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Megafauna restoration as a legal obligation: International biodiversity law and the rehabilitation of large mammals in Europe

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Abstract

Restoring functional ecosystems in Europe inter alia requires restoring large mammal (megafauna) diversity and densities to levels well above the current downgraded state, which results from a human-driven wave of megafauna extinctions and extirpations in the Late Pleistocene and Holocene. Combining law and natural science, we address the question to what degrees international legal instruments support or require such megafauna rewilding efforts. We provide an overview of Europe's current megafauna plus those species that would likely have been present without human interference. We categorize these species and restoration scenarios in ways that make sense from a legal perspective and identify and interpret relevant legal instruments. Our analysis indicates that Article 8(f) of the Convention on Biological Diversity requires restoring the diversity and densities of Europe's megafauna as far as possible—which is indeed quite far. Depending on the circumstances, megafauna rewilding measures can also be required or supported by various other legal instruments at global, pan-European, European Union and other levels.

1 | INTRODUCTION

Most European ecosystems are far removed from a healthy,[1] well-functioning state, due to a mix of causes under the familiar headings of habitat loss and fragmentation, unsustainable resource use, pollution and invasive alien species, with climate change a looming massive new threat.[2] Notable and well-known current stressors include nitrogen overload, pesticide use and a strongly modified hydrology.[3] One fundamental factor radically affecting ecosystem health is often overlooked, however, namely, a gaping shortage of naturally living megafauna. Large herbivores, omnivores and carnivores have been important components, shapers and maintainers of ecosystems in Europe—and elsewhere—for millions of years.[4] To get an approximate idea of the diversity and abundance of megafauna that formed the global pattern until quite recently, one must now travel to places like Chobe National Park in Botswana or Kaziranga National Park in India. Europe, in addition to today's deer, wild boar, ibex and occasional bison, lynx, wolves and brown bears, used to be home to elephants, rhinos, hippos, water buffalo, giant deer, aurochs, wild horses and onagers, cave bears, moon

[1]Different definitions of 'ecosystem health' exist, including 'the state or condition of an ecosystem in which its dynamic attributes are expressed within the normal range of activity relative to its ecological state of development': J van Andel and J Aronson, *Restoration Ecology* (Blackwell Science 2006). It is closely related to 'ecosystem integrity', which can be defined as 'the ability of an ecosystem to support and sustain characteristic ecological functioning and biodiversity (i.e. species composition and community structure)' and can be 'measured as the extent that a community of native organisms is maintained'; GD Gann et al, 'International Principles and Standards for the Practice of Ecological Restoration – Second Edition' (2019) 27 Restoration Ecology S1.

[2]European Environment Agency, *State of Nature in the EU* (EU Publications Office 2020).

[3]ibid.

[4]Accessible introductions to this topic include T Flannery, *Europe* (Penguin Books 2019); and R Barnett, *The Missing Lynx* (Bloomsbury Wildlife 2019).

bears (Asiatic black bears), scimitar cats, lions, leopards, hyenas and dholes (Asiatic wild dogs).[5] Then, during a brief period spanning the Late Pleistocene and Holocene—the blink of an eye in geological and evolutionary terms—many of these large mammals, including all the very largest, went globally extinct or were extirpated from Europe.[6] Others were decimated. The cause: *Homo sapiens*.[7] As discussed below, this megafaunal collapse has profound implications for the functioning of ecosystems and the prospects of biodiversity at large. It appears possible, however, to restore Europe's megafauna to significant degrees, both through natural range expansions and (re)introductions of lost species or 'surrogates' thereof.

Law, at national and international levels, always plays a role in such megafauna restoration scenarios.[8] This role is often significant, and sometimes decisive. In this article, we focus primarily on the role of international nature conservation law in this context. In particular, we address the question to what degree global and regional legal instruments in this area support or even require megafauna rewilding efforts in Europe. In pursuing an answer, we combine standard international and European law research methodology with knowledge and insights from the relevant natural science literature (particularly ecology and palaeontology).

Our approach comprises the following elements. First, we concisely present current scientific knowledge regarding the causes and consequences of the breakdown of Europe's megafauna and the scope for restoration (Section 2). Second, we identify the concrete species at issue, compiling an overview of Europe's remaining large wild mammals as well as those species that would most likely have been present without human interference (Section 3). Third, we attempt to categorize those species and restoration scenarios in ways that make sense from a legal perspective (Section 4). Fourth, we identify relevant legal instruments and provisions and interpret the latter inter alia in light of the best scientific information available (Section 5). Finally, we summarize and reflect on our findings (Section 6).

2 | MEGAFAUNA: IMPORTANCE, DEPLETION AND RESTORATION

The megafauna extinction wave that hit Europe and much of the rest of the world during the Late Pleistocene and the Holocene was not a 'natural' development in the classical sense, for the evidence points to humans as the driving force.[9] In Africa and southern Asia, where wildlife co-evolved with hominids, fewer extinctions occurred, albeit even these regions suffered reductions in megafauna diversity.[10] Then *H. sapiens* spread across the globe, trailing a wake of extinctions[11]—likely triggered by a suite of human 'behavioural and technological adaptations for which the megafauna was totally unprepared', as palaeontologist Ross Barnett puts it.[12] There is a 'freaky coincidence' across continents and islands: 'People turn up and megafauna disappear'.[13] Europe is no exception, although extinctions were not as sudden and severe as in Australia and the Americas. This is probably linked to the fact that European fauna already had some prior experience with hunting hominids when *H. sapiens* arrived. The end result is the same: Europe became a 'drabber' place, 'pruned of all the strangest, largest and wildest animals.'[14] It cannot be excluded that climatic changes played a role in some extinctions,[15] but most if not all of the lost megafauna would probably still be around today had it not been for our ancestors. These losses left faunas in Europe and around the world in a downsized state that is unprecedented for at least 30 million years.[16]

Besides the loss of these large mammal species themselves, their disappearance has profound implications for European ecosystems and biodiversity at large. Megafauna are of great importance for the functioning of ecosystems through a range of mechanisms.[17] Large herbivores shape vegetation structure and the physical environment

[5]See, e.g., B Kurtén, *Pleistocene Mammals of Europe* (Routledge 1968/2017); and Table 1, which also provides the scientific names of the species listed there.
[6]ibid.
[7]See Section 2.
[8]See, e.g., N Pettorelli et al, 'Making Rewilding Fit for Policy' (2018) 55 Journal of Applied Ecology 1114; P Jepson and C Blythe, *Rewilding: The Radical New Science of Ecological Recovery* (Icon Books 2020); A Trouwborst, 'Megafauna Rewilding: Addressing Amnesia and Myopia in Biodiversity Law and Policy' (2021) 33 Journal of Environmental Law 639; A Trouwborst et al, 'Conservation Translocations and the Law' in M Gaywood et al (eds), *Conservation Translocations* (Cambridge University Press forthcoming).
[9]See, e.g., PS Martin, 'Pleistocene Overkill' (1967) 76 Natural History 32; AD Barnosky et al, 'Assessing the Causes of Late Pleistocene Extinctions on the Continents' (2004) 306 Science 70; DA Burney and TF Flannery, 'Fifty Millennia of Catastrophic Extinctions after Human Contact' (2005) 20 Trends in Ecology and Evolution 395; C Sandom et al, 'Global Late Quaternary Megafauna Extinctions Linked to Humans, Not Climate Change' (2014) 281 Proceedings of the Royal Society B 20133254; S Faurby and J-C Svenning, 'Historic and Prehistoric Human-Driven Extinctions Have Reshaped Global Mammal Diversity Patterns' (2015) 21 Diversity and Distributions 1155; S Varela et al, 'Differential Effects of Temperature Change and Human Impact on European Late Quaternary Mammalian Extinctions' (2015) 21 Global Change Biology 1475; BBA Araújo et al, 'Bigger Kill than Chill: the Uneven Roles of Humans and Climate Change on Late Quaternary Megafaunal Extinctions' (2017) 531 Quaternary International 216; J Dembitzer et al, 'Levantine Overkill: 1.5 Million Years of Hunting Down the Body Size Distribution' (2022) 276 Quaternary Science Reviews 107316.
[10]JT Faith, 'Late Pleistocene and Holocene Mammal Extinctions on Continental Africa' (2014) 128 Earth-Science Reviews 105; ST Turvey et al, 'Late Quaternary Megafaunal Extinctions in India: How Much Do We Know?' (2021) 252 Quaternary Science Reviews 106740.
[11]See sources in n 9.
[12]Barnett (n 4) 25.
[13]ibid 27.
[14]ibid 293.
[15]However, we do not know any case where good evidence exists for climate change having caused any of the Late Pleistocene megafauna extinctions.
[16]FA Smith et al, 'Body Size Downgrading of Mammals over the Late Quaternary' (2018) 360 Science 310.
[17]See, e.g., K Danell et al (eds), *Large Herbivore Ecology, Ecosystem Dynamics and Conservation* (Cambridge University Press 2006); JA Estes et al, 'Trophic Downgrading of Planet Earth' (2011) 333 Science 301; CJ Sandom et al, 'High Herbivore Density Associated with Vegetation Diversity in Interglacial Ecosystems' (2014) 111 Proceedings of the National Academy of Sciences of the United States of America 4162; WJ Ripple et al, 'Status and Ecological Effects of the World's Largest Carnivores' (2014) 343 Science 1241484; WJ Ripple et al, 'Collapse of the World's Largest Herbivores' (2015) 1 Science Advances e1400103; Y Malhi et al, 'Megafauna and Ecosystem Function from the Pleistocene to the Anthropocene' (2016) 113 Proceedings of the National Academy of Sciences of the United States of America 838; ES Bakker et al, 'Combining Paleo-Data and Modern Exclosure Experiments to Assess the Impact of Megafauna Extinctions on Woody Vegetation' (2016) 113 Proceedings of the National Academy of Sciences of the United States of America 847; B van Valkenburgh et al, 'The Impact of Large Terrestrial Carnivores on Pleistocene Ecosystems' (2016) 113 Proceedings of the National Academy of Sciences of the United States of America 862; CE Doughty et al, 'Global Nutrient Transport in a World of Giants' (2016) 113 Proceedings of the National Academy of Sciences of the United States of America 868; FA Smith et al, 'Megafauna in the Earth System' (2016) 39 Ecography 213; M Galetti et al, 'Ecological and Evolutionary Legacy of Megafauna Extinctions' (2018) 93 Biological Reviews 845; JC Svenning, M Munk and A Schweiger, 'Trophic Rewilding: Ecological Restoration of Top-down Trophic Interactions Promote Self-Regulating Biodiverse Ecosystems' in JT du Toit, N Pettorelli and SM Durant (eds), *Rewilding* (Cambridge University Press 2019) 73; A Perino et al, 'Rewilding Complex Ecosystems' (2019) 364 Science eaav5570; Jepson and Blythe (n 8); EJ Lundgren et al, 'Functional Traits of the World's Late Quaternary Large-Bodied Avian and Mammalian Herbivores' (2021) 8 Scientific Data 17.

through their grazing, browsing, physical disturbance and dispersal of propagules and nutrients. These effects are themselves influenced by interactions with large carnivores. Further, the living bodies, carcasses and dung of megafauna provide a range of specialized biotic microhabitats for other species. Large mammals' great mobility generates high biotic connectivity through dispersal of many species of plants, fungi and invertebrates, affecting their colonization, distribution and maintenance within and between landscapes—thereby also helping those species adapt to climatic and other change.[18]

In general terms, functional, diverse megafaunas are thus expected to foster overall biodiversity at local and landscape scales via promoting heterogeneity in vegetation and soils, via providing a diversity of biotic microhabitats, and via enhancing dispersal, all of which are well-established biodiversity-promoting factors.[19] These effects are expected to enhance biodiversity in all ecosystems, also future 'novel'[20] ecosystems. Importantly, these ecological effects are strongly mediated by megafauna functional diversity, for instance, body sizes and diet preferences of herbivores.[21] To illustrate, horses, cattle and European bison exhibit different dietary preferences with likely significant ecological implications, with bison, for instance, more frequently debarking trees and hence expected to provide the stronger constraints on tree performance.[22]

In addition to their importance for biodiversity conservation and restoration, ecosystems with a diverse and functional megafauna can provide 'nature-based solutions' in the areas of climate change mitigation and adaptation[23]—including carbon storage,[24] flood management and wildfire control[25]—and other co-benefits such as invasive species control,[26] soil health,[27] zoonotic disease prevention,[28] and rich opportunities for ecotourism.[29] The extent to which humans can successfully mimic the countless ecological roles of megafauna at relevant scales is limited, and the management actions employed in trying tend to be costly.[30]

The good news is that it appears possible to repair the damage to a significant degree and to 'bring back species and ecological processes that have been shunted aside'.[31] Depending on the species, such megafauna restoration can be achieved by enabling a natural expansion of range and numbers; by active reintroduction; or by introduction of proxies for extinct species. These efforts link to the rising interest in 'nature-led' restoration, that is, rewilding.[32] Rewilding can be defined as restoration to promote self-regulating complex ecosystems through restoring non-human ecological factors and processes while reducing human control and pressures.[33] This includes trophic rewilding, which emphasizes the use of species introductions to restore top-down trophic interactions, generally with a focus on megafauna, given their ecological importance but widespread removal from our current landscapes.[34]

Not every single species will be equally essential for ecosystem and biodiversity restoration, but maximizing the functional diversity and abundance of megafauna as such is evidently crucial. Recovery of the megafauna-associated processes outlined above is not only expected on theoretical grounds,[35] but empirical studies from a rising number of real landscapes across Europe provide validation of this expectation, documenting effects of megafauna on, inter alia, vegetation structure and plant and insect diversity.[36] For example, a recent

[18]See, e.g., EC Fricke et al, 'The Effects of Defaunation on Plants' Capacity to Track Climate Change' (2022) 375 Science 210.

[19]See, e.g., E Barbero, C Palestrini and A Rolando, 'Dung Beetle Conservation: Effects of Habitat and Resource Selection (Coleoptera: Scarabaeoidea)' (1999) 3 Journal of Insect Conservation 75; J Buse et al, 'Dung Beetle Richness is Positively Affected by the Density of Wild Ungulate Populations in Forests' (2021) 30 Biodiversity and Conservation 3115; EI Damschen et al, 'Ongoing Accumulation of Plant Diversity through Habitat Connectivity in an 18-Year Experiment' (2019) 365 Science 1478; D Martín-Vega, A Baz and V Michelsen, 'Back from the Dead: *Thyreophora cynophila* (Panzer, 1798) "Globally Extinct" Fugitive in Spain' (2010) 35 Systematic Entomology 607; A Stein, K Gerstner and H Kreft, 'Environmental Heterogeneity as a Universal Driver of Species Richness Across Taxa, Biomes and Spatial Scales' (2014) 17 Ecology Letters 866.

[20]RJ Hobbs, E Higgs and JA Harris, 'Novel Ecosystems: Implications for Conservation and Restoration' (2009) 24 Trends in Ecology and Evolution 599.

[21]See, e.g., Bakker et al (n 17); C Baltzinger, S Karimi and U Shukla, 'Plants on the Move: Hitch-Hiking with Ungulates Distributes Diaspores Across Landscapes' (2019) 7 Frontiers in Ecology and Evolution 38.

[22]JPGM Cromsigt et al, 'Rewilding Europe's Large Grazer Community: How Functionally Diverse are the Diets of European Bison, Cattle, and Horses?' (2018) 26 Restoration Ecology 891; see also R Kowalczyk, T Kamiński and T Borowik, 'Do Large Herbivores Maintain Open Habitats in Temperate Forests?' (2021) 494 Forest Ecology and Management 119310.

[23]Y Malhi et al, 'The Role of Large Wild Animals in Climate Change Mitigation and Adaptation' (2022) 32 Current Biology 181.

[24]ibid; JPGM Cromsigt et al, 'Trophic Rewilding as a Climate Change Mitigation Strategy?' (2018) 373 Philosophical Transactions of the Royal Society B 20170440; CJ Sandom et al, 'Trophic Rewilding Presents Regionally Specific Opportunities for Mitigating Climate Change' (2020) 375 Philosophical Transactions of the Royal Society B 20190125; JA Kristensen et al, 'Can Large Herbivores Enhance Ecosystem Carbon Persistence?' (2021) 37 Trends in Ecology and Evolution 117.

[25]Cromsigt et al (n 24); Sandom et al (n 24); CN Johnson et al, 'Can Trophic Rewilding Reduce the Impact of Fire in a More Flammable World?' (2018) 373 Philosophical Transactions of the Royal Society B 20170443.

[26]TT Derham et al, 'Hope and Caution: Rewilding to Mitigate the Impacts of Biological Invasions' (2018) 373 Philosophical Transactions of the Royal Society B 20180127.

[27]Doughty et al (n 17).

[28]CE Doughty, 'Megafauna Decline Have Reduced Pathogen Dispersal Which May Have Increased Emergent Infectious Diseases' (2020) 43 Ecography 1107.

[29]Jepson and Blythe (n 8).

[30]See, e.g., JG Hodgson et al, 'How Much Will It Cost to Save Grassland Diversity?' (2005) 122 Biological Conservation 263; A Holzkämper and R Seppelt, 'Evaluating Cost-Effectiveness of Conservation Management Actions in an Agricultural Landscape on a Regional Scale' (2007) 136 Biological Conservation 117; JS Schou et al, 'Economic Assessment of Rewilding Versus Agri-Environmental Nature Management' (2021) 50 Ambio 1047.

[31]JB MacKinnon, *The Once and Future World* (Vintage Canada 2014) 67.

[32]Recent introductions to the burgeoning literature on rewilding include S Carver et al, 'Guiding Principles for Rewilding' (2021) 35 Conservation Biology 1882; and Jepson and Blythe (n 8).

[33]JC Svenning, 'Rewilding Should Be Central to Global Restoration Efforts' (2020) 3 One Earth 657; Carver et al (n 32) 1888 define rewilding as 'the process of rebuilding, following major human disturbance, a natural ecosystem by restoring natural processes and the complete or near complete food web at all trophic levels as a self-sustaining and resilient ecosystem with biota that would have been present had the disturbance not occurred'.

[34]JC Svenning et al, 'Science for a Wilder Anthropocene: Synthesis and Future Directions for Trophic Rewilding Research' (2016) 113 Proceedings of the National Academy of Sciences of the United States of America 898.

[35]See, e.g., E Berti and JC Svenning, 'Megafauna Extinctions Have Reduced Biotic Connectivity Worldwide' (2020) 29 Global Ecology and Biogeography 2131; D Schowanek et al, 'Reintroducing Extirpated Herbivores Could Partially Reverse the Late Quaternary Decline of Large and Grazing Species' (2021) 30 Global Ecology and Biogeography 896.

[36]M Dvorský et al, 'Reintroduction of Large Herbivores Restored Plant Species Richness in Abandoned Dry Temperate Grassland' (2022) Plant Ecology; P Garrido et al, 'Experimental Rewilding Enhances Grassland Functional Composition and Pollinator Habitat Use' (2019) 56 Journal of Applied Ecology 946; K Gilhaus et al, 'High Fodder Value and Feeding Likelihood Favour Endozoochorous Plant Dispersal' (2017) 28 Journal of Vegetation Science 357; M Konvička et al, 'Restoring a Butterfly Hot Spot by Large Ungulates Refaunation: The Case of the Milovice Military Training Range, Czech Republic' (2021) 21 BMC Ecology and Evolution 73; Kowalczyk et al (n 22); M Köhler, G Hiller and S Tischew, 'Year-Round Horse Grazing Supports Typical Vascular Plant Species, Orchids and Rare Bird Communities in a Dry Calcareous Grassland' (2016) 234 Agriculture, Ecosystems and Environment 48; D Rupprecht, K Gilhaus and N Hölzel, 'Effects of Year-Round Grazing on the Vegetation of Nutrient-Poor Grass- and Heathlands – Evidence from a Large-Scale Survey' (2016) 234 Agriculture, Ecosystems and Environment 16; PA Stroh, JO Mountford and FMR Hughes, 'The Potential for Endozoochorous Dispersal of Temperate Fen Plant Species by Free-Roaming Horses' (2012) 15 Applied Vegetation Science 359.

study found that the translocation of European bison, Exmoor ponies and Tauros cattle to abandoned grassland areas in the Czech Republic had, after seven years, substantially influenced the ecosystem, 'increasing its species richness and functional diversity, proportion of flowering forbs and abundance of red-listed taxa'.[37]

3 | EUROPE'S DIMINISHED MEGAFAUNA: AN OVERVIEW

Much of Europe's megafauna has thus, 'like the fabled trolls and goblins of mythology, retreated long ago to distant or invisible realms', Tim Flannery observes in his recent book on the continent's natural history.[38] Every now and then, fossil finds reveal glimpses. An intriguing example is a fossilized stretch of beach in Doñana National Park in Spain, where about a 100,000 years ago, wild boar, red deer, wolves, geese and small wader birds left their footprints alongside those of aurochs and straight-tusked elephants (a temperate-climate elephant species).[39] When a storm surge uncovered this scene in 2020, researchers identified a maze of elephant footprints from adults, adolescents, juveniles and newborns, painting a vivid mental image of a matriarchal herd of straight-tusked elephants roaming along together in much the same way as present-day elephants continue to do in parts of Africa and Asia.[40] The fact that most people today do not realize that European landscapes are incomplete without elephants, rhinos, lions[41] and other lost megafauna is a consequence of the 'shifting baseline syndrome': each new generation of humans tends to regard the circumstances they grow up in as normal and to unconsciously accept the cumulative ecological damage inflicted by prior generations.[42]

How much of Europe's megafauna has disappeared to 'invisible realms' becomes clearer from Table 1. It lists all terrestrial mammals of 10 kg or more that are naturally present in Europe, as well as the species that would in all likelihood have currently occurred in Europe, had it not been for the influence of (early) modern humans (*H. sapiens*).[43] Europe is defined here as running up to the Ural mountains, the Greater Caucasus mountains and the Sea of Marmara and Bosporus. Of the 74 species that would have naturally composed Europe's megafauna today, 39 have gone missing—a loss of more than 50%. But the damage is not evenly spread. Even a brief glance at Table 1, which orders species by weight, makes obvious that the biggest species—with their concomitantly big importance for ecosystem function[44]—have been hardest hit. When looking at species of 100 kg or more, the loss exceeds 75%. Of 35 such species, only eight remain.

In total, 30 large herbivores vanished from Europe, including all eight 'megaherbivores' weighing over 1000 kg, that is, hippos, rhinos and elephants. This reflects a global pattern, whereby the largest and grazing herbivores have suffered the greatest losses, resulting in the current imbalanced situation wherein browsing species predominate, with sizable gaps in the species composition for grazers and mixed feeders when compared to natural baseline situations.[45] Of the large carnivores, nine disappeared from the continent,[46] and two others, leopard and striped hyena, have barely a toehold. The latter two species' situation illustrates an important point, namely, that Table 1 only registers species' *presence* in Europe. For extant species, it neither shows across how much (or little) of the continent they occur, nor in what densities.[47] Many species registered as 'present' in Table 1 occur in small and fragmented parts of their former ranges, and in densities that are below 'natural' levels, with both circumstances curtailing these species' ecological functionality to significant degrees.[48]

It should be noted that humans are not only responsible for the removal of many native species but also for the addition of several non-native megafauna species, not mentioned in Table 1, to various parts of Europe. In particular, this concerns the herbivores Reeves' muntjac (*Muntiacus reevesi*), Chinese water deer (*Hydropotes inermis*) and sika deer (*Cervus nippon*) from Asia; North American beaver (*Castor canadensis*) and white-tailed deer (*Odocoileus virginianus*) from North America; and aoudad (*Ammotragus lervia*, Barbary sheep) from Africa.[49] All of these have an average weight of less than 100 kg, so in no way make up for the loss of the largest native European species.

4 | MAKING LEGAL SENSE OF MEGAFAUNA RESTORATION SCENARIOS

Table 1 not only shows how much has been lost but also demonstrates the tremendous potential for restoring Europe's megafauna, given the will to do so. The possibility and likelihood of restoring different species will depend on many factors—including legal ones. Table 1 indicates species' status, if any, under various international legal instruments in the field of nature conservation, that is, the Convention on the Conservation of European Wildlife and Natural

[37]Dvorský et al (n 36).
[38]Flannery (n 4) 305.
[39]CN de Carvallo et al, 'First Vertebrate Tracks and Palaeoenvironment in a MIS-5 Context in the Doñana National Park' (2020) 243 Quaternary Science Reviews 106508.
[40]CN de Carvallo et al, 'First Tracks of Newborn Straight-Tusked Elephants (*Palaeoloxodon antiquus*)' (2021) 11 Scientific Reports 17311.
[41]Even palaeontologists occasionally need to squeeze themselves: 'Lions are a native British species, which is sort of mind-bending. They should be here but aren't'. Barnett (n 4) 103.
[42]See, e.g., F Vera, 'The Shifting Baseline Syndrome in Restoration Ecology' in M Hall (ed), *Restoration and History* (Routledge 2010) 98; M Soga and KJ Gaston, 'Shifting Baseline Syndrome: Causes, Consequences, and Implications' (2018) 16 Frontiers in Ecology and the Environment 222.
[43]Partly terrestrial marine mammals (polar bear, walrus, seals) are excluded; we have also left out two extinct hominids, that is, Neanderthals (*Homo neanderthalensis*) and Denisovans (*Homo denisova*) and *Homo sapiens* itself.
[44]O Hyvarinen et al, 'Megaherbivore Impacts on Ecosystem and Earth System Functioning: the Current State of the Science' (2021) 44 Ecography 1.
[45]Schowanek et al (n 35). The term 'baseline' is used here in the sense of a reference model for ecosystem restoration sensu Gann et al (n 1).
[46]Cave bears are included here for taxonomical reasons, although they were predominantly or exclusively vegetarians; see, e.g.,Y. Naito et al., 'Heavy Reliance on Plants for Romanian Cave Bears Evidenced by Amino Acid Nitrogen Isotope Analysis' (2020) 10 Scientific Reports 6612.
[47]C Fløjgaard et al, 'Exploring a Natural Baseline for Large-Herbivore Biomass in Ecological Restoration' (2021) 59 Journal of Applied Ecology 18.
[48]See, e.g., ibid; JDC Linnell et al, 'The Challenges and Opportunities of Coexisting with Wild Ungulates in the Human-Dominated Landscapes of Europe's Anthropocene' (2020) 244 Biological Conservation 108500.
[49]Linnell et al (n 48).

TABLE 1 Species that would likely have constituted Europe's terrestrial mammalian megafauna today without past human interference

Common name	Scientific name	Weight	Present in Europe	Global cons. status	BC	HD	CITES	EU CITES Reg.
Golden jackal	*Canis aureus*	10	V	LC	-	V	III*	C*
Sardinian dhole	*Cynotherium sardous*	11	-	EX	-	-	-	-
Barbary macaque	*Macaca sylvanus*	12	V	EN	-	-	I	A
Indian crested porcupine	*Hystrix indica*	12	V	LC	-	-	-	-
Dhole	*Cuon alpinus*	13	-	EN	II	-	II	B
Eurasian badger	*Meles meles*	13	V	LC	III	-	-	-
Iberian lynx	*Lynx pardinus*	13	V	EN	II	II, IV	I	A
Caracal	*Caracal caracal*	14	V	LC	II	-	I/II	A/B
Crested porcupine	*Hystrix cristata*	16	V	LC	-	IV	-	A
Wolverine	*Gulo gulo*	17	V	LC	II	II	-	-
Eurasian lynx	*Lynx lynx*	18	V	LC	II/III	II*, IV/V	-	A
Eurasian beaver	*Castor fiber*	19	V	LC	III	II*, IV/V	-	-
(Porcupine sp.)	*Hystrix refossa*	20	-	EX	-	-	-	-
European roe deer	*Capreolus capreolus*	23	V	LC	III	-	-	-
Northern chamois	*Rupicapra rupicapra*	26	V	LC	II/III	II*, IV/V	-	-
Balearic mountain goat	*Myotragus balearicus*	26	-	EX	-	-	-	-
Goitered gazelle	*Gazella subgutturosa*	29	V	VU	II	-	-	-
Saiga	*Saiga tatarica*	29	V	CR	-	-	II*	B*
(Cretan dwarf deer sp.)	*Candiacervus ropalophorus*	30	-	EX	-	-	-	-
Southern chamois	*Rupicapra pyrenaica*	30	V	LC	II/III	II*	II*	A*
Wolf	*Canis lupus*	32	V	LC	II	II*, IV/V	I/II	A/B
Wild goat	*Capra aegagrus*	34	V	NT	II	II*, IV*	III*	C*
Striped hyena	*Hyaena hyaena*	42	V	NT	-	-	III*	C*
(Cretan deer sp.)	*Candiacervus* sp. II	43	-	EX	-	-	-	-
Siberian roe deer	*Capreolus pygargus*	44	V	LC	III	-	-	-
Cheetah	*Acinonyx jubatus*	47	-	VU	-	-	I*	A*
Iberian ibex	*Capra pyrenaica*	50	V	LC	II/III	II*, IV/V	-	-
Eastern tur	*Capra cylindricornis*	50	V	NT	-	-	-	-
Leopard	*Panthera pardus*	55	V	VU	II	-	I	A
Western tur	*Capra caucasica*	55	V	EN	-	-	II	B
Fallow deer	*Dama dama*	56	V	LC	III	-	I*	A*
Mouflon	*Ovis orientalis/gmelini*	60	V	NT	III	II*, IV*	I*	A*
Spotted hyena	*Crocuta crocuta*	63	-	LC	-	-	-	-

TABLE 1 (Continued)

Common name	Scientific name	Weight	Present in Europe	Global cons. status	BC	HD	CITES	EU CITES Reg.
(European tahr sp.)	*Hemitragus cedrensis*	65	-	EX	-	-	-	-
(Sardinian deer sp.)	*Praemegaceros cazioti*	70	-	EX	-	-	-	-
Persian fallow deer	*Dama mesopotamica*	73	-	EN	III?	-	I	A
(Cretan deer sp.)	*Candiacervus cretensis*	79	-	EX	-	-	-	-
Alpine ibex	*Capra ibex*	85	V	LC	III	V	-	-
Reindeer	*Rangifer tarandus*	86	V	VU	III	II*	-	-
(European deer sp.)	*Haploidoceros mediterraneus*	100	-	EX	-	-	-	-
Wild boar	*Sus scrofa*	101	V	LC	III*	-	-	-
Moon bear	*Ursus thibetanus*	105	-	VU	II?	-	I	A
Red deer	*Cervus elaphus*	131	V	LC	II/III	II*, IV*	I/II/III*	A/B/C*
Lion	*Panthera leo* (incl. *P. spelaea*)	162	-	VU	-	-	I/II*	A/B*
Tiger	*Panthera tigris*	163	-	EN	II	-	I	A
Brown bear	*Ursus arctos*	181	V	LC	II	II*, IV	I/II	A
Scimitar cat	*Homotherium latidens*	189	-	EX	-	-	-	-
Onager	*Equus hemionus*	200	V	NT	-	-	I/II	A
Wild horse	*Equus ferus/E. przewalskii*	200	V	EN	-	-	I*	A*
(Cretan deer sp.)	*Candiacervus rethymnensis*	222	-	EX	-	-	-	-
(Ovibovine caprine sp.)	*Soergelia minor*	225	-	EX	-	-	-	-
(Horse sp.)	*Equus ovodovi*	227	-	EX	-	-	-	-
(Horse sp.)	*Equus hydruntinus*	227	-	EX	-	-	-	-
Muskox	*Ovibos moschatus*	341	V	LC	II	-	-	-
Moose	*Alces alces*	357	V	LC	III	-	-	-
Cave bear	*Ursus spelaeus*	390	-	EX	-	-	-	-
European bison	*Bison bonasus*	500	V	NT	III	II, IV	-	-
(Giant deer sp.)	*Candiacervus dorothensis*	539	-	EX	-	-	-	-
Giant deer	*Megaloceros giganteus*	700	-	EX	-	-	-	-
(Giant deer sp.)	*Candiacervus major*	708	-	EX	-	-	-	-
(Antelope sp.)	*Spirocerus kiakhtensis*	791	-	EX	-	-	-	-
Steppe bison	*Bison priscus*	800	-	EX	-	-	-	-
European water buffalo	*Bubalus murrensis*	800	-	EX	-	-	-	-
Dromedary camel	*Camelus dromedarius*	800	-	EW	-	-	-	-
(Island dwarf elephant sp.)	*Palaeoloxodon tiliensis*	809	-	EX	-	-	-	-
Aurochs	*Bos primigenius*	900	-	EX	-	-	-	-
(Island dwarf elephant sp.)	*Palaeoloxodon mnaidriensis*	1102	-	EX	-	-	-	-

(Continues)

TABLE 1 (Continued)

Common name	Scientific name	Weight	Present in Europe	Global cons. status	BC	HD	CITES	EU CITES Reg.
Hippopotamus	*Hippopotamus amphibius*	1418	-	VU	-	-	II	B
Woolly rhinoceros	*Coelodonta antiquitatis*	2693	-	EX	-	-	-	-
Narrow-nosed rhinoceros	*Stephanorhinus hemitoechus*	2943	-	EX	-	-	-	-
Merck's rhinoceros	*Stephanorhinus kirchbergensis*	3631	-	EX	-	-	-	-
Siberian unicorn	*Elasmotherium sibiricum*	4100	-	EX	-	-	-	-
Woolly mammoth	*Mammuthus primigenius*	6000	-	EX	-	-	-	-
Straight-tusked elephant	*Palaeoloxodon antiquus*	13,000	-	EX	-	-	-	-

Notes: Terrestrial mammals ≥ 10 kg, except semi-terrestrial marine mammals and hominids. Occurrence and weight largely based on the Phylogenetic Atlas of Mammal Macroecology (PHYLACINE) database: S Faurby et al, 'PHYLACINE 1.2: The Phylogenetic Atlas of Mammal Macroecology' (2018) 99 Ecology 2626 <https://megapast2future.github.io/PHYLACINE_1.2/>. Europe is defined as delimited by Ural mountains, Greater Caucasus mountains, Sea of Marmara and Bosporus. Global conservation status = IUCN Red List status (LC = least concern; NT = near threatened; VU = vulnerable; EN = endangered; CR = critically endangered; EW = extinct in the wild; EX = extinct); BC = Bern Convention; HD = Habitats Directive; EU CITES Reg. = EU Basic CITES Regulation; * = limited to certain subspecies/populations/countries/areas, or with other annotation.

TABLE 2 Categorizing species and restoration scenarios

Species	Ways of restoring	Example
Extant in Europe	Natural (re)colonization	Wolf
	Reintroduction/reinforcement	European bison
Extirpated in Europe but surviving elsewhere	Reintroduction	Lion
Globally extinct in the originally wild form(s), but surviving in domesticated (and often feral) form	De-extinction—back-breeding/feralization/ ecological replacement	Aurochs
Globally extinct	De-extinction—genetic engineering	Cave bear
	Ecological replacement/assisted colonization	Asian elephant

Habitats (Bern Convention),[50] the European Union (EU) Directive 92/43 on the Conservation of Natural Habitats and of Wild Fauna and Flora (Habitats Directive),[51] the Convention on International Trade in Endangered Species (CITES)[52] and the primary piece of legislation implementing CITES in the EU (EU Basic CITES Regulation).[53] These and other legal instruments at national and international levels can play positive and negative roles regarding megafauna rewilding efforts. Depending on the species and the circumstances, the applicable law can promote or even require restoration action or, conversely, make restoration efforts difficult or impossible.[54] In Table 2 and below, we break down the species from Table 1 into categories to help make sense of various possible megafauna restoration scenarios from a legal perspective. Borders between categories are not always airtight, and a single species may be subject to different scenarios in different areas or moments in time.

TABLE 3 Categories of conservation translocations

Reinforcement	The intentional movement and release of an organism into an existing population of conspecifics
Reintroduction	The intentional movement and release of an organism inside its indigenous range from which it has disappeared
Assisted colonization	The intentional movement and release of an organism outside its indigenous range to avoid extinction of populations of the focal species
Ecological replacement	The intentional movement and release of an organism outside its indigenous range to perform a specific ecological function

Source: IUCN Species Survival Commission (SSC), 'Guidelines for Reintroductions and Other Conservation Translocations – Version 1.0' (IUCN SSC 2013).

4.1 | Species presently occurring in Europe

A first category consists of species still (or again) occurring within the continent. Some of these can reach and reoccupy other parts of their former European range, or indeed new areas, by themselves. Species in the process of doing so include roe deer, red deer, wild boar and moose.[55] An especially remarkable example is the ongoing natural comeback of wolves in Western Europe.[56] European legal instruments, most notably the Bern Convention and Habitats Directive, expect countries where wolves return to welcome them home.[57] This also applies to other comeback species covered by these instruments (see Table 1), and even to species that colonize places where they (ostensibly or certainly) did not occur in the past, a prime example being the spectacular European range expansion of the golden jackal.[58]

Some extant megafauna species are unlikely to resettle certain areas in the foreseeable future by themselves because of barriers to natural dispersal—for example, highways and other human infrastructure, or areas of inhospitable habitat such as extensive croplands—or sheer distance. They need a helping hand from humans and their trucks and trains. Such translocations of native animals to former ranges, dubbed 'reintroductions' (see Table 3), tend to be looked upon favourably by (inter)national nature conservation law and may in some cases actually be obligatory.[59] Examples of past megafauna reintroductions within Europe include European bison, Alpine ibex, Iberian ibex, Eurasian beaver, brown bear, Eurasian lynx and Iberian lynx.[60] When animals are brought over to boost the prospects of a still existing population, such as the translocation of Slovenian brown bears to the Pyrenees,[61] this is called 'reinforcement' (Table 3). The recovery of quite a few species, for instance, the four aforementioned lynx and ibex species, has been driven by a combination of reintroduction and natural expansion.[62]

4.2 | Species extirpated from Europe but surviving elsewhere

A second category consists of species that are gone from Europe but survive elsewhere. These extirpated native species include hippopotamus, lion, tiger,[63] spotted hyena, moon bear and dhole. In theory, some might make their own way back into Europe in the distant future. As this seems unlikely to happen anytime soon, reintroduction is the restoration measure of choice. The position of lions, moon bears and hippos differs gradually—through distancing in space and time—but not fundamentally from that of lynx, brown bears, moose and European bison, and their reintroduction in Europe would be no less 'natural'. (Notably, lions disappeared only within the last couple of

[50]Convention on the Conservation of European Wildlife and Natural Habitats (adopted 19 September 1979, entered into force 1 June 1982) 1284 UNTS 209 (Bern Convention).
[51]Directive 92/43/EEC of 21 May 1992 on the Conservation of Natural Habitats and of Wild Fauna and Flora [1992] OJ L206/7 (Habitats Directive).
[52]Convention on International Trade in Endangered Species of Wild Fauna and Flora (adopted 3 March 1973, entered into force 1 July 1975) 992 UNTS 243 (CITES).
[53]Regulation (EC) No. 338/97 on the Protection of Species of Wild Fauna and Flora by Regulating Trade Therein [1997] OJ L61/1 (EU Basic CITES Regulation).
[54]Pettorelli et al (n 8); Trouwborst (n 8).
[55]S Deinet et al, 'Wildlife Comeback in Europe' (Zoological Society of London 2013).
[56]G Chapron et al, 'Recovery of Large Carnivores in Europe's Modern Human-Dominated Landscapes' (2014) 345 Science 1517.
[57]See, e.g. A Trouwborst, 'Managing the Carnivore Comeback: International and EU Species Protection Law and the Return of Lynx, Wolf and Bear to Western Europe' (2010) 22 Journal of Environmental Law 347.
[58]A Trouwborst, M Krofel and JDC Linnell, 'Legal Implications of Range Expansions in a Terrestrial Carnivore: The Case of the Golden Jackal (*Canis aureus*) in Europe' (2015) 24 Biodiversity and Conservation 2593; see also, e.g., P Männil and N Ranc, 'Golden Jackal (*Canis aureus*) in Estonia: Development of a Thriving Population in the Boreal Ecoregion' (2022) 67 Mammal Research 245.
[59]See Section 5; Trouwborst (n 8); and Trouwborst et al (n 8).
[60]See, e.g., Deinet et al (n 55).
[61]See, e.g., PY Quenette et al, 'Preliminary Results of the First Transplantation of Brown Bears in the French Pyrenees' (2001) 12 Ursus 115.
[62]Deinet et al (n 55). Incidentally, despite its name, the Iberian lynx also occurred in places like southern France and Italy; see, e.g., B Mecozzi et al, 'The Tale of a Short-Tailed Cat: New Outstanding Late Pleistocene Fossils of *Lynx pardinus* from Southern Italy' (2021) 262 Quaternary Science Reviews 106840.
[63]Tigers vanished from the Caucasus (and Turkey) only in the early 20th century; on the prospects of their return see, e.g., IE Chestin et al, 'Tiger Re-Establishment Potential to Former Caspian Tiger (*Panthera tigris virgata*) Range in Central Asia' (2017) 205 Biological Conservation 42.

millennia, and so did onagers until their recent reintroduction.[64]) As current scientific knowledge and pertinent guidance documents suggest,[65] any chronological baseline for determining 'native' status that is drawn after the ostensibly anthropogenic disappearance of the species involved would seem essentially arbitrary.

Still, the legal status of species from this category tends to be mistier, as European societies' collective amnesia regarding these species has come to be reflected in biodiversity law and policy.[66] For instance, none of them is listed in the Habitats Directive's annexes, and this blind spot directly affects the scope of the Directive's provision on reintroductions, which is limited to listed species.[67] What is more, when the species concerned are no longer recognized as indigenous under applicable national law and policy, reintroduction proposals risk running into rules on invasive alien species.[68] Notwithstanding such institutional memory loss, various legal instruments do support and may even require European reintroductions of such species, as discussed below.[69] Indeed, Przewalski's horses are a living example of a species form that was extinct in the wild in Europe but then reintroduced, in the exclusion zone around Chernobyl, from where it subsequently spread to Belarus.[70] Likewise, reintroduction of onagers is presently underway in Ukraine[71] and being considered in Spain.[72] And whoever moved Barbary macaques to Gibraltar, in the 1700s or earlier, performed a reintroduction *avant la lettre*.[73] When contemplating the return of species from this category, especially long absent ones, it appears advisable—despite their essentially native status—to carefully assess potential impacts on the target ecosystem in advance and to reintroduce them first into small, 'experimental' sites.

4.3 | Globally extinct species surviving in domesticated form

A third category consists of species that are globally extinct in originally wild form but survive to some degree in domesticated and often also feral form.[74] This particularly concerns aurochs and wild horses. Increasingly, these species' important ecological roles are being performed by hardy versions of domesticated cattle and horses introduced into natural areas for this purpose, which often live there virtually independently and year-round in herds displaying ostensibly natural behaviour. In some sense, such animals are being 'de-domesticated'. Mention should be made here of back-breeding programmes consciously designed to obtain animals resembling their wild ancestors as closely as possible, especially Heck cattle and the ongoing Tauros programme in the case of aurochs.[75] 'Feralization' is an alternative process, whereby populations (ideally of high genetic diversity) are established in the wild, whereby natural selection is allowed to shape their evolution going forwards—as opposed to pursuing replicas of the extinct form.[76]

An ethical and legal question is whether animals in this category—and also, for instance, (de-)domesticated water buffalo, and wild animals such as bison, moose and other megafauna kept in relatively small, fenced sites—ought to be considered 'kept' animals (with an active duty of care as starting point) or 'wild' animals (with a non-interference duty as starting point), or something in between.[77] The answer has significant practical implications. Insofar as animals are considered 'kept' before the law, all manner of veterinary, sanitary and animal welfare requirements can apply, with repercussions regarding such issues as transport, health inspections and medical care, supplementary feeding, provision of shelter and, last but not least, the (im)possibility of leaving dead animals in the landscape to feed the 'circle of life'.[78] Evidently, this status can also affect the typical legal question of liability following unfortunate animal-human encounters.

4.4 | Fully extinct species

A fourth and final category consists of 30 species that have gone globally extinct without leaving domesticated descendants. Most of these are heavyweights—15 species in the 100–1000 kg weight class and seven species that weighed over 1000 kg. They include various equids, scimitar cat, cave bear, various giant deer species, steppe bison, European water buffalo, four species of rhinoceros, woolly mammoth and straight-tusked elephant.

Aside from the distant but no longer entirely hypothetical possibility of recreating similar animals through genetic engineering[79]—raising throngs of legal questions[80]—these species have quite

[64]RS Sommer and N Benecke, 'Late-Glacial and Early Holocene Colonisation History of Felids in Europe (Felidae): A Review' (2006) 269 Journal of Zoology 7; M Masseti and PPA Mazza, 'Western European Quaternary Lions: New Working Hypotheses' (2013) 109 Biological Journal of the Linnean Society 66; JJ Crees and ST Turvey, 'Holocene Extinction Dynamics of *Equus hydruntinus*, a Late-Surviving European Megafaunal Mammal' (2014) 91 Quaternary Science Reviews 16.

[65]See also Section 5.2.

[66]Trouwborst (n 8).

[67]Habitats Directive (n 51) art 22(a).

[68]See, e.g., Convention on Biological Diversity (adopted 5 June 1992, entered into force 29 December 1993) 1760 UNTS 69 (CBD) art 8(h); Bern Convention (n 50) art 11(2)(b); Habitats Directive (n 51) art 22(b).

[69]See Section 5.

[70]S Gashchak and S Paskevych, 'Przewalski's horse (*Equus ferus przewalskii*) in the Chornobyl Exclusion Zone after 20 Years of Introduction' (2019) 18 Theriologia Ukrainica 80. Przewalski's horse is actually not a separate species, but a form of *Equus ferus*; see P Librado et al, 'The Origins and Spread of Domestic Horses from the Western Eurasian Steppes' (2021) 598 Nature 634.

[71]Rewilding Europe, 'Kulan Comeback: Wild Donkeys Set to Roam Free in the Danube Delta Region Once Again' (21 May 2020) <https://rewildingeurope.com/news/kulan-comeback-wild-donkeys-set-to-roam-free-in-the-danube-delta-region-once-again/>.

[72]Jepson and Blythe (n 8); J Palau, *Rewilding Iberia* (Lynx Edicions 2020).

[73]JE Fa, 'Apes on the Rock' (1981) 16 Oryx 73.

[74]It appears erroneous to refer to such species as extinct, as they survive in slightly modified form; they might indeed be best characterized as 'extinct in the wild'. In fact, the genetic diversities of horse and cattle are probably better preserved, through their widespread, historical domestic populations, than that of, for example, European bison and other severely bottlenecked species occurring only in wild form.

[75]R Goderie et al, *The Aurochs, Born to Be Wild* (Stichting Taurus, Ark Nature and Rewilding Europe 2013); E Stokstad, 'Bringing Back the Aurochs' (2015) 350 Science 1144.

[76]E Gering et al, 'Getting Back to Nature: Feralization in Animals and Plants' (2019) 34 Trends in Ecology and Evolution 1137.

[77]J Keulartz, *Dieren in Ons Midden* (Noordboek Natuur 2019); also FWM Vera, 'Large-Scale Nature Development – the Oostvaardersplassen' (2009) British Wildlife 28.

[78]J Lorimer, 'Probiotic Legalities: De-Domestication and Rewilding Before the Law' in I Braverman (ed), *Biopolitics, Law: Lively Legalities* (Routledge 2016) 39; P Jepson and F Schepers, 'Making Space for Rewilding: Creating an Enabling Policy Environment' (Rewilding Europe and University of Oxford 2016); Rewilding Europe et al, 'Supporting Effective Grazing Systems for Wildfire Prevention, Biodiversity, Climate Adaptation and Other Ecosystem Services' (2021).

[79]See, e.g., B Shapiro, *How to Clone a Mammoth* (Princeton University Press 2015); BJ Novak, 'De-Extinction' (2018) 9 Genes 548.

[80]For an overview of associated legal literature, see Trouwborst (n 8) fn 18.

definitively disappeared. Restoration attempts must therefore predominantly focus on proxy species likely to perform similar ecological roles. Candidate species includes Asiatic water buffalo (*Bubalus arnee*), (de-)domesticated water buffalo and existing rhino and elephant species. Scimitar cats, cave bears and giant deer seem harder to replace—although the ecological functions of extinct species may also be fulfilled by taxonomically quite unrelated species.[81] Introductions of non-native surrogate animals to play the ecological role(s) of extinct species are called 'ecological replacements' (Table 3). Species survival can be a supplementary reason to undertake such conservation translocations, which are then (also) called 'assisted colonization' (Table 3). To illustrate, introducing Asian elephants (*Elephas maximus*) in Europe could restore some of the lost ecological effects of straight-tusked elephants, whereas the new satellite populations would simultaneously enhance the prospects of Asian elephants themselves, which are presently listed as globally 'endangered' on the International Union for Conservation of Nature (IUCN) Red List.[82] The parties to various international wildlife treaties have formally expressed support for assisted colonization and ecological replacement as viable modes of conservation, not least with an eye on climate change.[83]

Yet, as they involve non-indigenous species, these two translocation categories tend to encounter more legal obstacles than reintroductions.[84] The size of these obstacles should not be exaggerated, however, especially when considering that initially introductions are likely to be conducted on a small-scale, experimental basis only, subject to monitoring, adaptive management and suitable safeguards to avoid undesirable impacts on local ecosystems, the animals' own well-being and human safety.[85] For instance, invasive alien species legislation aims to keep non-native species from causing harm to biodiversity. In the words of the CBD Conference of the Parties (COP), States 'should make all efforts to permit only those species that are unlikely to threaten biological diversity', and authorization of an introduction may be accompanied by conditions regarding monitoring and mitigation.[86] When subject to adequate monitoring and adaptive management, introduced populations of rhinos or elephants in European areas run very low risks of becoming uncontainable. These megaherbivores are easy to track and, unlike 'explosively reproducing' aliens like vines, bees or mussels, 'animals that reproduce as slowly as elephants, with an intrinsic rate of increase of about 5% per year, should be controllable'.[87]

4.5 | Further species and considerations

In this overview, mention should also be made of the separate category of non-native species, not covered by Tables 1 and 2, that have become de facto parts of today's European megafauna. The ecological impact and function of such species may vary from harmful to beneficial (even within a single species[88]), depending on the circumstances, and the implications of nature conservation law and policy will vary accordingly.[89] Given time, it is possible for such species to become 'naturalized' as native fauna before the law.[90]

The above plainly illustrates that the role of law regarding megafauna rewilding efforts is far from uniform across the various species categories. Also within categories, species' legal status under applicable legal instruments may vary—as illustrated in Table 1 with regard to the Bern Convention, Habitats Directive and the two CITES regimes. Concerning the latter, for species included in the appendices of CITES and/or the EU Basic CITES Regulation, one or more permits will be required for cross-border transports, with one condition being that the animals' movement may 'not be detrimental to the survival' of the species involved.[91] The degrees to which species depend on protected areas also influences the ways in which various legal instruments are involved.[92] Today, some megafauna species occur foremostly in protected areas, such as European bison and muskox, whereas other species have most of their distribution outside protected areas, including wild boar, both ibex and various deer.[93] Overall, the application and implications of legal and policy frameworks are clearly conditioned by the extent to which ecological baselines (reference models) have been recalibrated in light of current scientific knowledge on the natural species composition of European ecosystems.

As partly illustrated above, restrictions on endeavours to rewild European ecosystems through megafauna restoration may inter alia flow from (inter)national legal instruments addressing reintroductions, invasive alien species, protected areas, protected species, agriculture, trade, disease, biotechnology, animal welfare,

[81] See, e.g., J Lundgren et al, 'Introduced Herbivores Restore Late Pleistocene Ecological Functions' (2020) 117 Proceedings of the National Academy of Sciences of the United States of America 7871.

[82] PS Martin and DA Burney, 'Bring Back the Elephants!' (1999) 9 Wild Earth 57; CJ Donlan et al, 'Pleistocene Rewilding: An Optimistic Agenda for Twenty-First Century Conservation' (2006) 168 The American Naturalist 660; C Williams et al, '*Elephas maximus*' (2020) The IUCN Red List of Threatened Species e.T7140A45818198. Asian elephants occurred in Asia Minor until just a few millennia ago: E Albayrak and AM Lister, 'Dental Remains of Fossil Elephants from Turkey' (2012) 276–277 Quaternary International 198.

[83] See, e.g., CBD 'Decision X/33, Biodiversity and Climate Change' UN Doc UNEP/CBD/COP/DEC/X/33 (29 October 2010) para 8(e); Convention on the Conservation of Migratory Species of Wild Animals (CMS) (adopted 23 June 1979, entered into force 1 November 1983) 2306 UNTS 469, 'Resolution 12.21, Climate Change and Migratory Species', UNEP/CMS/Resolution 12.21 (October 2017) Annex; Bern Convention, 'Recommendation No. 158 (2012) of the Standing Committee, Adopted on 30 November 2012 on Conservation Translocations under Changing Climatic Conditions' (2012); see also, e.g., A Trouwborst and A Blackmore, 'Hot Dogs, Hungry Bears and Wolves Running Out of Mountain – International Wildlife Law and the Effects of Climate Change on Large Carnivores' (2020) 23 Journal of International Wildlife Law and Policy 212; JF Brodie et al, 'Global Policy for Assisted Colonization of Species' (2021) 372 Science 456; and Trouwborst et al (n 8).

[84] Trouwborst (n 8).

[85] Martin and Burney (n 82); Donlan et al (n 82); also D Bowman, 'Bring Elephants to Australia?' (2012) 482 Nature 30.

[86] CBD 'Decision VI/23, Alien Species that Threaten Ecosystems, Habitats or Species' UN Doc UNEP/CBD/COP/6/20 (27 May 2002) Annex, Guiding Principle 10(1).

[87] Martin and Burney (n 82).

[88] A prime example is the aoudad; see J Cassinello et al, 'Range Expansion of an Exotic Ungulate (*Ammotragus lervia*) in Southern Spain: Ecological and Conservation Concerns' (2004) 13 Biodiversity and Conservation 851; M Fernández-Olalla et al, 'Threat or Opportunity? Browsing Preferences and Potential Impact of *Ammotragus lervia* on Woody Plants of a Mediterranean Protected Area' (2016) 129 Journal of Arid Environments 9.

[89] For example, Bern Convention, 'Recommendation No. 77 (1999) on the Eradication of Non-Native Terrestrial Vertebrates' (1999) mentions sika deer and North American beaver as non-native species to be eradicated where feasible, given the threats they pose to native biodiversity.

[90] See also Trouwborst (n 8).

[91] CITES (n 52) arts III(2)(a), III(3)(a) and IV(2)(a).

[92] See, e.g., Trouwborst et al (n 8).

[93] Linnell et al (n 48).

property and liability.[94] The remainder of this article is mainly devoted to the opposite dimension of the law, which has received less scholarly attention so far, namely, the question to what degrees existing legal instruments actually *require* the restoration of megafauna in Europe.

5 | LEGAL OBLIGATIONS TO RESTORE MEGAFAUNA

'States shall cooperate in a spirit of global partnership to conserve, protect and *restore* the health and integrity of the Earth's ecosystem' is one of the pledges recorded in the non-binding but authoritative Rio Declaration of 1992.[95] Binding obligations to restore wildlife, ecosystems, natural areas or biodiversity flow from a wide range of international legal instruments.[96] To what extent they require European governments to undertake megafauna rewilding action is a matter of interpretation.

5.1 | Convention on Biological Diversity

At the highest level of law and policy on biodiversity, Article 8(f) of the CBD lays down a key obligation of ecological and species restoration for its parties, which include all European countries and the EU as an organization:

> Each Contracting Party shall, as far as possible and as appropriate: … [r]ehabilitate and restore degraded ecosystems and promote the recovery of threatened species, inter alia, through the development and implementation of plans or other management strategies.[97]

The word 'shall' denotes a strong obligation. The subsequent words 'as far as possible and as appropriate' endow individual parties with a measure of discretion to determine what, in their circumstances, is 'possible' and 'appropriate'. This discretion is not limitless, however, and may be very small indeed. Careful interpretation is required to determine the implications of the terms in question.

Generally, the Convention's objectives[98] and current scientific knowledge regarding the dimensions and consequences of the global biodiversity crisis[99] would appear to generate a strong presumption that performance of all activities enumerated in Article 8(a)–(m) of the CBD is highly 'appropriate'.[100] For the obligation to rehabilitate and restore degraded ecosystems in Article 8(f), this is reinforced by the declaration of 2021–2030 as the United Nations (UN) Decade of Ecosystem Restoration.[101] As a recent UN report emphasizes, ecosystem restoration is a 'cost-effective way of achieving multiple benefits', as it can 'simultaneously mitigate climate change, slow and reverse biodiversity decline and increase the benefits that people get from nature'.[102] The other qualifying term in CBD Article 8—'possible'—entails that, generally speaking, less ambitious restoration efforts might be required of countries lacking in resources, whereas much more is clearly 'possible' for, and therefore required of, European and other affluent countries. This reflects the notion of common but differentiated responsibilities.[103]

The meaning and practical implications of Article 8(f) are further informed by CBD COP decisions and other documents that can be taken, to some degree or other, to reflect 'agreement between the parties regarding the interpretation of the treaty or the application of its provisions', as the Vienna Convention on the Law of Treaties puts it.[104] For example, the situation envisaged by the COP's strategic Aichi Targets, which should have been attained by 2020, is that at a minimum 'ecosystems that provide essential services … are restored and safeguarded' and that 'ecosystem resilience' has been enhanced through 'restoration of at least 15% of degraded ecosystems'.[105]

[94] See also Jepsen and Schepers (n 78); Pettorelli et al (n 8); Jepson and Blythe (n 8); Trouwborst (n 8); Rewilding Europe et al (n 78); G. Pe'er et al., 'How European Policies, Especially the Common Agricultural Policy, Can Better Support Extensive Grazing Systems' (2021) <https://grazelife.com/publications/>; and Trouwborst et al (n 8).

[95] Rio Declaration on Environment and Development in 'Report of the United Nations Conference on Environment and Development' UN Doc A/CONF.151/26 (vol I) (12 August 1992) Principle 4 (emphasis added).

[96] See generally PA Rees, 'Is There a Legal Obligation to Reintroduce Animal Species into their Former Habitats?' (2001) 35 Oryx 216; RC Gardner, 'Rehabilitating Nature: A Comparative Review of Legal Mechanisms that Encourage Wetland Restoration Efforts' (2003) Catholic University Law Review 573; K Bastmeijer, 'Ecological Restoration in International Biodiversity Law: A Promising Strategy to Address Our Failure to Prevent?' in M Bowman, P Davies and E Goodwin (eds), *Research Handbook on Biodiversity and Law* (Edward Elgar 2016) 387; BJ Richardson, 'The Emerging Age of Ecological Restoration Law' (2016) 25 Review of European, Comparative and International Environmental Law 277; A Telesetsky, A Cliquet and A Akhtar-Khavari, *Ecological Restoration in International Environmental Law* (Routledge 2017); H Schoukens, 'Towards a Legally Enforceable Duty to Restore Endangered Species under EU Nature Conservation Law' in J Jendroska and M Bar (eds), *Procedural Environmental Rights* (Intersentia 2018) 287; JV López-Bao et al, 'Legal Obligations Regarding Species on the Verge of Extinction in Europe: Conservation, Restoration, Recolonization, Reintroduction' (2018) 277 Biological Conservation 319; A Cliquet, 'Ecological Restoration as a Legal Duty in the Anthropocene' in M Lim (ed), *Charting Environmental Law Futures in the Anthropocene* (Springer Nature 2019); A Cliquet et al, 'Upscaling Ecological Restoration: Towards a New Legal Principle and Protocol on Ecological Restoration in International Law' (2021) Restoration Ecology e13560.

[97] CBD (n 68) art 8(f); also potentially relevant is ibid, art 9(c) on ex situ conservation, requiring the adoption, 'as far as possible and as appropriate', of 'measures for the recovery and rehabilitation of threatened species and for their reintroduction into their natural habitats under appropriate conditions'.

[98] Its first stated objective is 'the conservation of biological diversity'; ibid art 1.

[99] See, e.g. Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) 'Summary for Policymakers of the Global Assessment Report on Biodiversity and Ecosystem Services of the IPBES' UN Doc IPBES/7/10/Add. 1 (29 May 2019).

[100] H Somsen and A Trouwborst, 'Loss of Biosphere Integrity (Biodiversity Loss and Extinction)' in D French and L Kotzé (eds), *Research Handbook on Law, Governance and Planetary Boundaries* (Edward Elgar 2021) 222, 230–231.

[101] UNGA 'United Nations Decade on Ecosystem Restoration' UN Doc A/RES/73/284 (6 March 2019).

[102] United Nations Environment Programme (UNEP), 'Making Peace with Nature' (UNEP 2021). As phrased by Bern Convention, 'Recommendation No. 206 (2019) of the Standing Committee, Adopted on 6 December 2019, on Nature-Based Solutions and Management of Protected Areas in the Face of Climate Change' (2019) preamble, 'ecosystems in a healthy condition deliver multiple benefits and services for human well-being and address economic, social and environmental goals, including climate change adaptation and mitigation and biodiversity conservation and restoration'.

[103] As stated in Rio Declaration (n 95) Principle 7: 'In view of the different contributions to global environmental degradation, States have common but differentiated responsibilities. The developed countries acknowledge the responsibility that they bear in the international pursuit of sustainable development in view of the pressures their societies place on the global environment and of the technologies and financial resources they command.' See also S Monsarrat and JC Svenning, 'Using Recent Baselines as Benchmarks for Megafauna Restoration Places an Unfair Burden on the Global South' (2022) Ecography e05795.

[104] Vienna Convention on the Law of Treaties (adopted 23 May 1969, entered into force 27 January 1980) 1155 UNTS 331 art 31(3)(a).

[105] CBD 'Decision X/2, The Strategic Plan for Biodiversity 2011–2020 and the Aichi Biodiversity Targets' UN Doc UEP/CBD/COP/DEC/X/2 (29 October 2010) Annex, Targets 14 and 15.

Draft targets for the post-2020 era include the ambition to ensure that by 2030 'at least 20% of degraded freshwater, marine and terrestrial ecosystems are under restoration'[106] and that 'active management actions' are taken to 'enable the recovery' of species.[107] According to a dedicated COP decision on ecosystem restoration,

> Ecological restoration refers to the process of managing or assisting the recovery of an ecosystem that has been degraded, damaged or destroyed as a means of sustaining ecosystem resilience and conserving biodiversity. Degradation is characterized by a decline or loss of biodiversity or ecosystem functions. Degradation and restoration are context-specific and refer to both the state of ecosystems and to ecosystem processes.[108]

Determination of the 'most appropriate measures for conducting ecosystem restoration', and those measures' implementation, must be based on the 'best available evidence' including the 'best available science'.[109] Effects of restoration measures should be regularly assessed, and plans and procedures adjusted through 'adaptive management based on monitoring results'.[110]

Importantly, given the state of the science summarized earlier, it appears inconceivable to rehabilitate and restore Europe's degraded ecosystems without rehabilitating and restoring its megafauna to levels much closer to natural diversity and densities—besides meeting other obvious conditions such as sufficient space, connectivity and room for natural dynamics (e.g. by removing dams from rivers).[111] In this regard, a UN Decade guidance document states that ecosystem restoration involves activities aimed at 'recovering an ecosystem to the trajectory it would be on if degradation had not occurred, accounting for environmental change'.[112] In other words, the aim is to get as close as possible to the situation that would have existed without human-caused degradation.

The centrality of trophic rewilding with megafauna in the application of Article 8(f) is bolstered further by the COP's understanding of the 'Ecosystem Approach', a dominant paradigm for the CBD's implementation. According to one of the Ecosystem Approach's principles, restoring 'ecosystem structure and functioning' should be a priority target, whereby recovery of ecological 'interactions and processes' is deemed 'of greater significance' for the long-term future of biodiversity 'than simply protection of species'.[113] Other recommendations by the COP likewise urge parties, when implementing their restoration obligations, to make use of research on the 'functions of species in ecosystems' and to give 'due consideration' to the 'restoration and recovery of species directly providing ecosystem services and functions, such as seed dispersal, pollination and maintaining the food web (such as key predators) and nutrient flows'.[114] When ecosystem restoration requires (re)introductions, parties are recommended to make use of 'native site-adapted species', but the possibility of introducing non-native species is clearly reserved. In this regard, 'if the use of alien species is being considered', actions should be 'guided by sound science and the precautionary approach', so as to 'avoid loss of habitat and species due to invasive alien species'.[115]

To revisit the words 'as far as possible' from Article 8(f), the exact recreation of cave bears or scimitar cats seems to be a clear-cut example of restoration action that is currently impossible and therefore not required for the time being.[116] However, ambitious ecosystem restoration efforts involving trophic rewilding with megafauna through all other scenarios discussed above appear eminently 'possible' sensu Article 8. Promoting natural recolonization; reintroducing species from elsewhere in Europe; reintroducing longer-lost native species sourced from Asia, Africa or ex situ populations; back-breeding and rewilding cattle and horses; and introducing proxy species for globally extinct European species—all of these are technically and economically possible. Lack of space is not exactly a prohibiting impediment either, given for instance the increasing abandonment of marginal farmland[117] and (inter)governmental pledges to dedicate significantly more land area to nature.[118]

The same applies to human coexistence with restored megafauna. Depending on the species, this will require certain changes, investments and/or sacrifices, but is nowhere near impossible. To illustrate, in recent decades, people in Germany, France, Denmark and the Benelux quickly discovered that life goes on after wolves come back. The same is true when more dangerous animals return, an apt illustration being the successful brown bear reintroduction in Italy's Trento region.[119] Also regarding even more challenging reintroduction candidates, if people in India can share the landscape with lions and elephants, and people in Tanzania and Zimbabwe manage to co-exist with hyenas and hippos, then surely this is also possible in Europe.[120]

A lack of political will could be a serious bottleneck for megafauna rewilding plans in European countries, but an absence of political will does not affect the 'possibility' of restoration in terms of CBD Article 8. Quite the contrary, among other things, law exists precisely to

[106]CBD 'First Draft of the Post-2020 Global Biodiversity Framework' UN Doc CBD/WG2020/3/3 (5 July 2021) Target 2.
[107]ibid Target 4.
[108]CBD 'Decision XIII/5, Ecosystem Restoration: Short-term Action Plan' UN Doc CBD/COP/DEC/XIII/5 (10 December 2016) para 4.
[109]ibid paras 10 and 15.
[110]ibid para 16(1).
[111]Regarding the latter, see Directorate-General for Environment, 'Guidance on Barrier Removal for River Restoration' (European Commission 2021).
[112]Food and Agriculture Organization of the United Nations (FAO), IUCN Commission on Ecosystem Management and Society for Ecological Restoration, 'Principles for Ecosystem Restoration to Guide the United Nations Decade 2021–2030' (FAO 2021).
[113]CBD 'Decision VII/11, Ecosystem Approach' UN Doc UNEP/CBD/COP/DEC/VII/11 (13 April 2004) Table 1, Principle 5.
[114]Decision XIII/5 (n 108) Appendix I.
[115]ibid.
[116]See, e.g., Novak (n 79).
[117]S Ceauşu et al, 'European Wilderness in a Time of Farmland Abandonment' in HM Pereira and LM Navarro (eds), *Rewilding European Landscapes* (Springer 2015) 25.
[118]For example, Target 3 of the CBD First Draft of the Post-2020 Global Biodiversity Framework (n 106) is to ensure that by 2030 'at least 30% globally of land areas … are conserved through effectively and equitably managed, ecologically representative and well-connected systems of protected areas and other effective area-based conservation measures'.
[119]M de Barba, C Groff and P Genovesi, 'Re-Introduction of the Brown Bear in the Central Alps, Trentino, Italy' in PS Soorai (ed), *Global Re-introduction Perspectives* (IUCN 2013) 125.
[120]See also, e.g., B Cretois et al, 'Coexistence of Large Mammals and Humans is Possible in Europe's Anthropogenic Landscapes' (2021) 24 iScience 103083.

make sure certain things happen *despite* a potential lack of political will. That said, in any event, political will for ambitious ecological restoration efforts does not seem in short supply, judging from, for example, the 'Leaders' Pledge for Nature', a declaration endorsed in 2020 by political leaders of over 80 countries, including 40 European ones, and the European Commission:

> We are in a state of planetary emergency: the interdependent crises of biodiversity loss and ecosystem degradation and climate change … require urgent and immediate global action. Science clearly shows that biodiversity loss, land and ocean degradation, pollution, resource depletion and climate change are accelerating at an unprecedented rate. This acceleration is causing irreversible harm to our life support system … Unless halted and reversed with immediate effect, it will cause significant damage to global economic, social and political resilience and stability … Nature fundamentally underpins human health, wellbeing and prosperity. … [T]he business case for biodiversity is compelling. The benefits of restoring natural resources outweigh the costs ten-fold, and the cost of inaction is even higher. … A transformative change is needed: we cannot simply carry on as before.[121]

For these reasons, the leaders concerned are committed to an 'ambitious and transformational' agenda for the coming decade to achieve major increases in areas where nature is protected, to 'restore a significant share of degraded ecosystems' and to promote a 'significant scale-up in nature based solutions and ecosystem-based approaches'.[122] Likewise, in 2019, the parties to the Bern Convention emphasized that 'a state of emergency now exists to avoid the breakdown of both the climate and biodiversity' and the 'ecosystems that support life on Earth'.[123]

Meeting the obligation of Article 8(f) may require parties to provide 'legal, economic and social incentives, and appropriate planning mechanisms' to promote restoration[124]—for instance, by ensuring that extensive grazing by wild or rewilded herbivores can fully benefit from subsidies under the EU Common Agricultural Policy.[125] Moreover, Article 8(f) can require parties to remove obstacles to megafauna rewilding efforts, including legal obstacles such as those mentioned in the previous section—for instance, by adjusting the legal status of rewilded, de-domesticated cattle, horses and water buffalo in a way that is conducive to ecosystem restoration[126]; by allowing the carcasses of such animals to remain in the field[127]; and by making sure that incongruous sanitary and veterinary standards do not apply to reintroduced wild species either.[128] In the words of the CBD COP, parties may need to '[r]eview, improve or establish legal, policy and financial frameworks for the restoration of ecosystems'.[129]

At any rate, given that many megafauna species—including most of the very biggest—are gone from Europe, and many others are only present in few places and unnaturally low numbers, it is clear from the above that the tasks imposed by Article 8(f) of the CBD on European States, and on the EU, are enormous.

5.2 | Bern Convention

Provisions that can entail obligations to restore European megafauna in particular scenarios can be found in many other legal instruments, but we lack the space to go in as much detail as with the CBD. We therefore limit ourselves to highlighting certain relevant provisions and illustrating a selection of them.

An important instrument for present purposes is the Bern Convention. Each megafauna species from Table 1 that is present in the European territory of one or more Convention parties is covered by a general but potentially demanding obligation to 'take requisite measures to maintain [its] population …, or adapt it to, a level which corresponds in particular to ecological, scientific and cultural requirements'.[130] These may well include restoration measures.[131] The express reference to *ecological* requirements may be taken to indicate that merely ensuring species survival (demographic and genetic viability) is insufficient to comply with the obligation involved and that species must instead be maintained at, or restored to, levels where they can duly exercise their ecological roles. Moreover, it can evidently be argued that the 'requisite measures' to 'adapt … the population of wild flora and fauna … to a level which corresponds … to ecological … requirements' may encompass megafauna (re)introductions, including of species not currently present in Europe. The great majority (29) of extant megafauna species, or subspecies thereof, are listed in the Convention's appendices and therefore subject to additional obligations of 'protection' (Appendix III)[132] or 'special

[121]'Leaders Pledge for Nature' (2020) <https://www.leaderspledgefornature.org>.
[122]ibid.
[123]Recommendation No. 206 (n 102) preamble; where it is also recognized that 'choices made now on … biodiversity conservation and restoration targets determine the very nature of the planet … which will be passed on to future generations'.
[124]Decision XIII/5 (n 108) para 14(1).
[125]Pe'er et al (n 94).
[126]An elaborate set of state-of-the-art recommendations for doing precisely this can be found in Rewilding Europe et al (n 78). An example is for Member States to make full use of the possibilities to derogate from animal identification and registration requirements under Regulation (EU) 2016/429 of 9 March 2016 on Transmissible Animal Diseases and Amending and Repealing Certain Acts in the Area of Animal Health [2016] OJ L84/1 (EU Animal Health Law) and Commission Delegated Regulation (EU) 2019/2035 of 28 June 2019 [2019] OJ L314/115.
[127]Commission Regulation (EU) No. 142/2011 of 25 February 2011 Laying Down Health Rules as Regards Animal By-products and Derived Products not Intended for Human Consumption and Implementing Council Directive 97/78/EC as Regards Certain Samples and Items Exempt from Veterinary Checks at the Border under that Directive [2011] OJ L54/1 expressly permits EU Member States, under certain conditions, to authorize such practices for the purpose of provisioning vultures, other scavenging birds of prey, and terrestrial carnivores, either by moving carcasses to outdoor 'feeding stations' or by leaving them where they dropped (see ibid art 14 and Annex VI, Chapter II, Sections 2 and 3). Most Member States, however, have not used this possibility yet, according to Rewilding Europe et al (n 78).
[128]A case in point is the current status of European bison under the EU Animal Health Law (n 126).
[129]Decision XIII/5 (n 108) para 14(1).
[130]Bern Convention (n 50) art 2.
[131]For further analysis of this provision see, e.g. A Trouwborst, FM Fleurke and JDC Linnell, 'Norway's Wolf Policy and the Bern Convention on European Wildlife' (2017) 20 Journal of International Wildlife Law and Policy 155.
[132]Bern Convention (n 50) arts 7–9.

protection' (Appendix II)[133]—the scope of which extends to any naturally recolonized areas—and obligations of habitat conservation.[134]

Reintroduction is expressly addressed in Article 11:

> Each Contracting Party undertakes … to encourage the reintroduction of native species of wild flora and fauna when this would contribute to the conservation of an endangered species, provided that a study is first made in the light of the experiences of other Contracting Parties to establish that such reintroduction would be effective and acceptable.[135]

Although not exactly unconditional, this provision may motivate or support megafauna reintroductions. Its scope appears to cover both (sub)species currently extant in Europe, whether listed in the Convention's appendices (e.g. European bison, moose, leopard and caracal) or not (e.g. Przewalski's horse and striped hyena), as well as species that have been extirpated from the continent (e.g. hippopotamus, lion, tiger and spotted hyena). From the latter category, dhole and tiger are listed in Appendix II, providing explicit support for the presumption that they are indeed 'native' to (parts of) Europe. A good case can be made that moon bears are also covered by Appendix II, which lists 'all species' of Ursidae.[136] Regarding the question whether a given species is 'native' to a given country in the sense of Article 11, it is important to note that the latest version of the IUCN's authoritative conservation translocation guidelines no longer requires or suggests that a species should have occurred in the recent, historic past for it to qualify as 'indigenous'.[137] The guidelines generously define the term 'indigenous range' as follows:

> The indigenous range of a species is the known or inferred distribution generated from historical (written or verbal) records, or physical evidence of the species' occurrence. Where direct evidence is inadequate to confirm previous occupancy, the existence of suitable habitat within ecologically appropriate proximity to proven range may be taken as adequate evidence of previous occupation.[138]

The Bern Convention is notable too for the express endorsement by its Standing Committee (the Bern Convention 'COP') of ecological replacement as a restoration tool. The following recommendation was adopted in 2012:

> Where relevant, prioritise the species or populations to be translocated, based on criteria such as their ecological role, their evolutionary distinctiveness or uniqueness, their role as flagship species, their threatened status, or potential as ecological replacements; where species are extinct, consequent changes in the ecosystem can indicate a need to restore the ecological function provided by the lost species, which can constitute justification for exploring an ecological replacement.[139]

This is of evident relevance for the substitution of globally extinct European megafauna species, such as rhinos and elephants. In this regard, the Committee has also recognized that 'assisted colonisations are expected to be increasingly used in future biodiversity conservation'.[140] Parties are furthermore urged to follow the aforementioned IUCN guidelines when considering or conducting any type of conservation translocation, whether it be reinforcement, reintroduction, assisted colonization or ecological replacement.[141]

5.3 | Carpathian Biodiversity Protocol

In connection with the UN Decade on Ecosystem Restoration, the COP of the Carpathian Convention[142] has called on contracting parties to 'make strong commitments to achieve *transformational* ecosystem restoration'.[143] In fact, it seems such commitments are already in place in the Convention's Protocol on Biodiversity Conservation.[144] Its stated objective is to 'enhance the conservation, *restoration* and sustainable use of biological and landscape diversity of the Carpathians'.[145] Each of the Protocol's seven parties 'shall develop and implement policies and strategies in its national territory aiming at the conservation, *restoration* and sustainable use' of the biodiversity of the Carpathians and 'take measures in its national territory with the objective to ensure the long-term conservation, *restoration* and sustainable use of natural habitats' of the region.[146]

Crucially, the Protocol defines the term 'restoration' as the 'return of an ecosystem or habitat to its *original* structure, *natural* composition of species, and *natural* functions'.[147] In light of the foregoing, a sound argument can be made that the words 'original' and 'natural' imply that the reference baseline for restoration efforts is to be drawn before the megafauna extinctions of the Late Pleistocene (and Holocene).[148] Thus, it would appear that the scope of parties'

[133] ibid arts 6 and 8–9.
[134] ibid art 4.
[135] ibid art 11(2)(a).
[136] A similar case can be made for Persian fallow deer and Appendix III, which latter lists 'all species' of Cervidae.
[137] IUCN Species Survival Commission (SSC), 'Guidelines for Reintroductions and Other Conservation Translocations – Version 1.0' (IUCN SSC 2013); see also Trouwborst (n 8) 659–660.
[138] IUCN Species Survival Commission (n 137) 2.
[139] Recommendation No. 158 (n 83) para 6.
[140] ibid preamble.
[141] ibid para 7.
[142] Framework Convention on the Protection and Sustainable Development of the Carpathians (adopted 22 May 2003, entered into force 4 January 2006) <www.carpathianconvention.org>.
[143] Carpathian Convention, 'Decision COP6/5, Cooperation with Other Conventions and International Bodies', CC/COP6/DOC3/ADOPTED (2020) para 6 (emphasis added).
[144] Protocol on Conservation and Sustainable Use of Biological and Landscape Diversity (adopted 19 June 2008, entered into force 28 April 2010) <www.carpathianconvention.org>.
[145] ibid art 1(1) (emphasis added).
[146] ibid arts 4 and 8(2) (emphasis added).
[147] ibid art 3(r) (emphasis added).
[148] See also Trouwborst (n 8).

obligations not only encompasses current reintroduction, reinforcement and range expansion measures for European bison[149] and the like but also reintroductions of onagers, leopards and lions (which persisted in the area far into the Holocene) and even introductions of proxy species to fill the ecological niches left empty by the extinct rhinoceroses and elephants that used to call the Carpathians home.[150]

5.4 | Other international legal instruments

Depending on the circumstances, the Carpathian Protocol's counterpart in the Alps, the Nature Conservation Protocol to the Alpine Convention,[151] may also require its parties to restore megafauna, especially pursuant to a general restoration obligation[152] and a specific provision on reintroductions.[153] Furthermore, in areas that qualify as 'natural heritage' in terms of the World Heritage Convention, the (re) introduction of certain large mammals may be part of a European contracting party's implementation of the Convention's Article 5:

> To ensure that effective and active measures are taken for the protection, conservation and presentation of the … natural heritage situated on its territory, each State Party to this Convention shall endeavour, in so far as possible, and as appropriate for each country: … to take the appropriate legal, scientific, technical, administrative and financial measures necessary for the identification, protection, conservation, presentation and *rehabilitation* of this heritage.[154]

Similar considerations apply with regard to wetlands listed under the Ramsar Convention, given parties' obligation to 'formulate and implement their planning so as to promote the conservation' of these wetlands.[155] Conceivably, provisions of the Convention on Migratory Species may also, in particular scenarios, provide a basis for megafauna restoration measures in Europe.[156]

5.5 | EU law and policy

In the realm of EU law, the Habitats Directive can provide an additional basis for megafauna restoration. It generally calls for measures to 'maintain or *restore*, at favourable conservation status', the habitats and species it covers.[157] Whereas rewilding processes may not be fully compatible with the Directive's requirements everywhere, megafauna restoration measures will in many cases be supported or required by the Directive's provisions regarding Natura 2000 sites. For instance, in many areas, restoring large herbivores appears necessary to counter uniform vegetation densification and avoid the loss of numerous species dependent on open and semi-open habitats,[158] species dependent on dispersal by megafauna[159] and species directly dependent on megafauna. Megafauna can furthermore be effective suppressors of invasive alien species.[160] The European Commission has also stressed the importance of 'dynamics of ecosystems', 'natural processes' and 'allowance of natural disturbances' for the conservation of several Natura 2000 habitat types and species.[161] Significantly, the Bern Convention's Standing Committee has expressly called on governments to use the Natura 2000 network (and other protected areas, including the Emerald Network created in non-EU Convention parties) to 'actively deliver a comprehensive range of ecosystem services' and to expand protected areas and ecological networks 'to achieve win-win measures for adapting sites, habitats and species to climate change and for developing nature-based solutions to mitigate climate change and disaster risk reduction'.[162]

To illustrate, when the Annex I habitat types or Annex II species for which a particular site was designated are threatened by notorious invasive plants like giant hogweed (*Heracleum mantegazzianum*), black cherry (*Prunus serotina*) or Himalayan blackberry (*Rubus armeniacus*), then reintroducing European bison—which have all three plants on their menu[163]—may be an excellent, cost-effective way for the Member State concerned to comply with its obligations to 'establish the necessary conservation measures' for the habitats and species

[149] See, e.g., K Perzanowski and W Olech, 'A Future for European Bison *Bonasus bonasus* in the Carpathian Ecoregion?' (2007) 13 Wildlife Biology 108; T Kuemmerle et al, 'European Bison Habitat in the Carpathian Mountains' (2010) 143 Biological Conservation 908; Rewilding Europe, 'Largest Ever Bison Reintroduction in Southern Carpathians Boosts Population by 23 Animals' (2018) <https://rewildingeurope.com/news/largest-ever-bison-reintroduction-in-southern-carpathians-boosts-population-by-23-animals/>.

[150] See, e.g., Kurtén (n 5); A Németh et al, 'Holocene Mammal Extinctions in the Carpathian Basin: A Review' (2016) 47 Mammal Review 38; Sommer and Benecke (n 64); Crees and Turvey (n 64).

[151] Protocole d'Application de la Convention Alpine de 1991 dans le Domaine de la Protection de la Nature et de l'Entretien des Paysages (adopted 20 December 1994, entered into force 18 December 2002) <www.alpconv.org>.

[152] ibid art 2; the Protocol's objectives stated in art 1 also expressly include ecological restoration.

[153] ibid art 16(1).

[154] Convention Concerning the Protection of the World Cultural and Natural Heritage (adopted 16 November 1972, entered into force 17 December 1975) 1037 UNTS 151 art 5 (d) (emphasis added); see also arts 2 and 4.

[155] Convention on Wetlands of International Importance (adopted 2 February 1971, entered into force 21 December 1975) 996 UNTS 245 art 3(1); see also, e.g., Ramsar Convention, 'Resolution VIII.16, Principles and Guidelines for Wetland Restoration' (2002) <https://www.ramsar.org/sites/default/files/documents/pdf/res/key_res_viii_16_e.pdf>.

[156] CMS (n 83) arts III(4), IV(3)–(4) and V(1) and (5). CMS Appendix I includes Przewalski's horse and cheetah; Appendix II includes goitered gazelle, saiga, onager, lion and leopard.

[157] Habitats Directive (n 51) art 2(2).

[158] See, e.g., FWM Vera, ES Bakker and H Olff, 'Large Herbivores: Missing Partners of Western European Light-Demanding Tree and Shrub Species?' in Danell et al (eds), *Large Herbivore Ecology, Ecosystem Dynamics and Conservation* (Cambridge University Press 2006) 203; A Timmerman et al, 'Pervasive Early 21st-Century Vegetation Changes Across Danish Semi-Natural Ecosystems: More Losers than Winners and a Shift towards Competitive, Tall-Growing Species' (2015) 52 Journal of Applied Ecology 21; R Buitenwerf et al, 'Land Surface Greening Suggests Vigorous Woody Regrowth Throughout European Semi-Natural Vegetation' (2018) 24 Global Change Biology 5789; MS Warren et al, 'The Decline of Butterflies in Europe: Problems, Significance, and Possible Solutions' (2021) 118 Proceedings of the National Academy of Sciences of the United States of America e2002551117.

[159] WA Ozinga et al, 'Dispersal Failure Contributes to Plant Losses in NW Europe' (2009) 12 Ecology Letters 66.

[160] See, e.g., Derham et al (n 26).

[161] European Commission, 'Guidelines on Wilderness in Natura 2000' (European Commission 2013) 25–26. For further discussion of the extent to which the Natura 2000 regime calls for, and allows for, management giving free rein to ecological dynamics, see K Bastmeijer, 'Natura 2000 and the Protection of Wilderness in Europe' in K Bastmeijer (ed), *Wilderness Protection in Europe* (Cambridge University Press 2016) 177.

[162] Recommendation No. 206 (n 102) paras 5–6.

[163] ARK Natuurontwikkeling 'Wisent Helpt bij Terugdringen Exoten' (Nature Today, 27 September 2020) <https://www.naturetoday.com/intl/nl/nature-reports/message/?msg="26721">; E Klein Lebbink et al, *Wisent op de Veluwe: Evaluatie 2016–2020* (ARK Natuurontwikkeling/Staatsbosbeheer and Stichting Wisent op de Veluwe 2021). Horse and cattle are also effective against giant hogweed.

involved and to 'take appropriate steps to avoid … deterioration of natural habitats and the habitats of species' within the area.[164] Incidentally, the European bison itself is also a species for which Natura 2000 sites must be designated, as it features in Annex II of the Directive—along with 13 other megafauna (sub)species (see Table 1). Megafauna restoration may also be based on the Habitats Directive's provision on reintroduction, although it is formulated in rather qualified terms, and moreover limited to species presently listed in Annex IV (see Table 1).[165]

The bison example just given also invites mention of the EU Invasive Alien Species Regulation, which lists giant hogweed as one of the species that Member States must control or eradicate.[166] In other words, certain megafauna rewilding actions may also be necessary for, or construed as, implementing obligations under this Regulation. A final example is the significant role reserved for beavers, rewilded cattle, horses and other large herbivores in maintaining or restoring the 'structure and condition' of 'riparian zones' as much as possible in or to 'undisturbed conditions', thus helping EU Member States meet their obligations to maintain or restore a 'good ecological status' of rivers and other surface waters under the Water Framework Directive.[167]

The far-reaching obligations imposed by Article 8(f) of the CBD seem to align well with the headline ambition stated in the EU's new Biodiversity Strategy, endorsed by all 27 EU Member States in 2020, to 'ensure that by 2050 *all* of the world's ecosystems are restored, resilient, and adequately protected'.[168] When it comes to implementing Article 8(f) within the EU, an important role appears to be reserved for the 30% of the EU land area that should, according to the Strategy, at a minimum have received legal protection by 2030, and especially for the 10% of EU land earmarked to be 'strictly protected'.[169] The latter category, which presently covers only 3%, comprises areas managed and protected to leave 'natural processes essentially undisturbed'.[170] A recent working document of the European Commission stresses the importance of 'wilderness management' and ecological processes particularly in connection with these strictly protected areas, expressly mentioning the term 'rewilding' in this context:

> [W]ilderness management … is not only relevant to areas with existing wilderness values but also applicable to areas with potential for rewilding. The areas under strict protection have to be *functionally meaningful*, so that their strict protection regime can produce the expected results in terms of conservation. … [S]trictly protected areas should be large enough for *key natural processes to take place essentially undisturbed*.[171]

The Commission missed the opportunity to draw attention to the vital role of megafauna in this regard.

Future plans offer ample opportunity to remedy this. A potentially very significant development is the EU Nature Restoration Plan that was announced as part of the Biodiversity Strategy, which has a scope extending also beyond protected areas.[172] The plan is intended to 'improve the health of existing and new protected areas' and 'bring diverse and resilient nature back to all landscapes and ecosystems'.[173] In this regard, new EU legislation is in the pipeline, intended to lay down binding targets for ecosystem recovery, to 'restore degraded ecosystems, in particular those with the most potential to capture and store carbon and to prevent and reduce the impact of natural disasters'.[174] Evidently, there are compelling arguments to pay explicit attention to the role of megafauna in the drafting of this new legal instrument.

6 | CONCLUDING OBSERVATIONS

The significance of Article 8(f) of the CBD in the present context is hard to overstate. Our analysis indicates that this provision, interpreted in light of current scientific knowledge, lays down a demanding ecological restoration obligation for European States. Meeting this obligation requires not only providing for sufficient space, ecological connectivity and room for natural dynamics but also restoring the diversity and densities of Europe's megafauna as far as possible—which is in fact quite far. Depending on the circumstances, megafauna restoration can also be required or supported by obligations under other legal instruments, including the World Heritage Convention, Ramsar Convention, Convention on Migratory Species, Bern Convention, Carpathian Biodiversity Protocol, Alpine Nature Protocol, EU Habitats Directive, EU Water Framework Directive and EU Invasive Alien Species Regulation. Furthermore, restoring Europe's megafauna is necessary to meet non-binding but high-profile intergovernmental policy commitments. Importantly, to meet their obligations and pave the way for megafauna restoration, governments will need to effectively address the manifold legal obstacles noted above. This may require adjustments of (the application of) legal frameworks at local, national or international levels.[175] Regarding the near future, the proposed EU legislation on ecosystem restoration clearly provides a unique opportunity to boost megafauna restoration efforts in EU Member States.

There appear to be no solid reasons for European States *not* to comply with their existing megafauna restoration obligations under

[164] Habitats Directive (n 51) art 6(1)–(2).
[165] ibid art 22(1); this provision cannot therefore be considered to sufficiently implement Bern Convention (n 50) art 11(2)(a), discussed above.
[166] Regulation No. 1143/2014 of 22 October 2014 on the Prevention and Management of the Introduction and Spread of Invasive Alien Species [2014] OJ L317/35.
[167] Directive 2000/60/EC of 23 October 2000 Establishing a Framework for Community Action in the Field of Water Policy [2000] OJ L327/1 (Water Framework Directive) art 4(1)(a)(ii) and Annex V, Table 1.2; see, e.g., K Gilhaus, F Stelzner and N Hölzel, 'Cattle Foraging Habits Shape Vegetation Patterns of Alluvial Year-Round Grazing Systems' (2014) 215 Plant Ecology 169.
[168] Commission (EU), 'EU Biodiversity Strategy for 2030' (Communication) COM(2020) 380 final, 20 May 2020, 3 (emphasis added).
[169] ibid 4–5.
[170] ibid fn 24 (which indicates that strict protection does 'not necessarily mean the area is not accessible to humans').
[171] Commission (EU), 'Criteria and Guidance for Protected Areas Designation' SWD(2022) 23 final, 28 January 2022, 20 (emphasis added).
[172] Commission (EU) (n 168) 6.
[173] ibid.
[174] ibid.
[175] See also J Segar et al, 'Expert-Based Assessment of Rewilding Indicates Progress at Site-Level, Yet Challenges for Upscaling' (2021) Ecography e05836.

international law, and plenty reasons to comply other than being law-abiding. As indicated above, prime motives include the benefits for ecosystem health and function and for species survival as such, but these hardly exhaust the matter. To borrow from the CBD's first words, there is 'intrinsic value' to a healthy megafauna functioning within healthy ecosystems, alongside 'ecological, genetic, social, economic, scientific, educational, cultural, recreational and aesthetic values'.[176] To illustrate just one, the aesthetic angle is aptly captured in the 'drabber world' quote at this article's outset.[177]

Before closing, we highlight the important underlying *moral* motives for helping Europe's megafauna rise from the ashes, also bearing in mind that the law is inseparable from its normative underpinnings. First, there is the fundamental notion that a conscious agent who damages something of value, incurs an obligation to restore. And as Barnett puts it, even where a species' extinction was caused by a combination of climate change and human overhunting, it is 'clear where the fault lies', as '[o]nly one of these causes has agency, foresight, thought'.[178]

Second, an often overlooked but hardly less significant role is reserved in this context for the ethical notion of burden-sharing, particularly in the form of North–South solidarity, as reflected in the Rio Declaration's appeal to a 'spirit of global partnership' in the conservation and restoration of ecological integrity around the world.[179] Surely, few people would (dare) argue that Europeans deserve privileges that people in Africa and Asia do not—in this case the privilege of living without unruly large mammals that can pose a threat to human interests, including human safety. Yet, such inequality is entrenched in the present global situation, wherein the burden of conserving and coexisting with megafauna is very disproportionately borne by some of the world's least developed countries.[180]

The European responsibility becomes especially obvious when considering current and projected population densities. Europe has 34 people per square kilometre. India, for instance, has 464. Yet, India's human population of 1.4 billion (and growing) somehow still shares the landscape with inter alia elephants, rhinos, gaur (*Bos gaurus*, the world's largest species of wild cattle), wild water buffalo, some 20 species of deer and antelope, wild boar, an array of monkeys, as well as tigers, lions, leopards, snow leopards, caracals, brown bears, moon bears, sloth bears (*Melursus ursinus*), sun bears (*Helarctos malayanus*), striped hyenas, wolves, golden jackals and dholes. Meanwhile, Africa's megafauna, which hardly needs introduction, faces the challenge of coexisting with a human population that is expected to have more than tripled by the end of the century. As Tim Flannery succinctly phrases the rather inevitable conclusion,

> I think the moral case is unassailable: it is unacceptable to ask the people of Africa, whose population may reach around four billion by 2100, to live alongside lions and elephants while Europeans refuse to do so.[181]

In sum, rather than good reasons for non-compliance, there just appears to be a huge blind spot for the obligation(s) expounded above.[182] This blind spot may partly be caused by a lack of awareness that megafauna restoration in Europe is necessary and possible and is indeed what international law currently requires. We hope this article can contribute a little to remedying this deficit.

In closing, it is apt to cite Flannery once more: 'If the Europeans think small, Europe will remain a diminished place—one shorn of its greatest natural glories. But, if they think big, anything is possible.'[183] And, as shown above, thinking big is actually a legal and moral obligation.

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[176]CBD (n 68) preamble.
[177]Barnett (n 4) 293; see also, e.g. E Berti et al, 'Body Size is a Good Proxy for Vertebrate Charisma' (2020) 251 Biological Conservation 108790.
[178]Barnett (n 4) 34.
[179]Rio Declaration (n 95) Principle 7.
[180]Monsarrat and Svenning (n 103); also Trouwborst (n 8).
[181]Flannery (n 4) 310.
[182]For a curious parallel, see A Trouwborst, PC McCormack and E Martínez Camacho, 'Domestic Cats and their Impacts on Biodiversity: A Blind Spot in the Application of Nature Conservation Law' (2020) 2 People and Nature 235.
[183]Flannery (n 4) 307.