

guest editorial

'Pleistocene re-wilding' merits serious consideration also outside North America

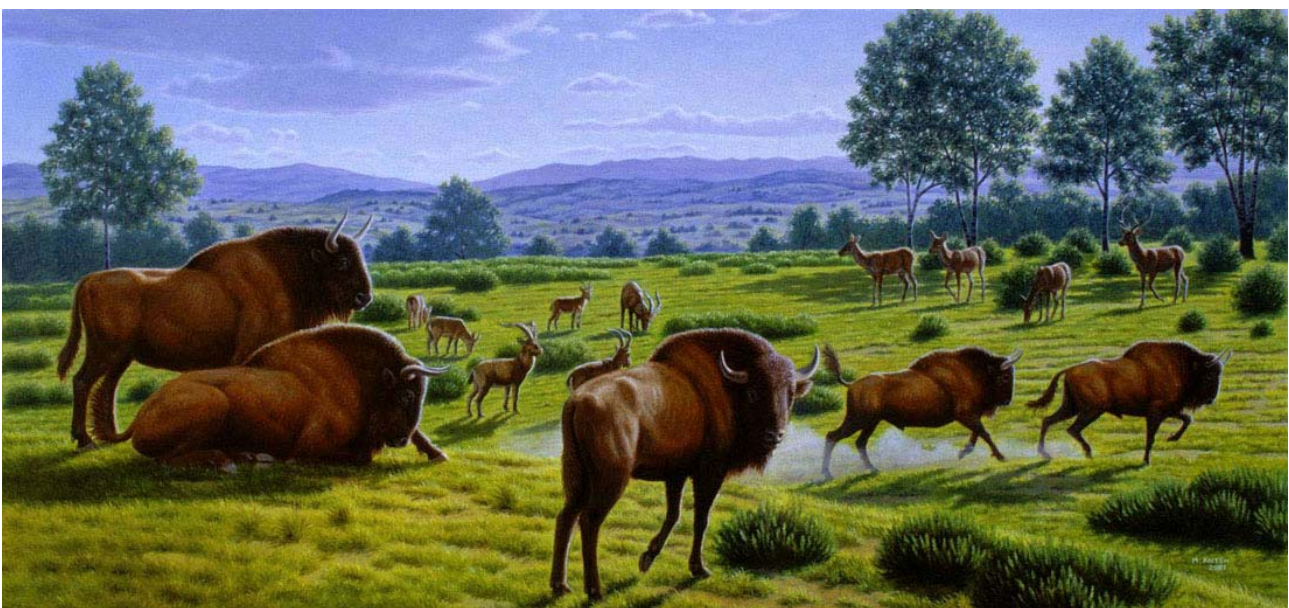
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Recently, Josh Donlan and coworkers have argued for 'Pleistocene re-wilding' as a new optimistic agenda for 21st century conservation in North America (Donlan et al., 2005, 2006; Donlan, 2007). Pleistocene re-wilding refers to the re-establishment of a megafauna similar to that which disappeared from that continent roughly 13,-11,000 years ago. Rewilding would be achieved by establishing closely related and functionally similar extant extra-regional species as replacements for their extinct counterparts. Donlan and coworkers provide a number of justifications for their proposal, including the ecological services such as grassland maintenance provided by large vertebrates, the re-establishment of the evolutionary potential of the megafauna, and the provision of safe havens for extant megafauna species. The re-wilding proposal has generated a much controversy. One potential problem that has been pointed out repeatedly is that reintroducing proxies of species that have been extinct for 10,000 years or

more may damage current biodiversity, just like invasive species are known to do, as ecosystems have changed and evolved after the Pleistocene extinctions (e.g., Rubenstein et al., 2006).



The purpose of the present paper is not to repeat this debate, but to point out that Pleistocene re-wilding deserves serious consideration also outside North America. During the last 50,000 years megafaunas have been decimated not only in North America, but on an essentially worldwide basis. Although an issue of perpetual controversy, there is increasing evidence that modern humans were the ultimate cause of this global event (e.g., Barnosky et al., 2004). Pleistocene re-wilding is already being implemented in a large-scale



Upper Pleistocene (warm period) landscape from Northern Iberian Peninsula, with European bisons, deer and ibexes (illustration by Mauricio Antón; <http://www.mauricioanton.com/>).

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Siberian project with the stated aim of preserving and extending Pleistocene-like grasslands at northern latitudes, <http://news.bbc.co.uk/1/hi/sci/tech/4533485.stm>. However, Pleistocene re-wilding could be much more broadly considered.

Here, I would like to highlight Europe as an obvious place to begin re-wilding projects (see also <http://www.sciam.com/article.cfm?chanID=sa004&articleID=BC67A20E-E7F2-99DF-3D342DE2470C6DDB>). While continental Europe lost many megafauna species during the latest Pleistocene and Holocene, most still survive elsewhere, have close relatives that do, or survive in domesticated form (the main exceptions are the scimitar cat [*Homotherium latidens*], cave bear [*Ursus spelaeus*], woolly mammoth [*Mammuthus primigenius*], woolly rhinoceros [*Coelodonta antiquitatis*], steppe rhinoceros [*Dicerorhinus hemitoechus*], and giant deer [*Megaloceros giganteus*]; Kurtén, 1968; Stuart, 1991). In this aspect Europe differs strongly from the Americas; where a much larger proportion of the extinct megafauna have no close extant counterparts, e.g., ground sloths, glyptodonts, sabertoothed cats, short-faced bear, giant beaver etc. In further contrast to the Americas,

many megafauna species did not disappear from Europe until well into the Holocene. Therefore, the invasive species analogy is hardly applicable in Europe and in general negative ecological or biodiversity impacts on a broad scale are hard to imagine. Hence, megafauna re-establishment would seem particularly feasible and logical in this region.

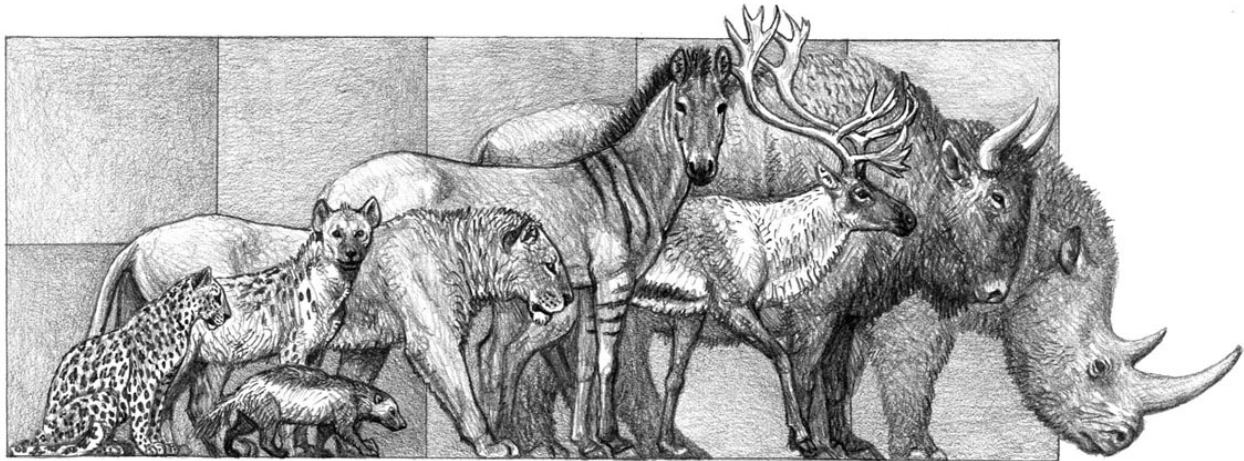
A European re-wilding strategy should obviously include the megafauna species still extant in Europe, many of which have strongly reduced ranges today, e.g. wolf (*Canis lupus*), brown bear (*Ursus arctos*), lynx (*Lynx lynx*), wild boar (*Sus scrofa*), moose (*Alces alces*), and European bison (*Bison bonasus*). In fact, many of these species have already been re-introduced to parts of their former ranges, the most noteworthy case being the European bison, which went completely extinct in the wild during the early 20th century, but today is re-established in scattered localities throughout Eastern Europe (Mitchell-Jones et al., 1999) and seriously considered for re-establishment in Germany (e.g., the subject of a 2007 workshop "European bison in Central European landscapes – experiences and perspectives", organized by the German Federal Agency for Nature Conservation).



Fallow deer (*Dama dama*) is now again widespread in Europe, following several millenia of re-introductions (photo: Biopix.dk [J.C. Schou]; <http://www.biopix.dk>).

Two large mammal species have already been re-established in Europe following their earlier complete extinction on this continent:

- The fallow deer (*Dama dama*) was widespread in Europe under temperate conditions during the Late Pleistocene and survived into the Holocene in the Balkans (Kurtén, 1968; Bökönyi, 1971). While it is doubtful whether any autochthonous European populations made it to the present day, the species survived in Asia Minor and is now widespread in Europe thanks to several millennia of re-introductions (Mitchell-Jones et al., 1999).

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Group of species from the Lezetxiki deposit (Upper Pleistocene; Guipúzcoa, Basque Country). This drawing shows the species currently extinct in the Iberian Peninsula. Other species still present in the Peninsula have been also found at this deposit, such as wolves, foxes, deers, chamois, wild boars, etc. (illustration by Mauricio Antón; <http://www.mauricioanton.com/>).

- The musk ox (*Ovibos moschatus*) occurred in Europe under cold climatic conditions until the late-glacial (Stuart, 1991), but small populations have now been re-established in the Scandinavian mountains since the middle of the 20th century.

In neither case has the re-introductions caused these species to widely displace extant native species.

In addition to the above species a number of other large mammal species that became extinct in Europe during the latest Pleistocene or Holocene could also be considered in a European re-wilding strategy:

In a number of cases the species in question still survives outside Europe, although often under precarious circumstances:

- Lion (*Panthera leo*): An obvious candidate for re-establishment would be the Asiatic lion (ssp. *persica*), now restricted to just 300+ individuals in a very limited region in India (<http://en.wikipedia.org/>

[wiki/Asiatic lion](http://en.wikipedia.org/wiki/Asiatic_lion)): Lions probably belonging to this subspecies occurred in the Balkans as far north as Hungary just a few thousand years ago, while lions also persisted into the early Holocene in the northern Iberian Peninsula (Vörös, 1983; Sommer and Benecke, 2006). Furthermore, lions of the extinct *spelaea* subspecies were widespread in Europe until the end of the last glacial, perhaps mixed with the modern Asiatic subspecies in Eastern Europe (Stuart, 1991; Yamaguchi et al., 2004).

- Leopard (*Panthera pardus*), spotted hyena (*Crocuta crocuta*), and dhole or Asiatic wild dog (*Cuon alpinus*): These large predators were widespread in Europe during the Late Pleistocene, with the leopard possibly still occurring in Greece into historic times, and the spotted hyena and dhole having last occurrences during the late-glacial (Kurtén, 1968; Stuart, 1991; Stewart, 2004; Sommer and Benecke, 2005, 2006; Voultsiadou and Tatolas, 2005). Of

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these, the leopard is declining, with several of its subspecies in danger of extinction or already extinct, while the dhole has just 2,500 free-living individuals and is declining as well (<http://www.iucnredlist.org>).

- Horse (*Equus caballus*) and cattle (*Bos taurus*): Both species were widespread in Late Pleistocene and Holocene Europe, but went extinct in wild form within the last 400 years. However, both species still exist in domesticated and feral form in Europe and de-domesticated forms are already being used in local re-wilding projects, see e.g. <http://en.wikipedia.org/wiki/Oostvaardersplassen>.
- Asiatic wild ass (*Equus hemionus*): This species occurred in south-eastern Europe into the Medieval Period (Willms, 1989). Furthermore, it could be introduced in Europe's drier regions a proxy for the closely related (conspecific?), extinct European wild ass (*Equus hydruntinus*), which was widespread in Europe during the Late Pleistocene and far into the Holocene, probably surviving in Portugal and Spain into medieval times and possibly as late as 1540 AD (Kurtén, 1968; Uerpmann, 1976; Vörös, 1981; Willms, 1989; Nores Quesada and Von Lettow-Vorbeck, 1992; Burke et al., 2003; Antunes, 2006; Orlando et al., 2006). The noun zebro was originally for this species, but was later transferred to the African striped equid by Iberian explorers (Nores Quesada and Von Lettow-Vorbeck, 1992; Antunes, 2006). The Asiatic wild ass is listed as vulnerable by the IUCN and has several critically endangered or extinct subspecies (<http://www.iucnredlist.org>).



The konik is a small semi-wild horse race that is similar to and partially descended from the last originally wild horses of Europe. It is increasingly used in the management of natural areas; here, Lille Vildmose in Denmark (photo: Biopix.dk [J.C. Schou]; <http://www.biopix.dk>).



Aurochs-like de-domesticated cattle is increasingly used in the management of natural areas in Europe; here, Lille Vildmose in Denmark (photo: Biopix.dk [J.C. Schou]; <http://www.biopix.dk>).

- The hippopotamus (*Hippopotamus amphibius*): The modern species was common in the Late Pleistocene Europe under warm-temperate conditions (e.g., in the Thames river during the last interglac-

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cial), probably becoming extinct on the European continent relatively early during the last glacial (Kurtén, 1968; Stuart, 1991; van Kolfschoten, 2000). Currently, the hippopotamus is declining in its African range and is listed as vulnerable by the IUCN (<http://www.iucnredlist.org>).

Some large mammal species that went extinct not only in Europe, but also globally during the Late Pleistocene have extant relatives that could be re-introduced as ecological and evolutionary proxies:

- Asiatic elephant (*Elephas maximus*): This species could be used as a proxy of the closely related straight-tusked elephant (*Elephas [Palaeoloxodon] antiquus*), which was widespread in Europe under warm- to cool-temperate conditions during the Late Pleistocene (Kurtén, 1968; Poulakakis et al., 2002). The straight-tusked elephant became extinct in continental Europe during the middle part of the last glacial (Mol et al., 2007), but Mediterranean island dwarf

forms survived later, notably until <4,000 year ago on the Greek island of Tilos (Stuart, 1991). It is worth noting that the Asiatic elephant is not an exclusively tropical species, but was widespread in temperate China during earlier in the Holocene (e.g., Tong and Patou-Mathis, 2003; http://www.nature.com/nature/journal/v430/n6999/full/430505a_fs.html). Currently, wild populations are declining and the species is listed as endangered (<http://www.iucnredlist.org>).

- The water buffalo (*Bubalus bubalis*): This Asian species could be used as a proxy for the extinct species *B. murrensis*, which occurred under warm-temperate conditions in Europe at least until the last interglacial (Kurtén, 1968; van Kolfschoten, 2000). The wild water buffalo is endangered and now numbers <4,000 individuals (<http://www.iucnredlist.org>).



*Upper Pleistocene landscape from Madrid (Central Iberia), with wolves, deers, wild horses, aurochs (wild cattle, *Bos primigenius*) and mammoths (illustration by Mauricio Antón; <http://www.mauricioanton.com/>).*

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- Sumatran or hairy rhinoceros (*Dicerorhinus sumatrensis*): If saved from the brink of extinction (e.g., http://en.wikipedia.org/wiki/Sumatran_Rhinoceros), this species of mountainous forest regions in Southeast Asia could possibly be used as a proxy for the extinct Merck's rhinoceros (*D. kirchbergensis*), a temperate forest species that became extinct during the last glacial (Kurtén, 1968).

In recent years the ecological role of large herbivores in European nature has been much debated (e.g., Vera, 2000; Svenning, 2002), and more or less free-ranging large herbivores are increasingly re-introduced to aid the management of natural areas. Moreover, as already mentioned Europe has already made successful experiences with megafauna re-introductions, notably European bison, fallow deer, and musk ox. Clearly, given the particularly good possibilities for re-establishing a near-complete European megafauna and the precarious circumstances under which many

of the candidate species exist outside Europe, Pleistocene re-wilding deserves to become more broadly considered in European nature conservation.

This is not to say that there will not be many, difficult cultural and sociological challenges to the implementation of full-scale Pleistocene re-wilding in Europe, perhaps even more so than in North America. Many of the candidate species require large areas and some, such as lions, are dangerous to humans. It may seem unrealistic to find living space for such animals in densely populated Europe. However, it is important to remember that the areas in Asia and Africa where the candidate species occur today also are home to large and growing numbers of people. To achieve long-term preservation of Earth's magnificent megafauna as evolutionary and ecologically viable, free-living species will require solutions that allow humans and large, dangerous animals to coexist.



Upper Pleistocene (cold period) landscape from Northern Iberian Peninsula, with mammoths, woolly rhinoceros, lions, reindeers and wild horses (illustration by Mauricio Antón; <http://www.mauricioanton.com/>).

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The drawings of the Iberian megafauna communities from the Upper Pleistocene that illustrate this article and the cover of this issue have been kindly handed over by **Mauricio Antón**.

Mauricio is a Paleontological Artist, specialized in creating images that bring prehistoric creatures and their environments back to life. He has created artwork for museum exhibits worldwide, co-authored and illustrated numerous books and magazine articles, and collaborated with the BBC and Discovery Channel in developing several documentary films. He is also a regular collaborator of many Paleontologists. The results of his research on the anatomy of fossil vertebrates have been published several academic journals (e.g., *Journal of Vertebrate Paleontology*, *Journal of Human Evolution* or *Proceedings of the National Academy of Sciences USA*). Mauricio is currently exploring the applications of computer graphic imaging and animation to paleoart. Some of his books are:

Agustí, J. & Antón, M. (2002) *Mammoths, Sabertooths, and Hominids*. Columbia University Press, New York. (on the evolution of European mammal faunas)

Turner A. & Antón, M. (2004) *Evolving Eden*. Columbia University Press, New York. (on the evolution of African mammal faunas)

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For further information see:

<http://www.mauricioanton.com/>

http://www.comunidadsmart.es/articulos_detalle.php?id=268
(in Spanish)

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