

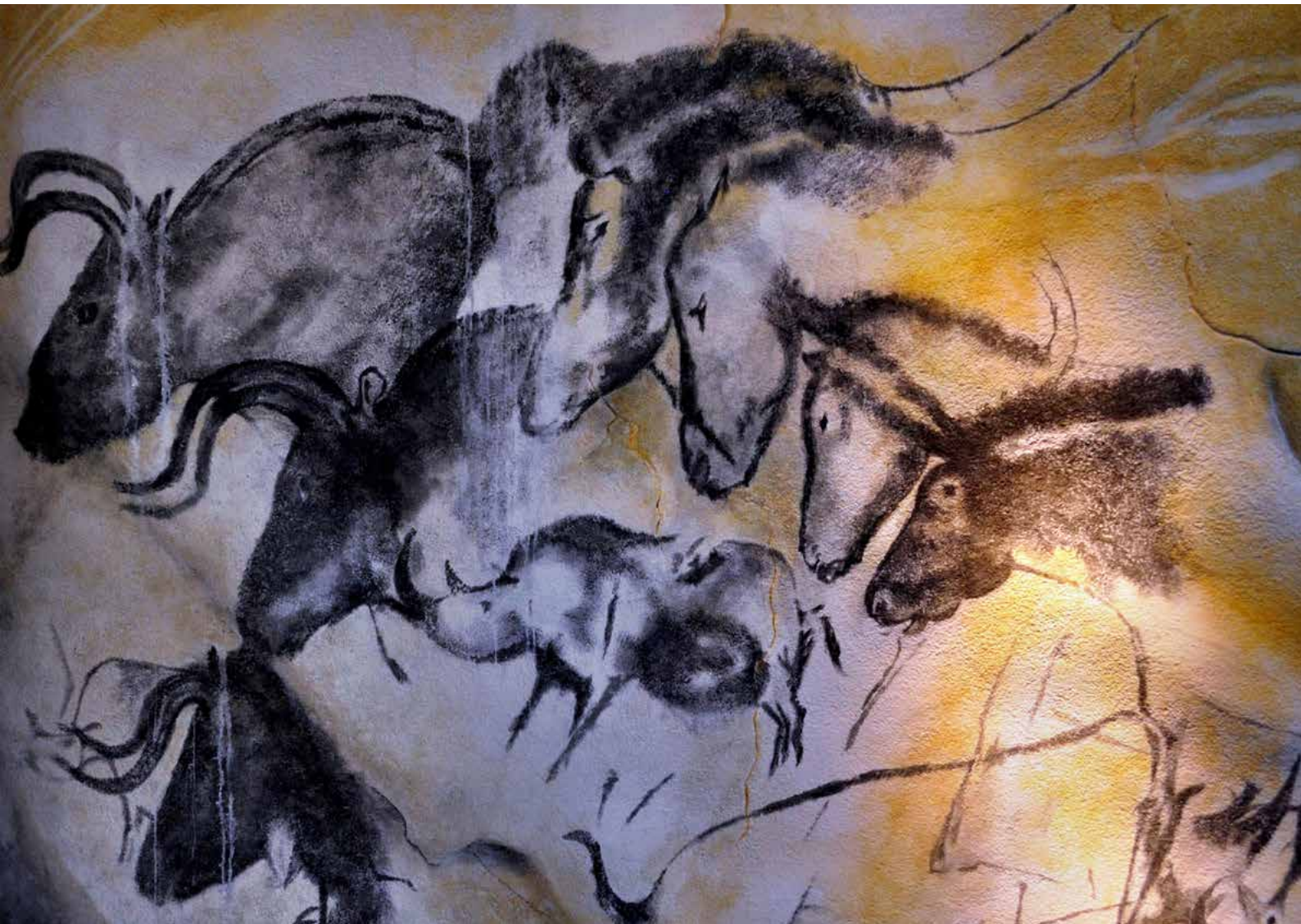
2.2. Ecological impact

Together with other natural processes like storms, forest fires, insect outbreaks and diseases, combinations of large herbivore species keep the landscape open or half open in many of Europe's climate zones, but only if their numbers are sufficiently high and the species composition sufficiently diverse. Different species occupy different niches and not only compete, but also facilitate each other. Their combined impact on the landscape is much more than the impact of one single species. In this combined grazing, horses play an important role as can be seen in modern-day nature reserves with wild horses or horses living in the wild, and other grazing mammals.

In the Mongolian Hustai National Park, argali, Mongolian gazelle and red deer returned after the Przewalski's horses were reintroduced. The horses turned the evenly tall grasslands into typically grazed mosaic grasslands, which were attractive to the other herbivores. Horses are able to survive on nutrient poor grasses and eat dead grasses as a major part of their diet. By removing the dead grassy material, they stimulate regrowth, enabling aurochs and deer to live in greater numbers in nutrient-poor landscapes. In nutrient-rich landscapes, grazing deer, bison and aurochs reduce the size of tall grasses and herbs to that preferred by horses [Nieuwdorp 1998a]. Horses in turn, maintain grasslands in a short-grazed state, preferred by grazers like rabbits and geese.

Often, nutrient-rich environments are seasonally available and horses and other grazing animals migrate from rich environments in summer to nutrient-poor in winter, thus using both habitat types. Not only did the horses shape the landscape, but the converse is also true. The available nutrients determine the horse's body size and intestine surface; so, a flat, open landscape brings horses with long legs, whereas mountains are best handled by horses with relatively short legs.

Horses also love debarking poplars, willows, spruce and beech; thus opening up patches of closed forests. However, as a non-ruminating species, they cannot digest the bark of poisonous species like elderberry or black cherry. Therefore, combined ruminant and non-ruminant herbivores reopen forests, offering space for open land species like bushes, herbs, grasses and the accompanying insects and birds.



Stone-age artwork in the Chauvet Cave, France, is more than 30,000 years old

Wild Retuerta horse in the Campanarios de Azaba Biological Reserve, Spain

Debarked tree in Keent, The Netherlands

On top of these effects, horses wallow in sandy patches, facilitating insects that need those small sandy patches for thermo-regulation or breeding. While grazing and walking they mix soil, dung and dead plant material, stimulating recycling of nutrients. In their coats, seeds are transported and their preference for roots and bulbs of reeds, grasses and sedges opens up monotone stands of these species, enabling herbs to colonise the area.

In many of these aspects horses are quite unique and seriously complement other large herbivores. Together these species have a major positive impact on the environment and its biodiversity.

Removing or drastically reducing the numbers of key players in an ecosystem, as humans have done since the late Pleistocene, results, via trophic cascades, in a decreased biodiversity [Eisenberg 2009, Sandom *et al.* 2014]. Wild horses, elephants and aurochs were such key players, as were wolves and lions and without them, Europe's early Holocene grasslands and savannah woodlands transformed into a tree-dominated landscape. The remaining open land species – horse, bison, aurochs – were forced to retreat to inhospitable places, like wetlands or mountains, where grasses were still available [van Vuure 2014], or started living in forests in much lower densities.

3. Extinct, but not lost

From somewhere between 6000 and 5000 BC onwards domesticated animals, such as cattle, sheep, goats and pigs, started to appear in Central and Northern Europe. Current knowledge suggests that horses joined the domestic herds after 3000 BC. Their domesticated counterparts now replaced the dwindling populations of wild herbivores. Competition from domestic herbivores and constant hunting pressure forced wild herbivores to retreat even further. Wild animals were kept from agricultural fields and predators were fiercely hunted in order to defend livestock. Fertile lowland grasslands were more and more abandoned by wild herbivores, while retreating into mountains, dark forests and marshes. The isotope contents of the bones of ancient aurochs bear witness of this change in habitat [Noe-Nygaard *et al.* 2005, Drucker & Bocherens 2009, Cromsigt *et al.* 2012].

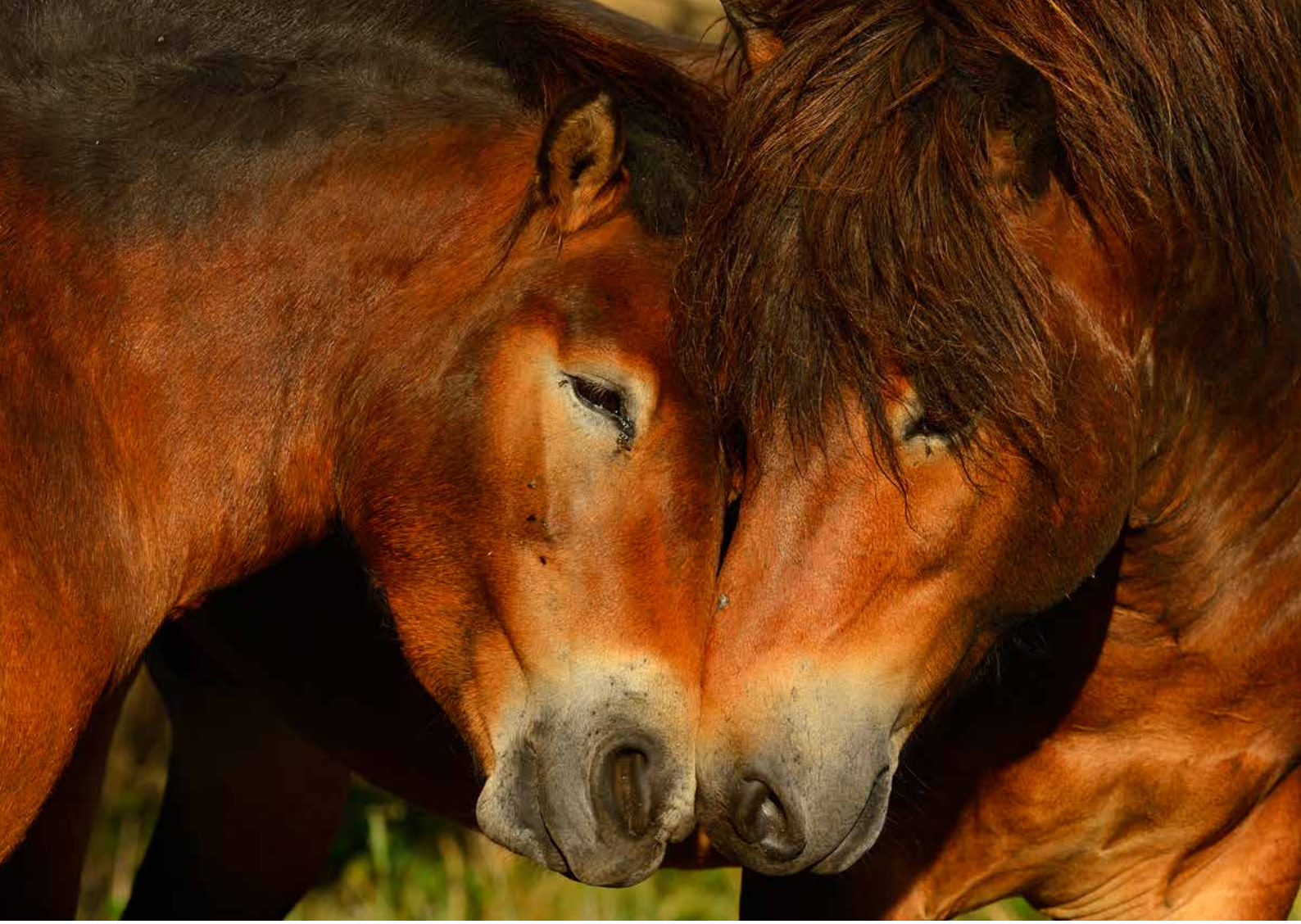
Around 2000 BC breeding domestic livestock was widespread, and the clearing of forests began. For the second time, humankind changed the landscape on a large scale. The post-Ice Age open forest landscapes returned, but now with domestic cattle, horses, pigs, sheep and goats. Their wild counterparts still survived, but in restricted numbers and hidden in uninhabited and often inhospitable places. During the course of history, humans were able to colonise more and more of these last refugia, causing wild herbivores and their predators to further decline. One by one species became extinct: the aurochs in 1627, the 'tarpan' in 1909 and the last wild bison in 1927. It is however unclear if the last horses living In the wild, seen in the forests of Europe during the 18th and 19th centuries; such as the tarpan, were genuine wild horses or were of mixed feral origin.

Extinct, but not lost, the genetic heritage of both the European wild horse and aurochs survived in their domesticated form. Recent mDNA investigation has shown that domesticated horses derived from at least 77 different mare bloodlines. Current knowledge shows however low variation of mDNA in wild horse populations, indicating this broad variation was not obtained from domestication on one or two locations. Instead, it probably meant that while tamed horses spread through Eurasia, local gene variants of wild mares were added to the domestic herds [Jansen et.al. 2002, Cieslak *et al.* 2010, Pachyornis 2014]. And vice versa, as wild stallions would also have included tame mares in their harem or covered them on occasions. Thus while domesticated horses replaced the wild herds, the Europe-wide inbreeding with wild mares contrastingly helped to preserve much of the local adaptations and variation. Variation among present breeds has been built partially on pre-domestic variation. However, many variants are introduced by human breeding, such as many, if not all, racing horses, show jumping horses and large horses for carrying people or for performing hard labour. They had adapted to the different climates, landscapes and food supplies in the different corners of Europe. Roughly speaking, there seem to have been steppe, lowland and mountain versions, all over Europe.

Geographically, local versions can be distinguished in Iberia, the Balkans and the European lowlands and along the West coast ridge (Viking route), formed by Great Britain, Ireland, Iceland, Scandinavia and the Baltics.

Horses show their adaptations to the environment by their physical appearance. This can be seen in archaeological finding. For example: short-muzzled horses are adapted to cold weather where their short, broad nose cavity is used to warm up the cold air. Compact builds are adapted to more closed landscapes and heavy terrain such as snow and mud. More lightly built, slender and long-legged horses are adapted to running and walking long distances in open, dry landscapes [pers. comm. V. Eisenmann]. Although our interpretation may turn out to be subjective, for rewilding purposes the proof is always in the practice.

Throughout history, war and trade brought domestic and sometimes even wild horses from one place to another. Alexander the Great, the Huns, the Arabs, the Vikings, Genghis Khan and many other conquerors travelled thousands of kilometres with their armies, even by boat, and fought in many locations, dispersing horse gene variants across large distances. Presumably, after



Exmoor ponies, one of the oldest and most primitive horse breeds in Europe, in the Keent Nature Reserve, The Netherlands

the Ice Age, horses in West and Central Europe were dark brown in colour and had mealy muzzles as can still be seen in Exmoor ponies today [Hoovens 2013]. However, analysis of ancient DNA and rock paintings show surprisingly that the so-called dun, piebald and leopard colours were already present for a long time [Chauvet 1995, Pachyornis 2013].

Where in ancient times domestic and wild animals could meet, crossbreeding often occurred. Wild stallions or bulls covered domestic mares and cows in heat. Domestic animals escaped and joined wild herds or formed feral herds of their own. During war or plagues animals were left behind and became feral, as the so-called mustangs did in America. This continued into modern times when during the war in Croatia, sturdy regional horses were left behind in the mountain pastures of Velebit. In the Letea forest (Danube Delta) a large group of horses has rewilded in recent decades. Recently, both groups also became feral and are thriving. Therefore, both breeds have started their paths to rewilding.

In many places in Southern and Eastern Europe, local breeds traditionally roam free in mountainous areas in a semi-feral state; also in Great Britain (e.g. Exmoor) and in Iceland. Thanks to this tradition, natural selection was still in place and wild survival gene variants were kept intact. Predator avoidance, free partner selection, competition between stallions, winter hardiness, rain and ice resistant coats were all preserved. These breeds may even be direct descendants of wild horses carrying few domesticated horse gene variants. Irrespective of the amount of domesticated gene variants, the absence of strong human selection and the presence of natural selection have kept them fit for rewilding. This is in contrast to highly specialised modern horse breeds. The absence of natural selection and human selection regarding conformity, gracefulness, colour, tameness, etc., encouraged inbreeding and produced animals unfit for rewilding. Luckily, for the process of rewilding, breed registries are a relatively recent invention and most appeared only from the end of the 19th century onwards. And what's more, while some individuals were 'improved' according to breed registry standards, others were still kept traditionally and maintained their natural characteristics. Unfortunately, land abandonment in rural areas has caused a sharp decrease in semi-feral kept herds, urging us to advance rapidly and start rewilding horses as soon as possible.

4. Fit for rewilding

4.1. From domestic breeds to wild herds

The original, local versions of the ancient wild horse were naturally very well-adapted for local survival in the wild. Their DNA with specific gene variants and gene expressions has partly been lost, but their phenotype can be recovered. However, there is still a lack of clarity on the genome of the European wild horse and its variation. Also, the genetic background of modern rewildable horse breeds is very often heavily disputed. By unravelling one ancient horse genome, the knowledge on this subject has recently increased, enormously. Nevertheless, there is still a lot to be studied and clarified, like the original DNA variation in wild horses, the variation in the stallions Y-chromosome, the original coat colour variation, etc. What is known is that the first horses were domesticated on the Central-Asian steppes and that keeping horses spread quickly across Eurasia.

During this expansion local wild horses were integrated into the new domesticated herds [Jansen 2002], resulting in a broad variety of locally adapted horse types in Europe. Alternatively, horses could have been domesticated in several locations, spread over Eurasia, or a combination of both [Cieslak 2010]. Archaeological evidence however points to the first alternative

Retuerta horses release, originating from Coto Donana National Park, Spain

[Jansen 2002], as does the small diversity of the male Y-chromosomes compared to the very broad diversity of mare mDNA [Lindgren 2004]. As a result, the wild horses of Europe still survive in all of their domesticated, feral and semi-feral offspring. That is why the amount of adaptation of a horse to local circumstances and living in the wild, is a good standard for selecting suitable founders. "Fit for purpose" is what makes a founder suitable for rewilding.

4.2. Przewalski's horse (Takh)

Przewalski's horse is a genuine wild horse and does not need to be rewilded. Przewalski-type horses were present in Europe during the ice age, as can still be seen in various ancient cave drawings [Chauvet 1995], and followed the cold steppes north-eastwards as the ice melted. Przewalski's horse is an Asiatic horse nowadays, although it lives in several places in Europe in fenced, natural areas. Whether Przewalski's horse is a subspecies of a different species is still scientifically debated. A 2011 mitochondrial DNA study concluded that Przewalski's horses and modern domestic horses diverged some 160,000 years ago [Ryder 2011]. An analysis based on whole genome sequencing and calibration with DNA from old horse bones gave a divergence date of 38–72 thousand years ago [Orlando 2013]. Przewalski's horse has a very low genetic variation and has one extra pair of chromosomes , but can (still) produce fertile offspring when interbred with modern horses. Rewilding, i.e. releasing Przewalski's horses in large East European steppe reserves will greatly help this (sub) species to survive. Przewalski's horses do not need to be selected, since they are not domesticated or changed. However they do need to adapt to their new environment, especially when this differs much from their place of origin. For instance, animals have to adapt to the composition of the bacterial flora in their stomach and intestines from the changed diet.

4.3. Breeds for rewilding

When choosing horse breeds for rewilding, it seems wise to use local, well adapted breeds, especially if they have an ancient phenotype (adaptation), which can be developed further by natural selection after rewilding. The consequence of rewilding is leaving breed standards. This includes the possibility to rewild a population of mixed breeds or joining and thereby mixing several populations of different breeds. As long as all breeds included are suitable according the criteria. Suitable local breeds are often very similar in appearance and used to be one horse type before the breed standards that drove them apart were established. Re-joining these breeds in their original type broadens the genetic diversity and therefore their fitness for survival. When selecting individuals from several breeds, care must be taken that all individuals do appear like the original type, thus avoiding an artificially mixed appearance. For example in Iberia, many breeds are developed in isolated mountainous areas, but they are still quite similar. Mixing breeds for rewilding has an advantage for genetic diversity and is a basic form of back breeding that gives room for natural selection. New research can help clarify the roots of certain breeds, but should never overrule the 'fit for purpose' standard. Rewilding means working towards a future wild horse, using domesticated offspring of extinct wild horses from the past. But only after a successful step-by-step feralisation (i.e. the process of becoming feral), can horses be truly rewilded.

Garrano horses in the Faia Brava reserve, Portugal

4.4. Selection criteria

Domestication is an ongoing process. Rewilding means to switch from this domestication process towards a process of adapting to a future life in the wild. To understand this switch, we need to understand what happened during domestication. In general:

- animals became tame.
- adults retained imitation behaviour typical for young animals (neoteny), rendering them obedient and eager to learn.
- adaptation to the local natural environment decreased, but fortunately, not as acutely as in sheep and cattle.
- body sizes became very differentiated, with very large and very small breeds appearing.
- physical appearance changed.
- social behaviour changed.
- reproduction increased.
- genetics changed.

In order to reverse domestication, these changes and their implications for rewilding are discussed in detail below. Characteristics can domesticate quickly, with the risk of losing the wild ones through gene erosion. The above changes were used to select horse breeds for the table of rewildable horses. The table is not expected to be exhaustive, and some breeds may have been omitted in error. New research can bring new insights and can change the relative ranking of breeds on fitness for rewilding.

From fossil DNA, old rock carvings, written sources etc., we can partly reconstruct the original European wild horse types as effectively as possible and compare how the wild and domestic horses differ from each other. However, resemblance to the ancient wild horse does not necessarily mean 'fitness for purpose'.

Scarcity

Selecting horses for rewilding and the process of rewilding itself means losing gene variants that belong to domestication. Many of the fit-for-rewilding horse types are rare breeds with low to very low genetic variation. It is therefore wise to restore genetic diversity by combining horses from several related local breeds when building herds for rewilding [Vermeulen 2012]. Especially where local breeds look quite similar, this approach increases genetic variation without losing local climate and terrain adaptations. During subsequent rewilding, natural selection will decrease this variation again by removing the unwanted gene variants, that is, gene variants that are unwanted in a wild population. Nevertheless, this 'mixed' wild population may end up with more genetic variation than several of the original breeds.

Tameness

We cannot measure the impact of domestication. We can only compare it with the only wild horse species left in the world; the Asiatic Przewalski. This species cannot be tamed. In contrast, Mustangs are still easily tamed, even after being feral for five centuries. We can also see that there is a difference in tameness in different breeds, where it is important not to confuse it with learned behaviour. Evasive behaviour can be learned and even imitated between individuals. For rewilding, the aspect of tameness has an uncertain outcome. It is not known if gene variants for wild behaviour have been lost forever as this was the characteristic which was de-selected most heavily during domestication. During the rewilding process, we will learn quickly how this tameness disappears, or if it disappears at all.

Wildness

The domestication of horses did not change their gene variants as much as it did with many of our other domestic mammals. The absence of strong human selection and the presence of natural selection have rendered some of the wilder and more original breeds perfectly fit for a natural life in the wild. All across Europe, several of the local

Przewalski's horses in Haut Thorenc, France

Wild Retuerta horses in the Campanarios de Azaba Biological Reserve, Spain

horse breeds have traditionally roamed free in natural areas in a semi-wild state. These horses were expected to find their own food and shelter. This turned out to be a guarantee to preserve important wild traits and appearances, enabling horses to stay fit and alive under semi-wild conditions. The knowledge of how to avoid or defend themselves against predators, the competition between the stallions, how to survive cold, snow and drought, developing coats resistant to rain, snow and ice, was preserved and developed. Populations of rewilded and semi-wild horses store very important gene sources and individuals that adapted have survived most successfully and will continue to do so. Rewilding horses takes generations, in order to fully adapt and learn to live in the wild again. It is therefore precisely these well-hardened breeds that are eligible for rewilding. Often these are the ancient terrestrial types [Hall 2002]. Most of these breeds share a lot of similarities with their wild ancestors. Past and current lifestyle – feral, semi-feral or stable living – of individual horses, is an important factor in deciding if a horse is fit for rewilding. The relative position on this scale determines the time and effort it takes to successfully rewild a certain horse. Many of them eventually do, but some will not.

Body size and confirmation

Rock carvings show sturdily built, medium-sized horses, with only some differences. Ancient fossils show that body size and confirmation of ancient horses varied with the environment; with glacial horses which were small and robust; temperate horses which were more slender; and larger body sizes and robust limb bones correlated with mosaic steppe inhabitants [van Asperen 2010]. In general, they all have strong legs, strong joints, strong jaws and teeth. As differences were the result of climate, vegetation and landscape, it can be expected that wild horses had several ecotypes or subspecies. Recent mDNA investigation shows that while tamed horses spread through Eurasia, local wild mares were added to the herds and joined local gene variants into the domestic herds [Jansen et.al. 2002], thus adding local adaptations to the domestic herds. Contrastingly, Y-chromosome variation in current day horses is low [Lindgren 2004, Pachyornis 2014b], indicating that only a few stallions were domesticated. Finding new Y-chromosome variations in a breed or type could be an indication of ancient local domestication. More research needs to be done on Y-chromosomes, as the current knowledge is limited. As a result

of mixing local mares with domesticated horses from elsewhere, several modern day domesticated horse types still carry most of the phenotypic adaptation of their local wild ancestors, resulting in differences in body type, shape of head and length of legs. This includes the composition of muscles, bones and joints. A horse adapted for a flat landscape therefore has less chance of survival in a mountainous area compared to a horse adapted for a mountainous terrain. Adaptation of the skeleton takes many generations; therefore rewilding means that landscape determines the founders.

We know, from data gathered from ancient bones, that depending on the habitat, the size at shoulder height varies between 1.20 m and 1.40 m. Most of the hardened breeds in our list are in this range. Height is one of the properties that can adapt very quickly. For instance, in the Oostvaardersplassen and other large-scale nature areas in the Netherlands, Konik developed a smaller and broader body size in 10 generations under natural selection [pers. obs. R. Meissner, J. Griekspoor]. Human selection can do this in less and has achieved this during domestication. Extremely oversized or undersized horses are not considered for rewilding. Sometimes this has to be decided on a case by case basis. Some breeds include human selected dwarf versions, like the popular Shetland pony. The original Shetland pony however was much taller and fits within the lower end of the natural height range. When using breeds like this, care must be taken to use only originally sized individuals for rewilding. In general, breeds may demonstrate a range of lineages from very human selected to feral. Where appropriate, a caveat is indicated in the table.

Coat colours

From genetic research we know that, originally, the wild coat colours were: bay, black and the recently -found colour of spotted grey (leopard gen) [Pruvost *et al.* 2011, Pachyornis 2013]. The appearance was also influenced by the wild, so-called, 'agouti-gene' that determines the spread of pigment over the body, resulting in dark body extremities. As far as is known now, other colouring appeared later, during or parallel to the process of domestication. Although not (yet) found in genetic research, there are cave paintings from much earlier dates that seem to show colouring like piebald and duns with wild striping. Also grey and black used to be present in Exmoor but was selected out after the breed standard was formulated [Green 2013, Pachyornis 2014], a breed that is considered by many as a descendant of the original British wild horse [Hovens *et al.* 2013]. In general dun coloured horses are well camouflaged in open grassy landscapes, whereas dark coloured horses are more difficult to detect in closed, forested landscapes [Pachyornis 2013, pers. obs. L. & E. Linnartz]. This could have resulted in dark horses in the more forested central and western parts of Europe and light coloured horses in the steppe areas of the east, as shown by modern day wild equines with their dun coat colours and dry steppe habitats [Pachyornis 2013]. Future research will shed light on the coat colour mystery. Popular colours in modern horse breeds, such as sorrels (erythrism), roans and white markings seem to occur as a result of domestication. Currently, knowledge on this issue is rapidly expanding. Where present, the colour factors agouti (e.g. in some Exmoor), pangare (in Exmoor, Przewalski) and sooty (in Dartmoor, some Letea horses and some Retuerta horses) are superimposed on other colours and have a countershading or camouflaging effect. These are probably wild properties that can mislead predators. Colours could also have helped horses in hiding from human hunters. A black colour in dark wooded areas and dun in tall dry grasses greatly decreases visibility. It could have been helpful in times when humans became more numerous and wild horses rarer. As discussed previously, it is uncertain if the so-called wild striping pattern comes with domestication or was already present in wild horses. The latter seems to be reasonable as it works as camouflage. Due to ever-changing and growing scientific knowledge, coat colour is not the most important criterion for choosing the best rewildable horses. At an individual level, colours that bring discomfort, like albino, should be avoided. Also white markings and pink hooves should be avoided to a realistic extend, as rewilding is also a process of restoring the appearance of a wild animal. Furthermore, from the perspective of a wildlife manager, a natural look is clearly preferred. Domestic features such as white markings and high withers largely undo that wild image objective.

Manes

Manes in horses are stiff and this can also be seen in European wild horses depicted in ancient rock paintings.. However, longer, and most probably - hanging manes, can also be seen in some cave paintings and in the Yukon fossil horse. Environmental factors could play a role where stiff manes help to protect against cold, but hanging manes help to run off rain. Therefore, hanging manes could already have been present in Holocene wild horses of Eurasia [Hovens 2013], but this feature could also be a result of domestication [pers. comm. C. Van Vuure]. Nevertheless, horses with stiff manes can be considered maladapted for

Przewalski's horses on the grassland of the Hortobagy National Park, Hungary

the current wet climate in Europe and therefore for rewilding [pers. comm. Meissner and Kerkdijk-Otten].

Forelock

The forelock between the ears is absent in Przewalski's horses. It seems to be related to dry climates just like the stiff manes. A short forelock is seen occasionally at an individual level in many modern breeds, while some breeds more generally, have shorter forelocks than other breeds. It could have been an adaptation in wild horses to a dry climate [Loohuis unpubl.]. A long forelock protects the eyes against rain and insects. The extreme long forelock of Yakut horses helps to protect from very cold weather. During domestication a long forelock was probably favoured. Forelock size is not a selection criterion, unless it hampers fitness for rewilding.

Hooves

The growth potential and shape of hooves is strongly related to the environment. Soft marshy wetlands make for wide, slow-growing hooves. Rocky surfaces demand strong, fast-growing, small and narrow hooves. Domestication has influenced the growing potential by shoeing and trimming horses hooves' used for cart-pulling or riding. Therefore, there must be no history of trimming or shoeing during the previous generation of horses used for rewilding ,and they should be adapted to the same type of soil as the rewilding site. However, experience with Dutch Konik showed that horses can adapt hoof constitution quite quickly and pass this epigenetically on to their offspring. Within a few generations, a good adaptation to local conditions is already visible [pers. exp. R. Meissner]. Adaptation in the first generation of rewilding brings less discomfort if horses with fast-growing hooves are introduced to soft soils than vice versa: hooves that are too long will break off, while hooves that are too short are very painful and make natural movement impossible. Hoof condition is highly important for survival and the level of adaptation to local circumstances should be used to select breeds and individuals before introduction.

Suitable coat

Coat condition: domestication has removed the need to safeguard against cold and especially wet conditions. The impact has been different for each breed. Founders for rewilding herds have to have the ability to protect themselves against the environment, against extremes of temperature, wetness, insect bites, seasonal changes, etc. For the most part, this means having a double coat in winter as a strict selection criterion.

Social behaviour

Once again we have no other reference point available other than to draw comparisons with the reintroduced Przewalski's horses and feral breeds, worldwide. There seems to be a lot of similarity in social behaviour, which makes it logical to assume that the genetic properties expressing it are still close to the original wild ones, although nobody knows the exact natural social behaviour of wild European horses. Studies on Asiatic wild ass show that natural, social behaviour in equids can differ and depend on local circumstances, such as predation pressure [Feh *et al.* 1994]. Research shows that original, or at least useful, social behaviour arises when the right herd conditions are offered to a rewilding herd such as; natural gender distribution, age structure, existing bonding and relationships, which results in bachelor stallion groups and multiple harems [Nieuwdorp 1998b, Feh 2001]. Depending on local circumstances, the social structure can vary; such as harem size, and lead stallions that are assisted by zero or more assisting stallions [Feh 1999, Linnartz in prep.]. All horse breeds show this useful social behaviour when given the opportunity. However, a strong social structure is important when having to fight off predators, like wolves. Balanced social behaviour also brings natural use of the environment, while distributing according to the environment, instead of according to former unnatural habits.

Stallions that did not grow up in a competitive environment often perform poorly or unnaturally when having to compete with other stallions as an adult. Mares that did not grow up in a social environment will have problems with integration and bonding. Unnatural behaviour brings unbalance in the herd, which makes it vulnerable to predators. Therefore, individuals that have grown up within a natural social structure are preferred over individuals that grew up without it. In addition, integrated groups are preferred over individuals. This is not a breed selection criterion, but an important argument to choose for experienced herds. In general, groups of horses habituated to living in natural herds with multiple stallions are strongly preferred for rewilding purposes.

Reproduction

Domestication selection in horses was never so much about characteristics related to reproduction or lactation. Birth synchronisation in the most suitable time of the year, will restore in one or a few generations and udder sizes and milk-giving seem to be intact. Early fertility in domestic breeds may occur, but is less visible in feral horses. Birth problems are rare, even in underdeveloped mares. Sometimes young mares lose their young foals

Wild horses in the Danube delta, Romania

which can be a natural occurrence, but may also be a signal of early fertility. We do not know how wild horses reproduction rates were during the lifespan of a mare, and thus this is not a criterion for selection. Altogether, it seems that domestication has not had so much of an influence on reproduction.

The attribute in horses to easily abort foetuses suggests that birth rates react to natural circumstances. This is an intact characteristic which is even seen in domestic horses. The long-term study of rewilded populations will probably teach us more on this issue. Results from mustangs and Przewalski's horses indicate that reproduction rates are less when compared to domestic mares or semi-feral mares. External conditions, like wolf predation, can further reduce effective reproduction. For introduction management in rewilding areas, the best advice is to start with animals that are already in a natural cycle, corresponding with the local climatic zone.

Gaits

Mobility is very important for survival as horses are designed to take flight in order to escape from predators. They can, or should be able to, walk long distances for daily food and drinking needs; an adaptation to dry steppe areas. Legs and joints should be both strong and mobile and provide the ability to sprint, reach high speeds and to run long distances. And above all, this should be possible in different landscapes. In this aspect it is interesting to note that a gene mutation has recently been found for alternative gaits. This provides the additional possibility that the legs are used laterally instead of purely diagonally [Andersson *et al.*]. This can also be seen in other species; for instance elephants use it while moving quickly. It is possible that this mutation arose in wild horses and gave them an additional opportunity to increase their speed in mountainous landscapes. Meissner [pers. com.] imagines that early humans selected these horses for breeding, perhaps because they offered a smoother ride. Lateral gaiting was highly selected for horse riding until carts and roads came in fashion. From then onwards, this property only survived in remote, domestic breeds or was extremely exposed for showing. Some of the rewildable breeds still have these lateral gaits. It is not a selection criterion but it may turn out to be one in future if research demonstrates this mutation in pre-domestic wild horse DNA.

Exmoor ponies in Keent, The Netherlands

5. Selected horse breeds

5.1. General

Horses used to living in the wild and in natural social groups are preferred above other breeds or individuals. Horses used to living in fully domesticated circumstances should not be used for rewilding. Those horses should first adapt to a semi-feral lifestyle, before continuing for further rewilding. Adaptation to local circumstances – soft or rocky soils, mountainous or wet terrain, birth synchronisation with the regional start of spring, etc. – is highly preferred above maladaptation. In the worst cases, it can lead to dying horses and failure of the project. Although horses can learn quickly, learning takes time and sometimes even generations. During this time, rewilding necessarily pauses at the first steps and takes a much longer time. Not only to complete, but also to have the look and feel of real, wild horses. A group of horses living on hay and fenced off from predation doesn't feel like authentic wild horses, regardless of their physical appearance.

Given the selection criteria above, the following set of horse breeds are best suitable for rewilding (for details see the table in this chapter):

- Exmoor pony for Northwest Europe and England, with possibilities to add the Dartmoor and Welsh pony to restore genetic diversity or Eriskay pony in more harsh climates (e.g. Scotland);
- Yakoet pony for harsh climates in northernmost Europe and Siberia;
- Konik Polski from Latvian or Dutch/Belgium herds living in the wild in the lowland areas of Northern / Central Europe (Netherlands, Belgium, Northern France, Germany, Poland and the Baltics);
- Hucul in the Central and Eastern-European mountains, ranging into the Alps;
- Pottoko can be used in the mountains of South-Western Europe, such as in France, Spain and Portugal. Asturcon, Losiño, Monichino, Cabalo

Galego/Faco or Garrano/Minho/Géres can be mixed to improve genetic diversity as they have equal rewildable qualities and comparable characteristics. The long-legged Retuerta should be used in more or less flat open steppe areas of Central and Southern Spain;
- Przewalski's horse for large Eastern European continental steppe areas;
- In the Balkans a number of horse types are suitable, such as the Karakachan horse, Bosnian and Serbian mountain ponies, the Myzegea horse and the Pindos pony/Thessalier. The differences between these horse types are often minor and all horse types are adapted to mountainous terrain and often have experience with predators such as wolves or bears. For rewilding, a mix of these breeds would be preferred to improve genetic diversity.

Locally several other horse types are available for rewilding:
- In mountainous areas in Italy, Pentro, Esperia or even Bosnian mountain ponies can be used;
- In Sardinia and other Mediterranean islands the Giara/Achetta can be used;
- In Mediterranean deltas, the Camargue horse can be used.

As indicated before, breed standards are of no use anymore after rewilding and the new wild horses should not be considered as belonging to a certain breed. Unwanted colour morphs or white markings can be selected out at first, but for the most part, nature will carry out the selection process. Several local horse types may be mixed at the start of a rewilding project, as their breed names and standards were artificial to start with and mixing and inbreeding between various local horses was common for thousands of years. Combining breeds restores wild diversity and gives natural selection the opportunity to pick the most suitable animals in a much more effective way than we can. After rewilding, wolves, bears, harsh winters and dry summers will all harden the new wild horses, and as with the Konik in the Oostvaardersplassen, height and other traits will slowly adapt to the new environment and standard of living. What will appear is a range of new wild horses, based on hardened, ancient types, but evolved into a set of new wild horse types, all adapted to living in the wild in their own regional environments.

5.2. Overview of selected horse breeds for rewilding

A broad range of horse breeds suitable for rewilding is shown in the table on the following pages. All of them are strong, robust and pony-sized animals that are scarcely developed by human breeding. Some of them may have ancient, wild gene variants and many have a feral history [according to various literature sources and the internet], and very often it is a mixture of those two aspects. After a process of rewilding, the founding breeds will no longer be a certain breed, but will gradually change to rewilded horse types. Rewilding Europe will use these horse breeds in their rewilding areas across Europe.

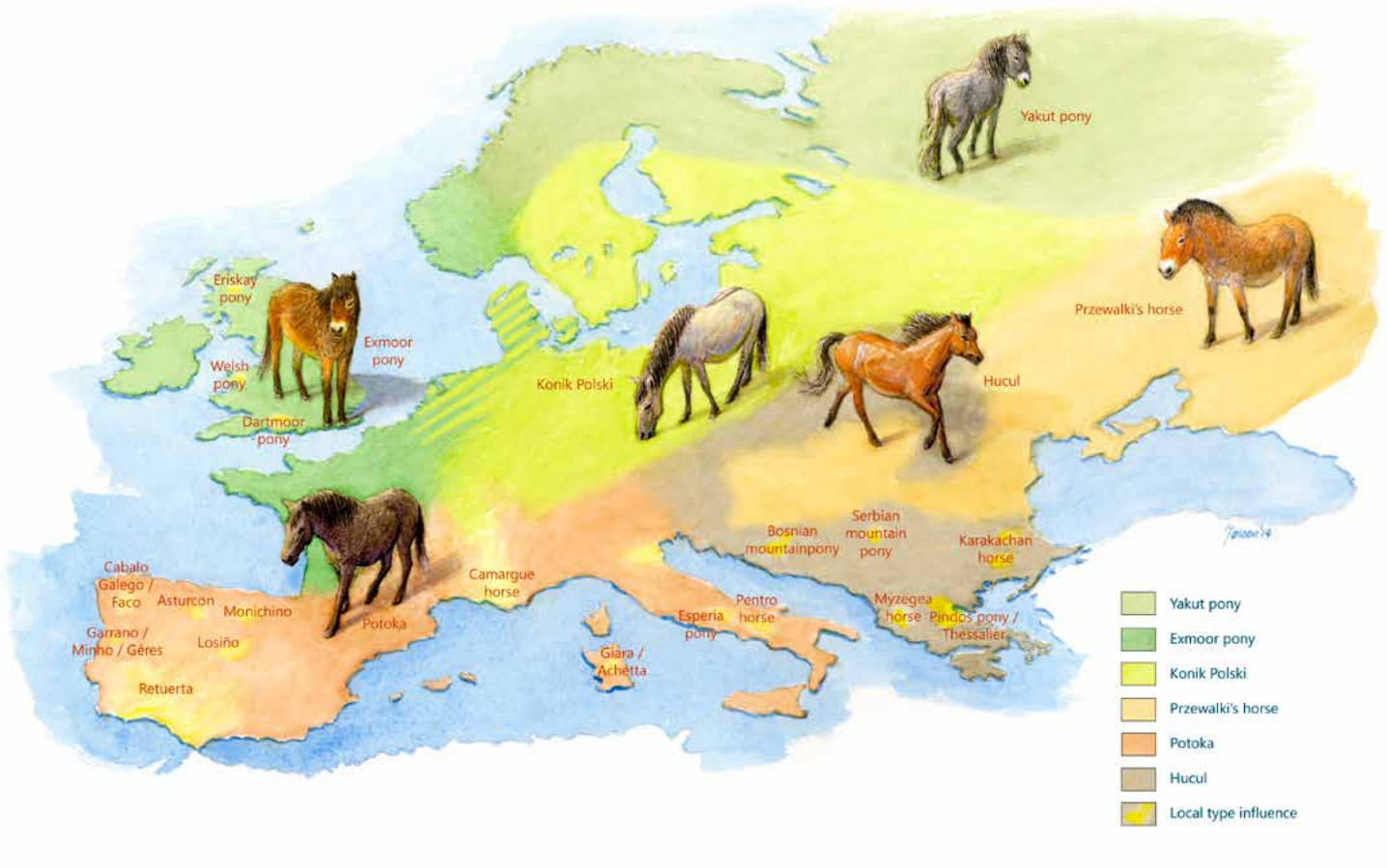


Table of rewildable horses

very suitable and readily available types | suitable and readily available types | not as suitable as the previous types or not readily available

Horse type name	European zone, country Local region of origin	Climate	Landscape, vegetation, soil of origin	Status of wildness in place of origin	Predation experience	History of the type	Colour Average height in metres	Locations of (semi-) feral populations	Overall fitness for purpose	Availability	Attention Remarks for rewilding
Exmoor pony	NW-Europe SW-England	Temperate Maritime Rainfall	Hills Moors Peats	Semi feral	No	Rather unchanged phenotype. Isolated population. Closed breeding since 1921.	Uniform colour. Bay, mealy. Originally also grey and black. 1.30	Exmoor in England, Netherlands, Brittany in France.	Very good	Good	Attention for genetic diversity and for purity
Dartmoor pony	NW-Europe SW-England	Temperate Maritime Rainfall	Hills Moors Peats	Semi feral	No	Often mixed with other breeds	Dark bay, grey, brown, black. 1.30	Dartmoor	Good	Rare	Use only pure hill ponies
New Forest	NW-Europe S-England	Temperate Maritime Rainfall	Flatland Open forest, sandy, loamy soil	Semi feral	No	Often mixed with other breeds	Original type: all colours. 1.35	New Forest Netherlands	Reasonable	Rare	Use only original type and semi-feral horses
Welsh pony	NW-Europe SW-England, Wales	Temperate Maritime Rainfall	Hills Moors Peats	Feral herd Carneddau, Brecon Beacons Natural herds	No	Rather unchanged phenotype since at least Roman times	Dark bay, grey, brown, black. 1.28	Not known	Good	Rare	Use only original type and (semi)-feral horses
Highland/ Fellpony	NW-Europe Scotland, Borderlands England	Cold Maritime Rainfall	Mountains Peats, gleys.	Kept	No	Often mixed with other breeds	All colours, dun shades, wild striping. 1.40.	Not known	Reasonable	Rare	Use only semi-feral horses
Shetland pony	NW-Europe Scotland, Shetland Islands	Cold Maritime Rainfall Stormy	Hills, rocks Peat, Sandy soil	Semi feral	No	Isolated island pony since 4000 year, some influx from related breeds.	All colours. Original island type 1.15.	Marginal lands across Europe, Netherlands	Good/ reasonable	Good	Use only original type and semi-feral horses. For islands and very marginal dunes.
Eriskay pony	NW-Europe Scotland, Hebrides islands	Temperate Maritime Rainfall Stormy	Hills, rocks Peat, Moors Sandy soil.	Semi feral	No	Norwegian origin, rather unchanged phenotype since Viking times: 800 AD	Bay, black, grey. 1.30	Not known	Good	Rare	Attention for genetic diversity
Faeroe pony	NW-Europe Faeroe island	Maritime Rainfall, Stormy	Hills, volcanic fertile soil	Semi feral	No	Norwegian origin, rather unchanged phenotype since Viking times: 800 AD	Bay, black, dun shades. 1.20.	No, not allowed outside Faeroe	Good	Rare	Attention for genetic diversity
Kerry Bog	NW-Europe Ireland, Kerry	Temperate Maritime Rainfall	Hills Peats, grassy valleys Mineral rich soil	Kept, extensively	No	Some mixed from Asturia and Scandinavia by Vikings rather unchanged phenotype since 1700	All colours. 1.20	Not known	Reasonable	Rare	Attention for genetic diversity
Icelandic horse	Northern Europe Iceland	Cold Maritime Rainfall	Hills, rocks, volcanic fertile soil	Extensively kept	No	Rather unchanged phenotype since Viking times, 1200. Import ban.	All colours. 1.38	Netherlands, Germany, Norway	Good/ reasonable	Many	Use only semi-feral horses

Horse type name	European zone, country Local region of origin	Climate	Landscape, vegetation, soil of origin	Status of wildness in place of origin	Predation experience	History of the type	Colour Average height in metres	Locations of (semi-) feral populations	Overall fitness for purpose	Availability	Attention Remarks for rewilding
Fjord horse	Northern Europe Norway	Temperate Maritime Rainfall Snow	Mountains, fertile flatlands	Kept, semi-feral in Netherlands.		Rather unchanged phenotype for 4,000 years.	Bay dun, some red or grey-dun. 1.40	Netherlands	Reasonable	Good	Use only semi-feral horses
Nordlands-hest/ Lyngshest	Northern Europe Norway Lofoten	Temperate Maritime Rainfall	Mountains, fertile valleys, steep slopes	Extensively kept	No	Type known since Viking times or older.	All colours. 1.30	Norway, Lofoten	Good	Rare	Use only original type
Gotland Pony	Northern Europe Swedish Islands	Temperate Maritime Sub-Mediterranean	Hills, flatland, moor, chalky fertile soil	Wild on Lojstra wooded moor. Rest of island: semi feral until 1858, now kept.	No	Since prehistoric times wild in Loistra. Some mixing in 20th century.	Bay, black, duns. 1.30	Unknown	Good	Rare	Attention for genetic diversity. Use only (semi)-feral horses
Yakut pony	NE-Europe Siberia	Continental, extreme cold Snow	Tundra	Feral in Pleistocene Park in Tsjerski. Semi-wild kept by Yakoet people.	Yes	Probably old mixed descendant Yukon horse, Przewalski	All colours, many grey. 1.30	Not known outside Siberia	Very good	Many	Suitable for Rewilding in the far north of Europe. Used to survive deep snow.
Estonian horse/ Estonian bush pony	Northern Europe Estonia	Temperate maritime to dry continental	Open forest, flatland	Most extensive/ semi-feral kept.	Probably	Rather unchanged phenotype for 2,800 years.	Bay, duns, grey. Became taller by human selection. 1.45	Estonia Sweden, Öland Finland	Reasonable	Good	Use only semi-feral horses
Žemaitukas	Northern Europe Lithuania	Temperate maritime to dry continental	Open forest, flatland	Most extensively kept	Unknown	Rather unchanged phenotype the 6–7th century.	Bay, black, duns, grey. Became taller by mixing 1.35	Historically Poland/ Russia now unknown	Reasonable	Good	Use only original type and semi-feral horses
Konik Polski	Northern Europe Poland	Temperate continental	Flatland, wetlands	Feral, semi-feral, kept. Several big natural social herds.	Several popula-tions: wolf	Selectively breed since 20th century from semi wild robust local breed.	Black-dun, bay-dun, black, brown. Colour originally more diverse. 1.35	Netherlands, Belgium, Latvia, France, Bulgaria, England Germany	Very good	Many	Use only (semi)-feral horses
Danube Horse	Central Europe Romania Danube Delta	Continental	Flatland, wetlands, dunes, open forest, sub-steppe	Feral in Letea forest, Danube delta	Probably jackal	Descriptions of wild horses since centuries.	Black, bay, grey, duns. Became taller by (cross) breeding. 1.40	No	Reasonable due to recent feralisation	Good	Due to veterinarian regulation, replacement ban.

Horse type name	European zone, country Local region of origin	Climate	Landscape, vegetation, soil of origin	Status of wildness in place of origin	Predation experience	History of the type	Colour Average height in metres	Locations of (semi-) feral populations	Overall fitness for purpose	Availability	Attention Remarks for rewilding
Hucul	Central/ Eastern Europe Carpathian mountains	Continental	MountainsFertile valleys, steep slopes	Feral, semi feral and kept.	Yes, wolf	Rather unchanged phenotype since 1600. Migrated with nomads, probably older.	Bay, black, grey, dun, wild striping. 1.35	Ukraine, Romania, Hungary, Germany, Poland, Czech rep, Slovakia	Very good	Good	Use only semi-feral or extensive kept horses with only solid colours
Bosnian mountain pony	SE-Europe Bosnia and Herzegovina	Continental	Mountains, fertile valleys, steep slopes	Feral in Livno and Kupres	Yes, wolf	Rather unchanged phenotype since Middle Ages. Related to tarpan/ European wild horse, mixed with Mongolian horses	Bay, black, grey, dun, wild striping. 1.38	Bosnia, Herzegovina, Croatia, Slovenia	Good	Good	Use only feral and semi-feral horses
Serbian mountain pony	SE-Europe Serbia	Continental	Mountains Fertile valleys, steep slopes	Feral in Stara Planina	Yes, wolf	Rather unchanged phenotype since middle ages.	Bay, black, piebald, grey. 1.35	Serbia, Bulgaria, Croatia	Good	Good	Similar to Karakachan horse. Use only original type for rewilding
Karakachan horse	SE-Europe Bulgaria	Continental	Mountains Fertile valleys, steep slopes	Feral in Pirin, Rila and Rhodopi mountains	Yes, wolf	Rather unchanged phenotype since middle ages.	Black, bay. 1.30	Bulgaria, Serbia	Good	Rare	Similar to Serbian pony. Use only original type for rewilding
Posavina/ Turopolje	SE-Europe Croatia	Continental	Riverbanks, wetlands	Feral in nature reserves along the river Sava, Ljonko Polje.	No	Rather unchanged phenotype since middle ages. Became bigger by mixing with big horses.	Bay, brown. 1.45	Croatia	Reasonable	Rare	Use only semi-feral horses. Use only original type.
Myzegea horse	Southern Europe Albania	Mediterranean	Mountains and (marshy-) highland plains	Semi-wild, abandoned herds.	Probably	Introduced by Illyrian people 5th BC, mixed with other hardened breeds.	Black, bay, grey, brown. 1,32	Albania	Good	Many	Use only semi-feral horses Related to Hucul.
Pindos pony/ Thessalier	Southern Europe Greece	Mediterranean, alpine	Mountains Fertile valleys, steep slopes	Semi-feral in Thessaly and Epirus	Yes, wolves, bears.	Rather unchanged phenotype since 15th century, introduced by Turkish rulers.	Bay, brown, grey 1.40	Greece, Descendants on Ionian islands	Good	Rare	Mountain specialists
Skyros horse	Southern Europe Greece	Mediterranean, arid	Arid, rocky mountains	Feral on the island Skyros	No	Rather unchanged phenotype since 5-8th century BC. Small island type, remnant of very old land type.	All colours, many bay. 1.00	Greece, Skyros, some private Corfu, Attica Zoo Athens.	Reasonable	Rare	Ban on export from island.
Authentic Greek breeds	Southern Europe Peloponnesus, Greek islands	Mediterranean	Most arid mountains/ plains, valleys	Semi feral	No	Types known since ancient history, many local breeds.	All colours, 125-140	Greece Peloponnesus Rhodes, Crete, Kefallinia	Good	Good/rare	Use only semi-feral horses
Dülmener wildpferd	Northern Europe, Germany	Temperate	Moors, open forest	Semi-feral, Merfelder Bruch	No	First described 1300, probably older. Feral until 1950, semi feral now. Mixed with Welsh, Exmoor, Hucul, Konik.	Black-dun, bay -dun, wild striping. 1.32	Unknown	Reasonable	Many	Until now no experience with feral living nature reserves
Esperia pony	Southern Europe Italy	Mediterranean	Forested rocky mountains	Semi-feral	No	Related to Anadolu pony by inbreeding.	Black 1.35	Only local Lepini Mountains	Good	Rare	Use only semi-feral horses

Horse type name	European zone, country Local region of origin	Climate	Landscape, vegetation, soil of origin	Status of wildness in place of origin	Predation experience	History of the type	Colour Average height in metres	Locations of (semi-) feral populations	Overall fitness for purpose	Availability	Attention Remarks for rewilding
Pentro horse	Southern Europe Italy	Mediterranean, alpine	High plains, seasonable wetlands	Feral in high plains Pantano della Zittola/ Abruzzo mountains	Yes, wolf, bear	Type known for 2,000 years. Origin wild mixed with Berber horse. Mixed with Italian breeds since 1913, strong natural selection.	All colours, many chestnut, white markings. 1.38	Only local	Good	Rare	Use only original type
Monterufoli pony	Southern Europe Italy	Mediterranean	Forested, scrubbed hilly mountains	Feral in Montefuroli-Caselli nature reserve	No	Ancestor was Selvina horse, rescued since 1913 in nature reserve.	Black, some bay. 1.35	Only local	Reasonable	Rare	Use only original type
Sanfratellano	Southern Europe Sicily	Mediterranean, alpine	Forested mountains	Feral in Nebrodi nature Park	No	Type known since 11th century, mixed with other breeds	Black, bay. 1.50	Only local	Reasonable	Rare	Use only original type
Giara/Achetta	Southern Europe Sardinia	Mediterranean, alpine	Marshy highlands	Feral near Bardigiano, Foresta Burgos	No	Introduced by Gallicians, 4th century BC, related to Asturcon horse.	Black, bay, some grey, white markings. 1.30	Only local	Good	Good	Use only original type
Camargue horse	SW-Europe France	Mediterranean	Fertile saline marshes	Semi-feral in Rhone Delta	No	Rather unchanged phenotype since time immemorial, supposed ancient horse. Similar to cave painting Niaux,	Uniform colour grey. 1.42	Some nature reserves in France	Good	Many	Accustomed to mosquitoes. Use only semi-feral horses.
Merens	SW-Europe Pyrenees, Andorra	Temperate/ Mediterranean	Mountains Fertile valleys, slopes	Semi-feral	Until now not, but in future, wolves	Probably mixed with Iberian and Berber horses	Uniform black 1.40. Historically smaller.	Unknown	Reasonable	Good	Use only (semi-) feral horses. Attention for genetic diversity.
Landais/ Barthai	SW-Europe Les Landes, France	Maritime, warm	Lowland, forest, dunes, marshes river banks	Feral until 1950, recent semi feral in local nature reserves	No	Rather unchanged phenotype since before 700 AD. Some mixing with Iberian and Berber horses	Bay, black, chestnut. 1.28	Only local	Good	Rare	Good for marshy coastlands. Attention for genetic diversity.
Pottoka **Part of the Northern-Iberia group of horses**	SW-Europe France, Spain Pyreneans	Temperate maritime rainfall, snow	Mountains Fertile valleys, steep slopes	Feral and semi feral	Yes	Probably almost unchanged phenotype since Paleolithicum, little mixed with Exmoor in 20th century.	Black, piebald, chestnut. 1.30	In Basque mountains, Extremadura:Piornal / Pena Negra,	Very good	Good	Use only (semi-) feral horses
Asturcon **Part of the Northern-Iberia horses**	SW-Europe Spain, Cantabria	Temperate, cool, rainfall	Mountain slopes and highland plains	Feral in nature reserves in Eastern Asturia/ Sueve	Yes, wolves, bears	Related to the Celtic ponies and the pre-historic horse. Mentioned by Pliny (23-79 AD)	Black and some bay. White markings on head. 1.20	Spain Eastern Asturia	Good	Good	Use only (semi-) feral horses
Losiño **part of the Northern-Iberia horses**	SW-Europe Spain, Castilla Leon, Losa valley	Temperate, cool, rainfall	Mountain slopes, valleys	Semi feral in Pancorbo (Breed rescue program)	Yes	Rather unchanged phenotype since middle ages, probably older.	Uniform black. White head marks allowed, no fetlocks. 1.38	Spain Pancorbo, Quincoces	Good	Rare	Use only (semi-) feral horses. Small population, but 200 horses seem to be available in W-Iberia

Horse type name	European zone, country Local region of origin	Climate	Landscape, vegetation, soil of origin	Status of wildness in place of origin	Predation experience	History of the type	Colour Average height in metres	Locations of (semi-) feral populations	Overall fitness for purpose	Availability	Attention Remarks for rewilding
Monichino	SW-Europe Spain, Cantabria	Temperate, cool, rainfall	Mountain slopes, valleys	Semi-feral	Yes	Rather unchanged phenotype since Middle Ages, probably older. Recent decades mixed with slaughter horses.	Black, bay. 1.35	Spain Cantabria Small herd in Germany	Good	Rare	Use only original type. Small population
Retuerta	SW-Europe Spain, Doñana	Sub-steppe	Fertile floodplains	Feral	No	Rest population in remote area. Probably genetically close to original wild horse.	Uniform bay. 1.40	Spain Doñana, Campanarios de Azaba Reserve	Good	Rare	Use only (semi-) feral horses.
Cabalo Galego / Faco **part of the Northern-Iberia horses**	SW-Europe Spain Galicia	Temperate, cool, rainfall	Coastal hills, shrubs, dunes, forest	Feral	Yes	Rock carvings 2500BC. Known by Pliny, Strabo, Martial. Since 1600 export all over Europe, e.g. Iceland, Great Britain. Prob. related to Exmoor. In 20th century mixed with slaughter horses, back to origin since 1994.	Original type black, bay 1.28	Spain Around Pontevedra, Lugo	Good	Good	Use only original type. Near identical to Garrano
Garrano/ Minho/ Géres **part of the Northern-Iberia horses**	SW-Europe Portugal Minho, Geres, Tras-o-Montes, Alto douro	Temperate, cool, rainfall	Mountain Fertile slopes,	Nature reserves	Yes	Rather unchanged phenotype since 200 AD, probably older. Ancestor of Andalousian and Galego ? Recent decades mixed with slaughter horses	Original type black, bay 1.25	Portugal Minho, Tras-o-montes, Alto Douro	Good	Good	Use only (semi-) feral horses and original mountain type. Near identical to Galego
Sorraia	Europe Portugal, Santarem province	Maritime temperate climate	Fertile riverbanks, lowland	Kept in private herds, semi-feral in Valle de Zebro	No	Presumed ancient, rediscovered in feral state in 1920. Revived last decades. mDNA shows mixed origin and unrelated to ancient Iberian horses.	Only black-dun and bay-dun with wild striping. 1.40	Portugal Extensively kept: Canada, US Germany,	Reasonable	Rare	Use only (semi-) feral horses.
Przewalski's horse	Central Eurasia Mongolia	Continental steppe climate: cold in winter, hot in summer	Steppe	Wild in several Mongolian National Parks, semi-wild in European nature reserves	Yes, wolves in Mongolia	Genuine wild subspecies1 of the Eurasian wild horse.	Dun with pangaré 1.34-1.46	Mongolia, Germany, France, Hungary, etc.	Very good	Rare	Suitable for large eastern continental steppe areas. Has the status of a threatened wild species, which has management consequences.

Status of management: Domesticated, semi feral, feral, rewilded. Semi feral must be interpreted in many ways. Often the term is used for grazing on common grounds. Sometimes managed with additional feeding or movement to winter grazing areas. In all cases it means that the animals have owners, they are just scarcely looked after and surviving is by natural selection. Partner choice is not always natural, neither is the social organisation.

1 *Whether the Przewalski's horse should be seen as a subspecies or as a relatively recently split separate horse species, is still a scientific debate. This report considers the Przewalski's horse as a genuine wild and rare horse type, not to be mixed with horses of another (sub)species.*

6. Guidelines for rewilding horses

6.1. Rewilding takes time!

All living creatures adapt to their environments. Natural selection causes bad gene variants and gene mutations to disappear and good mutations to survive. Far more quickly than this, however, there are indications that during their lifetimes, living creatures can change their gene expression without changing the underlying DNA sequence by epigenetically changing their DNA-expression. Epigenetic changes have been shown to be inheritable and might provide a faster route towards adaptation to living in the wild, when compared to DNA mutation or changing their DNA sequence. Nevertheless, this epigenetic change also takes time, as every generation will adapt increasingly to a new environment. For instance, Konik imported into the Netherlands experienced problems in the first few years They were raised in Polish stables, had their hooves manicured and shoed, and therefore had problems with long hooves in their first few years in Dutch nature reserves. Hoofs with problems were handled conforming to individual welfare (see also new IUCN criteria), except for the most hopeless individuals, which were selected out. Now, after 30 years of human and natural selection, Konik are very self-sustainable and well-adapted to Dutch nature [ARK pers. exp., FREE Nature pers. exp., Linnartz in prep.].

However when brought to Latvian nature reserves, the Dutch Konik had to adapt and learn again. Dutch winters are much less severe than Latvian ones and do not include wolf predation. Thicker coats had to be grown and an effective predator defence had to be developed. After a few years, winter coats were thicker and their social structure was further improved to cope with wolf predation [pers. com. Jan van der Veen]; the first being an example of an epigenetic change, whereas the second was a learning process and a cultural change. Stallions learned how to defend their harems and stallions that assisted were regularly included in the harem. Rewilding is a process, combining both (epi) genetic and cultural changes. Year after year, adaptation and natural selection will improve the hardiness of the horses involved. The fittest stallions will have the most offspring, the best social structure and will experience fewer losses of foals to wolves, and inbreeding will be kept naturally low. The best terrain knowledge gives further advantages. Human interference can only disturb or undo these vital changes. Rewilding eventually means "hands off" and abandoning concepts such as breeds, races and studbooks. After years of rewilding, new wild horses will emerge, which are locally adapted and without a breed description or studbook. This should, however, not be mistaken as meaning the exclusion of research and monitoring.

6.2. Rewilding defined

When rewilded, all horses, whether their origin is feral, semi feral, de-domesticated or just fit for rewilding; have to become truly wild and have to deal with what can be called the rewilding process. It is necessary to realise that relocation for rewilding is not simply crossing a line between culture and nature, or between captive and wild animals. The animals concerned do not walk from domestication into the wild. It is a radical transition from an ethical domain of individual care to a concern for the ecological whole, where individual suffering is insignificant. How to deal with this transition is the responsibility of the project's wildlife manager and depends on the circumstances. For example, in a context where there is a herd of a local breed, already living semi-wild, the transition will be easy and fluent. On the other hand, a context which starts with animals from abroad that do not know each other, will demand professional consideration and time to ensure the transition is successful. **Reversing** or, even better, **changing** a process that took some thousands of years should not be underestimated. De-domestication and further steps towards rewilding asks for a differentiated and fine-tuned approach from different perspectives in order to achieve absolutely natural and truly wild horses [P. Koene 2002, pers. comm. R. Meissner].

Konik horses in Krammerse Slikken, The Netherlands

This may lead to a duality: attention paid to individual animals, coinciding with an overall eco-ethic approach; and no interference with the lives, suffering and death of the wild living animals. The duty of care is inversely proportionate to the size of the rewilding area; practically, ethically and with regard to laws and regulations. In practice, most rewilding areas will increase over time from hundreds of hectares to thousands of square kilometres. There will inevitably be a time gradient - not only because rewilding areas will expand over time, but also because newly-introduced animals should get the opportunity to adapt to the local conditions. The management procedure of a rewilding area will therefore be unique in each situation and should be formulated in a local action plan [IUCN guidelines]. To conclude; in smaller areas, animals are approached at the level of the individual, and in larger areas at the species level, whilst in unlimited wilderness, at the ecosystem level.

Rewilding is about respect for the authentic wildness of wild animals and thus respect for the potential wildness of rewilded animals. Where the authentic wildness of a species was once subject to natural selection, rewildable animals have to change and re-gain their human out-selected characteristics. Practical management will depend on the degree of potential wildness, expressed in the degree of self-sustainability, and the more similarities that can be found with the original wild horse, the better for the rewildable animal. However, whilst fitness for purpose is unconditional, resemblance to the original, extinct, wild horse could be a useful guide to select for survival in the wild.

6.3. Horse habitats

As a large herbivore, horses need a massive amount of food and are tolerant to low quality nutrition. Herbs, bushes and trees produce natural chemicals to avoid being eaten by herbivores. Horses are non-ruminants and therefore not equipped to cope with these chemicals. As a consequence, horses eat large quantities of grass supplemented with non-toxic bark, leaves and herbs. It can be said that grasslands and open forests are the preferred habitat of horses, even though they are a very adaptive species. It is a pitfall to consider areas with the last surviving wild horses as good or even suitable habitat. These habitats were inhabited under pressure of human land use and should be

seen as refugee habitats. They seldom consist of preferred habitat [Kerley *et al.* 2011],although due to their adaptability, this interpretation should not be too strict. Horses were once found all over Europe, in many different types of landscapes [Sommer *et al.* 2011]. However, they prefer grasslands and open landscapes, where predators can more easily be discerned and outrun, and this is also apparent in their physical composition: eyes at the side of the head, a muscular physique, strong and agile legs and strong hooves. Although they have the same strong, basic physical traits, some breeds show differences after living for generations in, for example, mountainous areas or in marshlands. They are often much better adapted to local environments than breeds from a different region.

6.4. Choosing a founder herd

When deciding on the founder herd to rewild in a specific rewilding area, the following steps should be undertaken:

1. The area should be suitable for a population of horses and large enough to support a larger group of horses to avoid inbreeding in the first few decades. Preferably, the starting group should include 3 socially integrated harems and 1 stallion group, containing 6 genetically distinct adult stallions and 12 genetically distinct adult mares and their offspring. There should be enough food, water and minerals in both summer and winter, and enough places to shelter from adverse weather conditions for the size of the starting group, and also for the growing herd several years later. Under optimal conditions the herd may increase yearly by up to 30%; however, harsh winters, predators, diseases and maladaptation can reduce this number to 0% or even less. In winter, large areas can be covered with deep snow, rendering food unavailable, and droughts can have a similar effect on food availability. In very nutrient-rich areas, horses can live in densities of 1 to 3 hectares per animal, but in poor or dry areas, up to 30 hectares per animal or more are needed (see also chapter 6.5). A herd of 150 genetically diverse animals is considered to be a self-sustaining population. Thus, the above densities result in a minimum area requirement ranging from at least 450 hectares in a nutrient-rich delta, up to at least 4,500 hectares or

Hucul or the Carpathian pony in the Bieszczady Mountains, Poland

more on poorer soil. Naturally, such a large area does not need to be present at start-up, but can be gradually added to as the herd grows in size. As an open grassland animal, horses do not need much of a shelter. Some big trees, bushes or cliffs could be all they need. If not, the area could be enlarged so that is does meet all of the above criteria, or a decision must be take that it is not suitable. See also IUCN guidelines on reintroductions.

2. Check chapter 5.4 for the best (combination of) breeds to start with. If one of these breeds is already present and semi-feral and kept in the area, it is preferable to select the most suitable horses from this herd and combine them with suitable horses for rewilding from elsewhere, as per chapter 5.4.

3. While selecting individuals, it is important to take care to select animals that:
   a) live nearest to the area;
   b) are well-adapted to the terrain type, local climate and other circumstances;
   c) are used to living in the wild;
   d) form a social herd with all age-groups represented [Meissner 1997, Nieuwdorp 1998, Vermeulen 2012];
   e) have no white markings or unnatural colours;
   f) are within the height range;
   g) are readily available;
   h) and do not upset local opinion. You may have to select a second best option.

4. Make sure the animals are healthy before translocation and before starting with rewilding and compare the health status and parasite presence of both the former and new environments. Wildlife populations including semi-feral horses are usually very healthy and demonstrate a high degree of resistance. They may nevertheless carry communicable diseases or have parasites that in turn can carry communicable diseases. Depending on their susceptibility, this can have consequences for all species present in the area. Translocating or rewilding unhealthy or contaminated animals will not only reintroduce horses into an area but also their diseases and parasites. Consulting good veterinary experts should reduce this risk to an absolute minimum. On the other hand, and where appropriate, newly introduced horses should also be prepared for the diseases and parasites for which they lack resistance and are about to encounter in their new area. Vaccination might be advisable in some cases. Therefore, consultation with experts will inform decisions on whether intervention is necessary or desirable. The well-being of individual animals is a criterion on whether or not to intervene. Health monitoring as part of a management plan, can provide good insight into the possible presence of diseases, and this may include a health check of deceased horses.

5. Make an action plan and start rewilding.

6.5. Ensuring adaptation

Management of a rewilded herd means considering all aspects at population level, thinking at herd level, acting at the social sub-group level and keeping a watchful eye out for each, individual animal; bearing in mind that reduced welfare for individuals will, over time and over generations, bring increased survival for the species. In general, it appears that domestic horses can quickly rewild and adapt to a natural way of life. Vice versa, they are easily tamed and this is clearly seen in mustangs and brumbies [Kerson 2011].

The new wild horses should preferably live like their wild ancestors did. Wild populations of any species will express a natural social behaviour, age structure and more or less even numbers of males and females, which leads to free partner choice, inbreeding avoidance [Duncan et al. 1984] and natural selection. Semi-feral or extensively kept horse herds have often lacked this freedom. Research on feral horse populations and reintroduced Przewalski's horses shows that it takes some generations to build and restore a solid natural population structure. It stresses the need to start with as many bloodlines as possible and fully integrated harems and bachelor groups, and this will help to avoid or diminish losses to predators and in-fighting, and will enable the herd to progress swiftly on the rewilding scale. Adding or removing animals should preferably be done in accordance with the existing social structure: pre-existing harems or bachelor groups should be translocated as a group. Removing individuals should also carried out in a similar way to that of natural social behaviour where young mares and stallions leave their birth harem at the age of 1-3 years and can therefore be removed with less stress for the remaining harem.

Where horses are used for restocking another rewilded herd, at least two animals should be translocated. In contrast, single, translocated horses will demonstrate insecure and uncertain behaviour and the introduction of individuals in an existing social group causes stress, which has a negative effect on the adaptive capacity. Both aspects make integration of the newly arrived horse difficult and sometimes

Wild Retuerta horse in the Campanarios de Azaba Biological Reserve, Spain

even impossible, and therefore it is always best to align with the natural, social behaviour and to translocate two or more animals. This will enable them to express their natural herd behaviour in their new environment. If it is necessary to add new bloodlines, and introductions of a complete integrated harem are not possible; new stallions can be added in. This is best done by adding two young, and as yet uncompetitive stallions, at the same time, enabling integration be as natural as possible. On the other hand, adding one or more individual adult stallions will often bring unrest and unnatural energy loss for the whole group, while there is a real risk that the new stallion will never engage in reproduction. In the case of adding mares, again it is important to avoid individual introductions. Introductions are more successful when the animals already known to each other. Fighting for the hierarchy will be more fluent and natural, with less chances of disorder and most chances for success.

Rewilding often means translocation of horses from their current habitat to their new rewilding area. This means that horses have to get to know their new territory; learn where food and water is available, where shelter can be found, where to stay away from harmful insects, and where to avoid predation. Knowledge of new plants has to be learned; which are palatable and which are poisonous. Their digestive system – e.g. intestinal bacteria – has to adapt to the new food. Their immune system has to adapt to local parasites and illnesses [Vermeulen 2012]. Hoof size and growth has to be adapted, and their fur has to adapt to the new conditions in all seasons. Muscles and tendons have to adapt, especially when moving from flat land to a mountainous area. Moreover, sometimes even the birth cycle has to adapt to the new climate. Horses can adapt relatively well, but it will take time, and the amount of time required depends of the amount of adaptation necessary. Terrain knowledge can be transferred into the new rewilding herd, by adding a few local horses living in the wild. Apart from terrain knowledge, they can serve as interpreters of local conditions. When these local horses are not intended as part of the rewilding herd, these specific individuals and their offspring should be removed after one or two years.

A few years after translocation, a herd should be able to survive under local, natural conditions. In areas with predators, it is necessary that horses are not the only wild prey species around. Sometimes it is necessary to introduce more wildlife in an area in order to successfully rewild large, slow reproducing species like horses. In areas with predators it is better to rewild a large group of horses with a strong social structure and preferably with (some) predator experience. Losses from predation will be less and will have less impact on the total genetic variation within the herd. A strategy for how to cope with predation in the first years of rewilding should form part of the introduction action plan, where introducing an existing set of social groups is a basic anti-predator measure. Another good option is to keep the new horses in a predator-free area to let them get accustomed to the local food, terrain and weather under semi-wild conditions and then after one or two years of adaptation and habituation they can roam free in an even larger area. When there is a need to increase the population, a social group of new horses can be added to an already experienced group, but care must be taken that the new group does not outnumber or dominate the old group otherwise the local rewilding and learning

Konik horses in Oostvaardersplassen, The Netherlands

process will have to start afresh. After a number of years, when numbers have increased and horses have developed efficient, anti-predator behaviour; human interference can be scaled down. From that point onwards, nature will select and determine the path and future of this new stock of wild horses.

Wild populations tend to live in balance with the food available to them, but in nearly all semi-feral populations living in the wild, humans intervene before populations reach the ceiling of food availability. That is why the knowledge about population dynamics and food availability is limited [Duncan, 2002], and therefore this knowledge needs to be built up during rewilding.

6.6. Human assistance during rewilding

In the first weeks, months or even a year, additional feeding might be necessary as long as the animals are not yet adapted to their new environment. When all open water freezes over and no snow is present, the animals need to be given supplementary water, which can be done by making holes in the ice. Often, experienced horses living in the wild will make these holes themselves. Attention should be paid to dried-up water sources in the dry season, as newcomers will not yet be familiar with the area and may not yet have found alternative sources. Supplying additional salt or minerals should not be necessary, as rewilding areas should preferably have sufficient minerals or natural mineral sites; only in very rare cases, and if the animals suffer from a lack of minerals - should this be considered. Preferably, the horses will be taught where to find the natural mineral sites in the area.

When dealing with health, well-being, diseases and contamination issues, while rewilding - a distinction should be made between individual illnesses and communicable, infectious diseases. Both affect the well-being of individual animals. In the case of illness or injury of an individual animal, it is best not to rush to intervene. However, in the case of fatal injuries or illness, the horse in question should be euthanised to end suffering. Vaccinations are unnatural and undesirable and should only be used for temporary protection when introducing the animals to a new area. Deworming is also undesirable, but might sometimes be necessary after horses have been translocated to a new area with different parasites.

In the case of infectious diseases within the rewilded population, consultation with experts will help decide if intervention is necessary, desirable or even mandatory; especially, in the case of a risk of disease exchange with other populations or species. Some infectious diseases are notifiable by law, because they can affect the animal health status of a country, which may have consequences for national trade interests. For all of these reasons, it is important to maintain regular contact with a local veterinarian and with the national veterinary service. Health monitoring by a veterinarian in a rewilding herd is not necessary but can be very useful in extending the expertise of rewilding in general, and to help prevent unwanted surprises. Depending on the country, a degree of monitoring might also be obligatory.

Once rewilded it will be difficult and undesirable to catch horses, although it might be necessary to tranquilise an animal for treatment or translocation; which clearly demands specific expertise and methodology.

Konik horses in Beuningen, The Netherlands

6.7. Rewilding horses and communication

In this day and age, people are no longer used to truly wild horses. Horse riding or pet ponies stabled in a riding school or in a small space are the new norms. These horses are fed when they need food, their coat is groomed, they have stables to live in when the weather is adverse and worst of all, and they are often vaccinated and de-wormed.

Before starting with the introduction of the horses, the public should be extensively informed about the process and the species and learn how and where to inform themselves further. When starting out rewilding horses, several key questions will naturally be raised by the general public. The wildlife manager will already be up to speed on a vast range of information regarding rewilding management, but will also be confronted by various questions from non-experts and visitors. It is important to ensure clear signage and brochures which clearly set out behaviour required of the visitors, is in place.

Frequently asked questions by the public and possible answers are presented below.

Don't we have to feed the horses when there is snow and ice?

Explain to the public what you are doing and demonstrate that the horses really don't need additional food. Giving the horses additional food will provide them with a disincentive to find it themselves and thus encourage dependency. The area is suitable, meaning there should be enough food, even in wintertime. Wild horses will shift snow aside to reach for the grasses below, and those horses which are experienced at living in the wild make these holes themselves. They will also debark trees, thereby increasing their effect on the (open) landscape.

Don't they need a stable for shelter?

No, they don't. A stable will keep their coat from reaching its normal winter thickness. The landscape with its trees, rock cliffs, mountain tops, and valleys will do the job and provide shelter, shade, a breeze against stinging insects, etc. The horses will learn quickly how to use them.

Do they need a veterinarian?
The horses are strong enough to live without the help of a veterinarian. When they are very badly wounded or too ill to recover, the wildlife manager or a predator will kill them to end their suffering.

May we feed them or hug them?
No, the new wild horses are supposed to live life in the wild and to keep some distance from visitors. By feeding them or hugging them they will continuously search the company of humans, and that will undo an important part of their natural effect on the landscape. Besides, horses might start to demand food from people, resulting in conflict and in people fearing them. Always keep your distance from the animals; at least 25 metres (this important piece of information should be clearly displayed on information panels.)

May we ride on them?
Riding wild horses can be very dangerous, especially when a horse has never been ridden before. The horse will panic and think that it has a predator on its back, and it will very much disturb the whole herd and increase the potential risks for the person involved.

Do we need to rub them?
No, they will not tolerate people doing this, and anyway it could render the coat permeable by rubbing the fat off. The seeds in the coat may look sloppy but are a natural process of dispersing plants.

Do we need to take care of the hooves?
No, their hooves will grow and wear down according to the surface. Cutting the hooves will make them grow too quickly and brings discomfort to the horses.

Do they need to be de-wormed?
No, they learn which plants have a de-worming effect and they will eat them when necessary.

Do we need to keep an eye on the young age of reproduction of mares?
Horses will only become fertile when their body is ready for reproduction.

Apart from these general questions, it is always best to keep the public informed and to establish and maintain good working relations with the people living in proximity to the rewilding area.

Horse release in the Campanarios de Azaba Biological Reserve, Spain

6.8. Rewilding horses pitfalls and challenges

When starting with rewilding horses, it is important to be aware of the following potential pitfalls and challenges:

- The most recent locations where semi-feral horses were widely kept or roamed, are not necessarily suitable for living in the wild all year round. Often these sites are only suitable for summer grazing, and winter grazing grounds must be included. Preferably not only poor grazing grounds, but also good grazing grounds should be included, and nowadays, land abandonment offers plenty of opportunities for doing so.
- At the beginning of the rewilding process, the number of horses should be much less than the local carrying capacity of the rewilding area. This gives the horses the opportunity to adapt to their new environment while there is plenty of food and offers space for the herd to increase in size.
- It is important to bear in mind that the carrying capacity in most rewilding areas is much less than in agricultural areas and rewilded, agricultural areas will gradually lose their increased fecundity. Densities can range from 1 animal per hectare on fertile soil to 1 animal per 15 or even 30 hectares, on poor sandy soil or in dry areas. It is also important to bear in mind that horses mainly feed on grasses. Open water, rocks and dark, closed forests do not offer much grazing capacity and should be included in the overall area but excluded when calculating carrying capacity and grazing densities.
- Carrying capacity is always calculated in the worst season (winter or dry summer).
- Many breeds on the rewilding list have gone through a genetic bottleneck. The number of founders is relatively low and current numbers may still be low. When starting with rewilding it is important to have as broad a genetic diversity as possible.
- When the area is small, the herd of rewilding horses must all remain small. Inbreeding and genetic erosion can appear and should be planned for; ideally by exchanging social groups of horses between two compatible rewilding areas.
- For upwards of 150 genetically diverse horses, additional inbreeding and genetic erosion is minimal for a long period of time [Kurstjens 2004, Smulders et al. 2006]. Numbers should be equally divided between both sexes, but even with high numbers, some exchange of groups of horses every once in a while, is preferable. This can also be achieved by connecting two rewilding areas, and allowing the horses to mix naturally.

Herd of semi-feral horses grazing on snowy mountain slope in the Central Apennines, Italy

A number of challenges can occur when horses are translocated to an environment to which they are not adapted:

- When moved from flat terrain into a mountainous area, horses' tendons can become very sore and painful. This hampers movement and decreases their ability to escape from predation.
- When moved from soft to hard terrain, their hooves wear down excessively and become painful. This also hampers movement.
- When moved from nutrient-rich terrain to nutrient-poor, food intake and digestive ability through the intestines, may not be sufficient. Animals will have to spend much more time feeding or may even not succeed in digesting an adequate amount of food. Their offspring will perform better, as their intestinal surface area is adapted to nutrient availability in the first years.
- In terms of excessive food intake, this is poses much less of a problem, as long as there is a natural social structure that protects them from this behaviour.
- When moved from a dry to a wet climate or vice versa, the coat has to adapt. Overheating can be a serious problem at the start of this process.
- When moved from warm to cold or vice versa, coat and fat deposition must change. Freezing to death or overheating can be a problem in first few years and should be avoided or at least the risks must be minimised.
- When moved from an area without predation to one with predation, prey animals like horses have a disadvantage and extra care (see above) should be taken to prevent predation until the animals have adapted to their new surroundings.

One or two years of adaptation are quite normal after translocation. Authentic rewilding starts with the first wild-born generation of horses or even with the first generation of wild-born foals from wild-born parents. The amount of time and the measures taken all form part of the local rewilding action plan. More information about releasing and managing the newly wild horses can be found in Vermeulen [2012].

6.9. Towards truly wild horses

The current body of European Union legislation divides animals into either wild or domestic. Wild animals are regulated under the Habitats Directive, whereas domestic, and animals kept in captivity, are regulated by both veterinary and food safety Regulations. In Europe, horses are deemed to be domestic animals. Each Member State makes its own list of endemic species for the Habitat Directive. For example, the wild Przewalski's horse is currently not on any of these lists and the Tarpan is on the endemic species list for Bulgaria, but listed as extinct. Within the framework of the European Union there is room for regulations at national, regional or even community level, as long as they do not contradict EU legislation. Currently there are no exceptions for rewilded horses. As a consequence, rules for kept animals still apply to rewilded horses. This means that rewilded horses have an owner who is responsible by law. According to current laws, owners of rewilded horses:

- are responsible for damages,
- have an identification duty for individual animals,
- have veterinary obligations, depending on local legislation or situation,
- can use horse meat for consumption,
- cannot leave carcasses in the field, unless exceptions to this are arranged,
- have ethical obligations around the animal's health and condition,
- must follow transport regulations which are identical for both rewilded and tame horses.

Wildlife managers of horse rewilding areas should inform themselves about all laws and regulations applicable to their work. Rules and regulations can be complicated, especially in cross-border situations both inside and outside the EU. When necessary, wildlife managers should be aware of, and implement any new provisions, measures or permits necessary [IUCN/SSC 2013].

Rewilding horses in rewilding areas brings the need for recognition of wild status for the newly rewilded horses. This should include appropriate legislation and perhaps also a separate official subspecies name. Obtaining wild status for rewilded horses would be an important step in the overall recognition of the new wild horse and its role in Europe's ecosystems. It would actually restore the wild horse's role and place in these ecosystems. Rewilding Europe is currently working on a separate status for rewilded horses in the European Union, i.e. wild versus domestic. If this project succeeds, rewilded horses would no longer have a responsible owner. Translocating or harvesting could thereafter regulate populations of the newly wild horses, and their meat would be considered as game or venison and carcasses could be left in the field for vultures, bears, insects, etc. Translocations, on the other hand, would then only be possible after official authorisation. For the sake of completeness, it should be clear that introduction of the (already) wild Przewalski's horse is possible if a country includes the species on its wildlife list where the EU Habitat Directive applies.

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Wild living, reintroduced Konik horses in the Eastern Rhodopes, Bulgaria

Glossary

Fit for rewilding
Fit for rewilding are horses that are potentially suitable for de-domestication and rewilding, but have not yet undergone action towards that goal.

De-domesticated
De-domesticated horses live wild in natural areas, but still have an owner who will take care of them when necessary and who is responsible by law. They are sometimes fed in wintertime, but only when really necessary because of extreme weather conditions. Often they have free partner choice and live in natural social groups.

Feral
Feral horses are escaped horses roaming free in natural areas. They have free partner choice and live in natural social groups. They live like rewilded or de-domesticated animals, except that their release was unintentional and could be reversed.

Semi feral
Horses living wild in natural areas, but they still have an owner who will take care of them when necessary and who is responsible by law. They may have free partner choice, but not always. Semi feral horses can sometimes be kept in stables in wintertime, taken to winter areas, artificially fed or treated by a vet.

Rewilded
Truly wild horses that live wild in large natural areas, have completely free partner choice, live in natural social groups, have no owner and their wild status is not supposed to be changed ever.

Aerials over the Letea forest in the Danube delta rewilding area, Romania

About Rewilding Europe

Founded in 2011, Rewilding Europe (RE) wants to make Europe a wilder place, with much more space for wildlife, wilderness and natural processes, by bringing back a variety of wildlife for all to enjoy and exploring new ways for people to earn a fair living from the wild. RE aims to rewild one million hectares of land by 2022, creating 10 magnificent wildlife and wilderness areas, which together reflect a wide selection of European regions and ecosystems, flora and fauna. Further information: www.rewildingeurope.com

About ARK Nature

ARK Nature is one of the founding partners of Rewilding Europe and it is involved together with Rewilding Europe in many joint actions and initiatives. ARK Nature is an innovative nature conservation organization, based in The Netherlands that aims to demonstrate in practice how changes in society can provide new opportunities for nature and landscape. ARK Nature is convinced that more room for nature in our thoughts and actions will improve the quality of life, for man and for nature alike. Robust, spontaneous nature is essential for plants and animals, but also for the economy and all people's well-being. Further information: www.ark.eu

About Herds & Homelands

Herds & Homelands is an independent Dutch consultancy. It is specialized in natural grazing with domesticated species to equal the ecological role of the extinct Aurochs and Wild Horse. Herds & Homelands has more than 20 years of international experience in rewilding cattle and horses in European nature areas, as well as a long time involvement in bringing back Eurasia's last surviving wild horse, the Przewalski, into the steppes of Mongolia and the reintroduction of European Bison in the Netherlands. The transformation of domesticated herbivores into the rewilded ecological key species that were once their wild ancestors, asks for a comprehensive approach. Expertise concerns natural grazing, species-specific behavior, social relationships, population dynamics, law and regulations, transports and veterinary aspects. By exploiting best practices, Herds & Homelands is often bridging the gap between field and theory or theory and prejudices. Always with an open eye for research and new insights in this pioneering field. Renée Meissner is founder and owner at Herds and Homelands.

Rewilding Europe®

Making Europe a wilder place

Rewilding Europe is working to make Europe a wilder Place

With much more space for wildlife, wilderness and natural processes. Bringing back the variety of life for all of us to enjoy, and exploring new ways for people to earn a fair living from the wild.

Any initiative aiming to rewild a continent will need a lot of support. We need your support in this effort. We would love if you, in one way or another, would like to become part of this groundbreaking initiative.

You are invited to be a part of Making Europe a Wilder Place!

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