The paradoxical extinction of the most charismatic animals

Franck Courchamp¹,²,³*, Ivan Jaric⁴,⁵,⁶, Céline Albert¹, Yves Meinard⁷, William J. Ripple⁸, Guillaume Chapron⁹

¹ Ecologie, Systématique and Evolution, Univ. Paris-Sud, CNRS, AgroParisTech, Université Paris-Saclay, Orsay, France, ² Department of Ecology and Evolutionary Biology, University of California, Los Angeles, Los Angeles, California, United States of America, ³ Center for Tropical Research, Institute of the Environment and Sustainability, University of California, Los Angeles, Los Angeles, California, United States of America, ⁴ Biology Centre of the Czech Academy of Sciences, Institute of Hydrobiology, Na Sádkách, České Budějovice, Czech Republic, ⁵ Leibniz-Institute of Freshwater Ecology and Inland Fisheries, Berlin, Germany, ⁶ Institute for Multidisciplinary Research, University of Belgrade, Kneza Viseslava, Belgrade, Serbia, ⁷ Université Paris Dauphine, Paris Sciences & Lettres Research University, CNRS, LAMSADE, Paris, France, ⁸ Global Trophic Cascades Program, Department of Forest Ecosystems and Society, Oregon State University, Corvallis, Oregon, United States of America, ⁹ Department of Ecology,grimso Wildlife Research Station, Swedish University of Agricultural Sciences, Riddarhyttan, Sweden

* franck.courchamp@u-psud.fr

Abstract

A widespread opinion is that conservation efforts disproportionately benefit charismatic species. However, this doesn’t mean that they are not threatened, and which species are “charismatic” remains unclear. Here, we identify the 10 most charismatic animals and show that they are at high risk of imminent extinction in the wild. We also find that the public ignores these animals’ predicament and we suggest it could be due to the observed biased perception of their abundance, based more on their profusion in our culture than on their natural populations. We hypothesize that this biased perception impairs conservation efforts because people are unaware that the animals they cherish face imminent extinction and do not perceive their urgent need for conservation. By freely using the image of rare and threatened species in their product marketing, many companies may participate in creating this biased perception, with unintended detrimental effects on conservation efforts, which should be compensated by channeling part of the associated profits to conservation. According to our hypothesis, this biased perception would be likely to last as long as the massive cultural and commercial presence of charismatic species is not accompanied by adequate information campaigns about the imminent threats they face.

One of the difficulties faced by endangered species conservation efforts is the lack of a strong public support and mobilization. Whereas the biodiversity decline shows no sign of abatement, public mobilization has not scaled up with the severity of this crisis. For example, 20 million Americans took to the streets to demonstrate on the first Earth Day in 1970, but similar levels of mobilization have not been seen in the 21st century. This surprising discrepancy between the
need for global mobilization to avert species extinction and the lack thereof might be due in part to the disconnection of the general public from nature [1], because many endangered species and ecosystems are of limited appeal for the broad public. Here, we argue that the problem stems from deeper roots, because even the most charismatic wild animals suffer from the same predicament. We show that, paradoxically, the most charismatic species remain severely endangered, and rather unknowingly so by the general public, a situation that has dramatically worsened over the last decades despite massive cultural and commercial presence.

The concept of charismatic species is pervasive in the conservation literature and refers to species attracting the largest interest and empathy from the public [2]. As a consequence, charismatic species are often considered as privileged by having enjoyed the bulk of conservation efforts [3]. Therefore, the conservation of charismatic species is often taken for granted, and accordingly the literature emphasizes the need to go beyond charismatic species to conserve more discrete ones [4] and even to shift the conservation focus towards units that are more integrative and less visible to the broad public, such as ecosystems or ecosystem functions [5].

Using four different methods, we established the ranking of the 10 most charismatic species for the public and reviewed their conservation status and the public knowledge of it. We unveil that the conservation status of the ten most charismatic species is grave, while the public ignores it. We surmise that this "beloved but ignored" paradox may stem from a mismatch between the virtual presence and natural presence of these particular species. We argue that the representations of charismatic species in commercial, artistic, and cultural outlets act as virtual, abundant populations competing for public attention against real threatened populations. The competitive advantage of virtual populations reinforces the perception that natural populations are not threatened and may paradoxically lessen the necessary conservation efforts and consequently accentuate the risk of extinction of these species most cherished by the general public. We propose a mechanism whereby these virtual populations would not compete against threatened species but instead benefit them through a payment mechanism represented by fees for rights of use for commercial purposes.

Identifying the 10 most charismatic animals

Although species charisma is increasingly used in conservation biology [2], this concept has never been operationalized, and which species the public considers the most charismatic has not been established. We collected data from four complementary sources to quantify the charisma of species for the Western public (see S1 Text for details): (i) an online large-scale survey ($n = 4,522$); (ii) a questionnaire given to primary schoolchildren of France, Spain, and England ($n = 224$); (iii) a survey of the animals displayed on the websites from zoos in the 100 largest cities in the world; and (iv) a survey of the animals featured on the covers of animated movies produced by Disney and Pixar (see S1 Text). The first two sources represented direct questions to the public about which species they perceived as charismatic, while for the other two, we worked under the assumption that the species displayed on zoo websites and movies would be selected by communication experts based on their appeal to the public. The survey on pupils was intended to complement the internet survey for which children below 15 years old represented only 0.9% of the 4,522 respondents. Collectively, these data provided a coherent list that can be considered representative of animals regarded by the Western public as being the most charismatic. We call them animals instead of species, because taxonomic precision to the species level for public knowledge was possible for none of the four sources and, among the top 10 animals cited, 2 represent more than one species. Indeed, elephants represent three species, while gorillas represent two species; we will thus hereafter mention 10 animals or 13 species.

The compiled list of the 10 animals considered the most charismatic by the public was in this order (S1 Fig): the tiger (Panthera tigris), the lion (P. leo), the elephant (Loxodonta africana, L. 
cyclotis, and *Elephas maximus*), the giraffe (*Giraffa camelopardalis*), the leopard (*Panthera pardus*), the panda (*Ailuropoda melanoleuca*), the cheetah (*Acinonyx jubatus*), the polar bear (*Ursus maritimus*), the gray wolf (*Canis lupus*), and the gorilla (*Gorilla beringei* and *G. gorilla*).

Severe endangerment of the most charismatic species

Although conservation efforts are indeed probably disproportionately focused on them, these 13 species are nevertheless in a dire conservation status (Box 1, Tables 1 and S1). Except for the gray wolf, all the species are either Vulnerable, Endangered, or Critically Endangered [6]. Furthermore, most of the species that are classified within lower threat categories, such as Vulnerable, are considered as such based on global and outdated assessments, masking important discrepancies between more threatened populations or subspecies. Although conservation biology has been particularly active the last three decades, dramatic declines have taken place over the same period, with losses often exceeding half of the entire species’ population in an extremely short time (Fig 1A). One interesting observation is that direct killing constitutes one of the principal causes of endangerment, a surprising finding for the 10 most charismatic animals (see S2 Text). Moreover, population estimates are generally provided as global numbers, masking the fact that the number of breeding animals is often much lower and that the global population corresponds to many disconnected populations, many of which are too small to be viable (see S2 Text). Demographic studies of minimum viable population (MVP) show insufficient population sizes to expect high survival probabilities in the short term if strong conservation measures are not taken rapidly (Table 1).

The severe decline of species ranges is even more of a problem because all these species are large mammals requiring extended individual home ranges and correspondingly wide population distributions (S1 Table). As a result, most species suffer simultaneously from the declining and the small population paradigms (Fig 2). In the few remaining habitats of those 10 charismatic animals, the percentage of range in protected area is insufficient (41 ± 20, mean ± SD, Table 1) and the percentage of land under human pressure remains substantial (33 ± 28, Table 1). An aggravating factor for all populations is the severe fragmentation, by both the number of patches (71.3 ± 81.1, Table 1) and the surface/edge ratio (0.069 ± 0.12, S1 Table).

Public ignorance of threatened status

Perhaps even more noteworthy than the poor conservation status of the animals that people cherish the most is our finding of the lack of awareness of the public on this matter. First, with two of our approaches to identify the most charismatic species (internet survey and pupil poll), we asked respondents whether they would associate each species with being “Endangered.” This attribute was selected less often than randomly, and less often than expected if the conservation status was known, suggesting that the public is often unaware that the animals they deem charismatic are threatened with extinction. Second, we conducted a targeted survey among students of the University of California, Los Angeles campus, in 2015. Ninety-six students were asked during individual interviews whether or not the 10 animals listed by the 4 sources were threatened; results (Fig 1B) show similarly that the public, even when represented by scientifically educated respondents, is often unaware of the dire conservation status of most of these species. On average, one in two persons was incorrectly assessing the endangerment of these animals, be it the general public or the supposedly more educated students of a world-class university. Exceptions are pandas, tigers, and polar bears, for which communication efforts may have borne their fruits in this regard—the first one being widely recognized as a global conservation icon and the two others as flagship species for traditional medicine and climate change impacts. Overall, these two lines of evidence suggest that these ten animals are
Box 1. The jeopardized future of the 10 most charismatic species.

- Tiger—total abundance estimated at less than 7% of their historic numbers [7]. Three subspecies (Bali tiger, \textit{P. tigris balica}; Javan tiger, \textit{P. t. sondaica}; and Caspian tiger, \textit{P. t. virgata}) are now extinct, and another one (the South China tiger, \textit{P. t. amoyensis}) is considered as possibly extinct [8,9].

- Lion—declining almost everywhere in Africa, with populations estimated to be at less than 8% of historic levels [10,11]. In Eurasia, with the exception of the only remaining population of about 175 individuals of \textit{P. leo persica} in India, all lions are now extinct [12].

- Elephant—the African savannah elephant never recovered from the 20th century massive poaching levels and are believed to remain at less than 10% of their historic numbers [13]; the African forest elephant declined in a mere 9 years (2002–2011) by 62%, with about 30% corresponding range contraction [14]; the Asian elephant lost 85% of historic range, and almost half of the remaining 15% is both fragmented and heavily impacted by an ever increasing human population [15,16].

- Giraffe—previously classified as Vulnerable because it was assessed as a single species [17]. Three of the four newly identified species [18] have declined by 52%–97% in the last 35 years and are likely to be uplisted by IUCN [17].

- Leopard—classified as a Vulnerable species because the 9 subspecies are altogether abundant and widely distributed [19]; however, 3 are Critically Endangered, 2 are Endangered, 2 are recommended for uplisting to Critically Endangered and Endangered, and 2 are Near Threatened [20]. Leopards have already lost as much as 75% of their habitat range, and 6 out of the 9 subspecies occupy a mere 3% of the remaining range [20].

- Panda—with fewer than 2,000 remaining individuals, distributed within 33 subpopulations and scattered on less than 1% of its historic range, its future remains particularly uncertain [21], especially in light of climate change, predicted to reduce most of its bamboo habitat [22,23].

- Cheetah—occupies only 9% of its historic range in Africa, being extirpated from 29 countries on the continent [24], while the Asiatic subspecies \textit{Acinonyx jubatus venaticus}, numbering fewer than 100 individuals, is listed as Critically Endangered [25].

- Polar bear—lack of population abundance and trend estimates; 9 out of the 19 known populations are of unknown status. It is considered severely impacted by climate change and related sea ice decline [6]. The few populations with available data show drastic population declines (see Fig 1).

- Wolf—once the world’s most widely distributed large predator, it has now lost about one third of its original range, becoming extinct in much of Western Europe and the United States and being endangered in several other regions [26].

- Gorilla—of the 4 gorilla subspecies, 2 are limited to a few hundred individuals in small and highly fragmented populations [27,28], while the 2 others have lost most of their numbers in about 20 years [29,30].
Table 1. Status and trends of the 10 most charismatic animals. See S1 Text for the calculus of variables. African forest elephants have been distinguished from savannah elephants when information was available.

| Species            | IUCN          | Demography       | Habitat                  | Fragmentation (#patch) |
|--------------------|---------------|------------------|--------------------------|------------------------|
|                    | Taxonomic fractionation | Status | Estimated population size | Current trend | Percent MVP (pop/#patch)/ MVP | Percent historical range | Percent range protected | Percent "viable" habitat |
| Tiger, Panthera tigris | 9 subspecies  | EN    | 3,159                | ³ Decr.        | 30 | <6⁹| 36 | 76 | >54⁹ |
| Lion, P. leo         | 2 subspecies  | VU    | 20,000⁸              | ³ Decr.        | 155 | 17⁹| 82 | 84 | 67¹ |
| Elephant, Loxodonta Africana | 3 species | VU    | 500,000⁹              | ³ Incr.        | 1,431 | 19.9⁹| 57 | 83 | 70⁰ |
| L. cyclotis          | /             | VU    | <100,000⁹            | ³ Decr.        | 231 | <25⁹| 57 | 83 | 70⁰ |
| Elephas maximus      | EN            | 47,000⁹ | ³ Decr. | 93 | 15¹,⁵⁰ | 30 | 67 | >138⁸ |
| Giraffe, Giraffa camelopardalis | 4 species, 9 subspecies | VU | 80,000⁹ | ³ Decr. | 714 | 11.3⁹ | 57 | 77 | >66³ |
| Leopard, P. pardus   | 9 subspecies  | VU    | Unkn.                | ³ Decr.        | / | 25¹ | 34 | 7 | 289³ |
| Panda, Ailuropoda melanoleuca | / | VU    | 1,864⁴ | ³ Incr. | 23 | <1¹⁰ | 62 | 94 | 33⁶ |
| Cheetah, Acinonyx jubatus | 9 subspecies | VU | 7,000⁷ | ³ Decr. | 45 | 9⁸ | 40 | 51 | 29⁹ |
| Polar bear, Ursus maritimus | / | VU | Unkn. | Unkn. | / | Dyn | 12 | 24 | 19⁹ |
| Wolf, Canis lupus    | 12 subspecies | LC | Unkn. | → Stable | / | About 66⁶ | 14 | 58 | / |
| Gorilla, Gorilla beringei | 2 species, 4 subspecies | CR | 3,800+880¹ | ³ Decr. | 388 | / | 51 | 93 | 2¹; 4¹ |
| G. gorilla           | CR            | 300+150,000⁸ | ³ Decr. | 5,330 | / | 24 | 89 | 13⁸; ⁴² |

References:

¹[31]
²[32]
³[14]
⁴[33]
⁵[25]
⁶[29]
⁷[30]
⁸[34]
⁹[35]
¹⁰[32]
¹¹[16]
¹²[20]
¹³[21]
¹⁴[24]
¹⁵[26]
¹⁶[9]
¹⁷[12]
¹⁸[36]
¹⁹[37]
²⁰[17]
²¹[38]
²²[27]
²³[39]

"#" means “no data available.”

* IUCN assessment of 2008; shown to be decreasing since

Abbreviations: #patch, number of patches; CR, Critically Endangered; Decr., decreasing; Dyn, dynamical; EN, Endangered; Incr., increasing; IUCN, International Union for the Conservation of Nature; LC, Least Concern; MVP, minimum viable population; Unkn., unknown; VU, Vulnerable.

https://doi.org/10.1371/journal.pbio.2003997.t001
not perceived as charismatic because of their conservation status, which is often not known. Conversely, these animals may be assumed to be abundant because of their omnipresence in our culture, as they are seen everywhere—in zoos and toys, on small and large screens, on advertisements and books alike. We emphasize that the gap between conservation status awareness and actual status should be especially unlikely in the most charismatic species, due to the high level of public attention they receive.

Competition between real and virtual populations

Despite their poor conservation status, these species are omnipresent in our modern societies. A good illustration is in the advertising realm. Charismatic animals are often prime candidates for product marketing purposes or general cultural consumption. For example, 48.6% of all non-teddy bear plush animal toys sold on Amazon (US) were one of the ten animals, suggesting high likelihood that a majority of children has/had at least one of them as a stuffed companion during their childhood. Similarly, the number of “Sophie la girafe” baby toys sold in France (800,000 in 2010) exceeds the number of babies born [49] and is over 8 times more than the number of actual, living giraffes in Africa [17]. To further support our idea, we asked 42 volunteers to document every encounter with one of the 10 species in “virtual” populations.
commercial, artistic, cultural, in zoos, books, magazines, on objects, on logos, on television, etc.) during 7 consecutive days. All volunteers lived in France, with a combination of rural and urban environments, living with or without television, with or without interest in animals, etc. On average, they encountered up to 31 individuals of each of the 10 species, which corresponds for each person to several hundred total encounters per month (S2 Fig). For example, the volunteers saw an average of 4.4 lions a day, meaning that people see on average two to three times as many “virtual” lions in a single year than the total population of wild lions currently living in the whole of West Africa. This reinforces our idea that the ubiquity of “virtual” species may be hindering the perception of rarity of these animals.

These species are therefore ubiquitous in our culture through what could be called virtual populations. The public perception of the conservation status of these species appears to reflect virtual populations rather than real ones. This is not surprising, because most people will only see wild animals in virtual populations. We suggest that the abovementioned mismatch between perceived and real conservation status may be due to the fact that people base their perception
of these species on their virtual rather than real populations. It is unfortunately difficult to un-
ambiguously demonstrate a causal relationship between the overabundance of virtual species
and the biased perception of their actual endangerment, mostly because causes of ignorance are
always multiple and difficult to isolate and unconditionally tie in.

This mechanism amounts to an intraspecific competition mediated by human perception,
in which abundant but virtual populations outcompete for human attention the real but threat-
ened populations (Fig 3). The perceived extinction risk, which is low, as it is influenced by highly
abundant, virtual populations, masks the real, high extinction risk. As humans would expectedly
strive to prevent extinction of, at the very least, the 10 animals they cherish the most, the fact that
they make decisions (or refrain from making any) based on perceived risk rather than the real
one [50] would likely prevent conservation efforts from getting the necessary support.

**Turning competition into cooperation for conservation**

One challenge for the success of conservation biology may therefore be how to transform these
omnipresent but virtual populations from a liability to an asset for real populations. By using
animals in their marketing, some products and brands gain a competitive market advantage,
but the induced damages of contributing to the creation of competing, virtual populations are
never taken into account and never compensated for. According to economic theory, such
damages are “externalities,” and they must be “internalized” through institutional

![Fig 3. Illustration of the competition hypothesis between virtual populations (here represented by iconic logos of
commercial companies) and natural populations (here represented by clip art of real animals), whereby
abundance of virtual animals in culture alters the perception of actual rarity in real animals and, therefore, the
perceived need for their conservation. A compensatory mechanism is needed to restore adequate conservation
funding. Credit for logo illustration and human silhouettes: Mathieu Ughetti.](https://doi.org/10.1371/journal.pbio.2003997.g003)
arrangements and/or payment mechanisms compelling companies to take responsibility for the damages they cause—albeit inadvertently [51]. Currently, companies do not pay a fee to use lions for their branding but, as we hypothesize, may unknowingly and indirectly weaken conservation support by contributing to a mistaken perception that lions are abundant, akin to a competition for attention from the public. Linking the use of threatened animal representations for commercial use to payment to conservation efforts could contribute to turning competition into cooperation between virtual and real populations. This logic of payment for rights to use is not different to, e.g., merchandising of derivative products: a clothes company needs to pay a fee to display the photo of a celebrity, of the illuminated Eiffel tower, or of the English Premier League logo on its products. That fee is paid to the brand copyright holder, in that latter case, the Football Association Premier League Ltd. Our proposed mechanism would scale up an idea that was once suggested for media firms [52] and applies it in areas where its benefits for biodiversity promise to be vastly superior. Assuming that biodiversity is a public good and that the above payment scheme should not be captured by private or sectoral interests, we propose that a scheme is established whereby companies would pay a fee to an existing or ad hoc institution representing the global public interest in preserving biodiversity, for using threatened animal representations in their branding. A voluntary program called “Save your logos” (http://www.saveyourlogo.org/) has been attempted, but we believe scaling up the idea requires grounding it in a formal compulsory mechanism. Global agreements such as the Convention on Biological Diversity (CBD) are often criticized for being ineffective due to their being non-compulsory and sometimes inexplicit [53]. The implementation of such payment mechanisms would be a major step towards improving their effectiveness to protect biodiversity.

The limits of so-called “standard economic” approaches to solve biodiversity conservation problems have been largely discussed in the literature [54,55]. The proposed mechanism should therefore not be seen as a panacea but rather as practical means to secure funding for conservation biology. The above critical analysis should also be used to identify and implement the important safeguards required to ensure proper implementation. These would include avoiding lobbying attempts to influence endangerment classification either way (from conservationists as well as from companies) and would address fairness as well as equity issues from the companies’ standpoints. Other perverse effects, such as attempts by companies to marginally modify representations to argue that they refer to fictitious rather than to real species, should also be listed and addressed. It would also probably be beneficial if the compensatory mechanism could be coupled with information campaigns from the companies about the reason for such funding, i.e., about the conservation status of their icons. This option would further benefit their conservation while possibly being better perceived by the company and their customers. Being perceived as acting at the forefront of the conservation of the imperiled charismatic animal that represents them could even create a very positive response from previous and new customers of such companies. Indeed, these firms may improve their corporate social responsibility by helping to save their icons, providing them with additional incentives to adhere to this scheme.

Another critical element will be the choice of the institution(s) entrusted to receive the money and allot it to conservation initiatives. Global institutions devoted to biodiversity are prominent candidates, but other smaller-scale nonprofit local nongovernmental organizations (NGOs) might prove more resilient to interest groups and more knowledgeable about relevant local conservation issues in some situations. Elaborating an adequate institutional design and quantitatively calibrating the fees falls beyond the scope of the present paper and should be covered by interdisciplinary collaborations between conservation scientists and experts in the economic theory of incentives, institutional economics, and property right laws [55].
Conclusion

Our study highlights that the 10 most charismatic animals for the public are in a dire conservation state but that the public is generally ignorant of this. Unless a radical change is operated, it is highly likely that most of these most-cherished species will go extinct in the wild within the next few decades. This situation is hidden by the large cultural abundance of these animals, which hinders conservation communication efforts and therefore acts as an additional, pernicious threat.

Beyond being a conservation tragedy in its own right, the likely extinction of these species can also turn into a double penalty for conservation biology. Indeed, charismatic species remain one of the most efficient vehicles to motivate the general public to support conservation action [56–58]. If these species go extinct in the wild, the whole conservation movement might suffer by losing its point in the eye of a large part of the general public.

We therefore claim that conservation studies, actions, and policies should stop seeing charismatic species as overprivileged conservation targets and face the fact that they are badly threatened species that urgently need an intensification of conservation effort. Such an intensification would not amount to demeaning the importance of conserving other elements of biodiversity, poorly known species, and whole ecosystems. For one thing, increasing the protection on the charismatic species does not mean zeroing on other conservation targets, especially if involved funding mechanisms are additive to already existing resources [53], as we propose here. Besides, because most charismatic species are keystone species with large habitat requirements, preserving them can have cascading co-benefits on the conservation status of numerous other species and ecosystem properties [59]. Similarly, communicating more about the endangerment of the most beloved species could raise public awareness of wider conservation issues.

Despite the fact that the increase needed in conservation revenue has been estimated to be more modest than other domains of public expenditure by at least one order of magnitude [60], in a world in which budget constraints are everywhere, our call for conservation intensification can look like wishful thinking. That is why we suggest, as a concrete mechanism to ensure its feasibility, a support from companies that use charismatic, endangered species for their branding. Setting up such a fund-raising scheme will require innovative interdisciplinary works involving conservation scientists, environmental economists, and legal scholars, but the relevant expertise is available, and action is required urgently.

Supporting information

S1 Text. (DOCX)

S2 Text. (DOCX)

S1 Table. Range size, proportion that is both suitable and protected (see S1 Text), and fragmentation (ratio of range size over perimeter of the range size) for the 10 most charismatic animals. (DOCX)

S1 Fig. Ranking of the 10 most charismatic animals, according to the general public. These correspond to 13 species, as elephants and gorillas are represented by three and two species, respectively. (TIF)

S2 Fig. Number of sightings of each of the 10 animals in “virtual” populations (commercial, artistic, cultural, in zoos, books, magazines, on objects, on television, etc.) during 7
consecutive days by 42 volunteers living in France. Dark blue is the number of sightings and light blue is the total cumulative number of individuals seen (e.g., a chocolate bar with 1 elephant counts as 1 in dark blue and 1 in light blue, while a bar with 2 elephants counts as 1 in dark and 2 in light blue). Volunteers all lived in France but in various settings (from staying always indoors with no television in a rural house, to regular use of the internet and television and going out every day to work and shop in a large city). Volunteers were asked to pay attention to representation of those 10 animals in order to record them but not to seek them. After an information meeting, a one-day trial was used to homogenize observation behaviors and information recording.

(TIF)

S3 Fig. Distribution of different drivers of threat for each of the 13 species, according to whether they are directly or indirectly human caused. Colors indicate whether a threat is primary (red) or secondary (yellow).

(TIF)

Acknowledgments
The authors wish to thank Morgane Barbet-Massin, Alice Fournier, Camille Leclerc, and François de Guibert for their help with modelling analyses of Table 1 and Céline Bellard, Muriel Perron, Luca Börger, and Duan Biggs for helpful comments on the manuscript. We are also grateful to the 42 volunteers who recorded sightings of virtual animals for a week.

References
1. Soga M, Gaston KJ. Extinction of experience: The loss of human-nature interactions. Front Ecol Environ. 2016; 14: 94–101. https://doi.org/10.1002/fee.1225
2. Ducarme F, Luque GM, Courchamp F. What are “charismatic species” for conservation biologists? Biosci Master Rev. 2013;July: 1–8.
3. Brambilla M, Gustin M, Celada C. Species appeal predicts conservation status. Biol Conserv. 2013; 160: 209–213. https://doi.org/10.1016/j.biocon.2013.02.006
4. Ford AT, Cooke SJ, Goheen JR, Young TP. Conserving Megafauna or Sacrificing Biodiversity? Bioscience. 2017; 67: 193–196. https://doi.org/10.1093/biosci/biw092 PMID: 28533560
5. Keith DA, Rodríguez JP, Brooks TM, Burgman MA, Barrow EG, Bland L, et al. The IUCN red list of ecosystems: Motivations, challenges, and applications. Conserv Lett. 2015; 8: 214–226. https://doi.org/10.1111/conl.12167
6. IUCN. The IUCN Red List of Threatened Species. In: 2017 [Internet]. [cited 4 Feb 2017]. Available: http://www.iucnredlist.org
7. Sanderson EW, Forrest J, Loucks C, Ginsberg J, Dinerstein E, Seidensticker J, et al. Setting Priorities for Tiger Conservation [Internet]. Second Edi. Tigers of the World. Elsevier Inc.; 2015. https://doi.org/10.1016/B978-0-8155-1570-8.00009-8
8. Goodrich J, Lynam A, Miquelle D, Wibisono H, Kawanishi K, Pattanavibool A, et al. Panthera tigris. IUCN Red List Threat Species 2015. 2015; doi:e.T15955A50659951
9. Dinerstein E, Loucks C, Wikramanayake E, Ginsberg J, Sanderson E, Seidensticker J, et al. The Fate of Wild Tigers. Bioscience. 2007; 57: 508. https://doi.org/10.1641/B570608
10. Riggio J, Caro T, Dollar L, Durant SM, Jacobson AP, Kiffner C, et al. Lion populations may be declining in Africa but not as Bauer et al. suggest. Proc Natl Acad Sci. 2015; 113: 201521506. https://doi.org/10.1073/pnas.1521506113 PMID: 26719424
11. Bauer H, Chapron G, Nowell K, Henschel P, Funston P, Hunter LTB, et al. Reply to Riggio et al.: Ongoing lion declines across most of Africa warrant urgent action. Proc Natl Acad Sci. 2015; 113: 201522741. https://doi.org/10.1073/pnas.1522741113 PMID: 26719423
12. Riggio J, Jacobson A, Dollar L, Bauer H, Becker M, Dickman A, et al. The size of savannah Africa: A lion’s (Panthera leo) view. Biodivers Conserv. 2013; 22: 17–35. https://doi.org/10.1007/s10531-012-0381-4
13. Lee PC, Graham MD. African elephants and human-elephant interactions: implications for conservation. Int Zoo Yearb. 2006; 40: 9–19. https://doi.org/10.1111/j.1748-1090.2006.0009.x
14. Maisels F, Strindberg S, Blake S, Wittemyer G, Hart J, Williamson EA, et al. Devastating Decline of Forest Elephants in Central Africa. PLoS ONE. 2013; 8(3): https://doi.org/10.1371/journal.pone.0059469 PMID: 23469289

15. Leimgruber P, Gagnon JB, Wemmer C, Kelly DS, Songer MA, Selig ER. Fragmentation of Asia’s remaining wildlands: implications for Asian elephant conservation. Anim Conserv. 2003; 6: 347–359. https://doi.org/10.1017/S13679430030303421

16. Goswami VR, Vasudev D, Oli MK. The importance of conflict-induced mortality for conservation planning in areas of human-elephant co-occurrence. Biol Conserv. Elsevier Ltd; 2014; 176: 191–198. https://doi.org/10.1016/j.biocon.2014.05.026

17. Muller Z, Bercovitch F, Brand R, Brown D, Brown M, Bolger D, et al. Giraffa camelopardalis. IUCN Red List Threat Species 2016. 2016; 1–8. https://doi.org/10.1126/science.194.4268.933 PMID: 17748550

18. Fennessy J, Bidon T, Reuss F, Kumar V, Elkan P, Nilsson MA, et al. Multi-locus Analyses Reveal Four Giraffe Species Instead of One. Curr Biol. Elsevier Ltd; 2014; 176: 191–198. https://doi.org/10.1016/j.cub.2014.05.026 PMID: 27618261

19. Henschel P, Hunter L, Breitenmoser U, Purchase N, Packer C, Khorozyan I, et al. Panthera pardus. IUCN Red List Threat Species 2008; 2008;

20. Jacobson AP, Gerngross P, Lemeris Jr. JR, Schoonover RF, Anco C, Breitenmoser-Würsten C, et al. Leopard (Panthera pardus) status, distribution, and the research efforts across its range. PeerJ. 2016;4: e1974. doi:10.7717/peerj.1974

21. Kang D, Li J. Premature downgrading of panda's status. Science (80-). 2016; 354: 295–295. https://doi.org/10.1038/nclimate1727

22. Durant SM, Mitchell N, Groom R, Pettorelli N, Ipavec A, Jacobson AP, et al. The global decline of cheetah Acinonyx jubatus and what it means for conservation. Proc Natl Acad Sci. 2016; 114: 201611122. https://doi.org/10.1073/pnas.1603144114 PMID: 28028225

23. Tuanmu M-N, Vilia A, Winkler J a., Li Y, Xu W, Ouyang Z, et al. Climate-change impacts on understorey bamboo species and giant pandas in China’s Qinling Mountains. Nat Clim Chang. Nature Publishing Group; 2013; 3: 249–253. https://doi.org/10.1038/nclimate1727

24. Ripple WJ, Newsom TM, Wolf C, Dirzo R, Everatt KT, Galetti M, et al. Collapse of the world's largest herbivores. Sci Adv. 2015; 1: e1400103–e1400103. https://doi.org/10.1126/sciadv.1400103 PMID: 26601172

25. Plumptre A, Robbins M, Williamson EA. Gorilla beringei. IUCN Red List Threat Species 2016. 2016;

26. Morrison JC, Sechrest W, Dinerstein E, Wilcove DS, Lamoreux JF. Persisten ce of Large Mammal Faunas as Indicators of Global Human Impacts. J Mammal. 2007; 88: 1363–1380. https://doi.org/10.1644/06-MAMMAL-D-05-00048.1

27. Barnes RFW. Is there a future for elephants in West Africa? Mamm Rev. 1999; 29: 175–199. https://doi.org/10.1046/j.1365-2907.1999.00044.x

28. Choudhury A, Lahiri Choudhury DK, Desai A, Duckworth JW, Easa PS, Johnsingh AJT, et al. Elephas maximus. IUCN Red List Threat Species 2010. 2008; doi:e.T7140A12828813
38. Peacock E, Sonsthagen SA, Obbard ME, Boltunov A, Regehr E V., Ovsyanikov N, et al. Implications of the circumpolar genetic structure of polar bears for their conservation in a rapidly warming Arctic. PLoS ONE. 2015; 10(1): https://doi.org/10.1371/journal.pone.0112021 PMID: 25562525
39. Bergl RA, Vigilant L. Genetic analysis reveals population structure and recent migration within the highly fragmented range of the Cross River gorilla (Gorilla gorilla diehli). Mol Ecol. 2007; 16: 501–516. https://doi.org/10.1111/j.1365-294X.2006.03159.x PMID: 17257109
40. Bauer H, Chapron G, Nowell K, Henschel P, Funston P, Hunter LTB, et al. Lion (Panthera leo) populations are declining rapidly across Africa, except in intensively managed areas. Proc Natl Acad Sci U S A. 2015; 112: 14894–9. https://doi.org/10.1073/pnas.1500664112 PMID: 26504235
41. Thouless CR, Dublin HT, Blanc JJ, Skinner DP, Daniel TE, Taylor RD, et al. African Elephant Status Report 2016. An update from the African Elephant Database. 2016.
42. Chase MJ, Schlossberg S, Griffin CR, Bouche PJC, Djene SW, Elkan PW, et al. Continent-wide survey reveals massive decline in African savannah elephants. PeerJ. 2016; 4: e2354. https://doi.org/10.7717/peerj.2354 PMID: 27635327
43. Bromaghin JF, McDonald TL, Stirling I, Derocher AE, Richardson ES, Regehr EV, et al. Polar bear population dynamics in the southern Beaufort Sea during a period of sea ice decline. Ecol Appl. 2015; 25: 634–651. https://doi.org/10.1890/14-1129.1 PMID: 26214910
44. Regehr EV, Amstrup SC, Stirling I. Polar Bear Population Status in the southern Beaufort Sea; U.S. Geological Survey. Reston, Virginia, USA.; 2006.
45. Plumptre AJ, Nixon S, Kujirakwinja DK, Vieilledent G, Critchlow R, Williamson EA, et al. Catastrophic decline of world’s largest primate: 80% loss of grauer’s gorilla (Gorilla beringei graueri) population justifies critically endangered status. PLoS ONE. 2016; 11(10): https://doi.org/10.1371/journal.pone.0162697 PMID: 27760201
46. Hilbers JP, Santini L, Visconti P, Schipper AM, Pinto C, Rondinini C, et al. Setting population targets for mammals using body mass as a predictor of population persistence. Conserv Biol. 2016; 31: 1–24. https://doi.org/10.1111/cobi.12846
47. Traill LW, Bradshaw CJA, Brook BW. Minimum viable population size: A meta-analysis of 30 years of published estimates. Biol Conserv. 2007; 139: 159–166. https://doi.org/10.1016/j.bioncon.2007.06.011
48. Reed DH, O’Grady JJ, Brook BW, Ballou JD, Frankham R. Estimates of minimum viable population sizes for vertebrates and factors influencing those estimates. Biol Conserv. 2003; 113: 23–34. https://doi.org/10.1016/S0006-3207(02)00346-4
49. Levin J. Sophie the Giraffe, the European teething toy that’s sweeping America. In: Slate [Internet]. 2011 [cited 11 Jan 2018]. Available: http://www.slate.com/articles/arts/number_1/2011/03/im_french_chew_on_me.html
50. Slovic P. The Feeling of Risk: New Perspectives on Risk Perception (Earthscan Risk in Society). EarthScan. London, Washington DC; 2010.
51. Ninan KN. Conserving and Valuing Ecosystem Services and Biodiversity: Economic, Institutional and Social Challenges. London, UK: EarthScan; 2009.
52. Jeppson P, Jennings S, Jones KE, Hodgetts T. Entertainment Value: Should the Media Pay for Nature Conservation? Science (80-). 2011; 334: 1351–1352. https://doi.org/10.1126/science.1213189 PMID: 22158806
53. Butchart SHM, Di Marco M, Watson JEM. Formulating Smart Commitments on Biodiversity: Lessons from the Aichi Targets. Conserv Lett. 2016; 9: 457–468. https://doi.org/10.1111/conl.12278
54. Sagoff M. The Economy of the Earth: Philosophy, Law, and the Environment. Second Edi. University C, editor. Cambridge, U.K.; 2008.
55. Vatn A. Environmental Governance. Institutions, Policies and Actions. Edward Elg. Cheltenham; 2016.
56. Macdonald EA, Burnham D, Hinks AE, Dickman AJ, Malhi Y, Macdonald DW. Conservation inequality and the charismatic cat: Felis felicis. Glob Ecol Conserv. Elsevier B.V.; 2015; 3: 851–866. https://doi.org/10.1016/j.gecco.2015.04.006
57. Colléony A, Clayton S, Couvet D, Saint Jaime M, Prévet A-C. Human preferences for species conservation: Animal charisma trumps endangered status. Biol Conserv. Elsevier Ltd; 2016; https://doi.org/10.1016/j.biocon.2016.11.035
58. Caro T. Conservation by proxy. Washington, Covelo, London: Island Press; 2010.
59. Ripple WJ, Chapron G, López-bao JV, Durant SM, Macdonald DW, Corlett RT, et al. Saving the World’s Terrestrial Megafauna. Bioscience. 2016; 66: 807–812. https://doi.org/10.1093/biosci/biw092 PMID: 28533560
Figure S1

Figure S2
**Table S1.**
Range size, proportion that is both suitable and protected (see Material and Methods), and fragmentation (ratio of range size over perimeter of the range size), for the 10 most charismatic animals.

| Species            | Estimated range size \(10^5 \text{ km}^2\) | Suitable and protected habitat (%) | Fragmentation (edge ratio) |
|--------------------|--------------------------------------------|-----------------------------------|---------------------------|
| Tiger              | 0.704                                      | 28.49                             | 0.144                     |
| Lion               | 1.69                                       | 67.27                             | 0.031                     |
| Elephant           | **Loxodonta africana**                      | 3.331                             | 47.51                     | 0.055                     |
|                    | **Loxodonta cyclotis**                      |                                   |                           |
|                    | **Elephas maximus**                        | 0.62                              | 25.83                     | 0.066                     |
| Giraffe            | **Giraffa camelopardalis**                 | 2.016                             | 46.58                     | 0.013                     |
| Leopard            | Panthera pardus                            | 9.254                             | 26.59                     | 0.018                     |
| Panda              | *Ailuropoda melanoleuca*                   | 0.034                             | 58.81                     | 0.430                     |
| Cheetah            | *Acinonyx jubatus*                         | 5.119                             | 23.92                     | 0.018                     |
| Polar bear         | *Ursus maritimus*                          | 22.605                            | 4.97                      | 0.004                     |
| Wolf               | *Canis lupus*                              | 51.201                            | 9.07                      | 0.006                     |
| Gorilla            | *Gorilla beringei*                         | 0.048                             | 48.36                     | 0.039                     |
|                    | *Gorilla gorilla*                          | 0.696                             | 22.69                     | 0.008                     |
Supplementary Text

Conservation status

Our study shows that the ten most charismatic animals for the public are globally in a dire conservation status. Not only are their conservation statuses globally disastrous (Table 1), but they have dramatically worsened recently. Despite representing a blink in the time scale of species evolution, and notwithstanding being the most active and successful period of conservation biology, the last few decades have been catastrophic for almost all these species (see Fig. 1).

In addition, it is noteworthy that these low numbers of remaining animals tend to understate the actual threats on the species. These aggregated population sizes overlook the fact that most species are scattered among many isolated populations, and that a significant proportion of animals are not breeding and cannot contribute to the future of the species.

The proportion of breeding individuals in a population is highly variable among species. Among the 3,159 remaining tigers, it is estimated that there are fewer than 1,000 breeding females [1]. In addition, most tigers currently live in isolated patches that are too small to shelter demographically viable populations: all extant populations hold fewer than 100 breeding individuals [1,2]. Similarly, African lions live in 67 fragments of habitat, most of which is unprotected and heavily populated, and the projections for the next few decades show further decline and local extinctions [3]. In Africa, there were at least 219 isolated populations of elephants in the last assessment in 2008 [4]. Asian elephants are in fact three different subspecies dispersed into at least 138 patches over 13 countries [5]. For the giraffe, only about 70% of the individuals can be considered ‘mature’ for status assessment purposes [6]. Leopards survive on less than 25% of their historical range (less than 5% for four subspecies) and the remaining populations are scattered across 273 separate patches [7]. Mature adults are estimated to account for only 50.5% of the total population of pandas, so the actual reproductive population would be closer to 1,000 individuals in total [8]. They are in addition divided into 33 small, fragmented areas, corresponding to several disconnected populations of much fewer individuals, each with increased probability of extinction [9]. The estimated 7,000 remaining cheetahs are distributed across 30 subpopulations, 28 of which are estimated to hold fewer than 250 individuals [10,11], which indicates low survival probability in the future.

Another surprising result of this study is the finding that although the focus species are the most charismatic, a major threat faced by almost all of them is direct killing by humans (Fig. S3). IUCN threat categories show that poaching, conflict with humans, civil unrest, trophy hunting, diseases and car accidents account for over half of all the threats on the 12 species. This is certainly counterintuitive for species supposed to be among the most beloved ones.

Studies about the future of these species are surprisingly few and restricted, given their cultural importance. Most studies focus on one single threat and/or on one single population, making it difficult to get a global picture of the extinction risks of any of these species. However, even extinction projections based on a subset of threats show very low survival probabilities in the wild in the coming decades. Bengal tiger (P. t.
Population models indicate a 63-99% extinction likelihood within two to four decades due to poaching [12] while extinction probability due to inbreeding is as high as 90% within the next 30 years [13]. These two causes are also likely to result in the extinction of nearly all subpopulations of the Sumatran tiger (P. t. sumatrae) within the next 40 years [14]. Unsustainable bushmeat hunting, trophy hunting, habitat loss and human conflict all combine to make most of African lion populations surviving the next few decades unlikely [15-17]. Because of their long generation time, models indicate that without stringent conservation measures, elephants will become extinct within 20-100 years, both in Africa [18] and in Asia [19]. The Great Elephant Census (GEC) also predicts a likely extinction of savannah elephants in the wild before the end of the century [20]. Climate change is predicted to eliminate most of the panda's bamboo habitat in the next decades, leading to predictions of dramatic decline of the remaining panda populations [21,22]. Modelling different scenarios of global cheetah populations showed further population declines by 53% to 70% over the next 15 years and likely global extinction in the short term [11]. A forecast for polar bears worldwide concluded that they will further decline by two thirds by 2050 and that extinction is the most probable overall outcome for all but one population within 50 years [23]. This is mostly because of declines in sea ice extent following climate change, with a loss of optimal polar bear habitat that will reach 68% by the end of the century [24]. With the current annual rate of decline of 5%, Grauer’s gorillas will probably become extirpated from many parts of their range within 2-5 years [25], with about 93% of the total population gone in just three generations [26].

The average minimum viable population sizes for 8 out of the 10 animals (no estimate was available for either giraffes or leopards) were all below 5,800 individuals [27,28].

Despite these dire figures, these species are not exceptions: it is now common knowledge that biodiversity as a whole is impacted by human populations in a number of ways. For example, the 2016 Living Planet assessment report [29] revealed that 58% of wild animals have disappeared in the last four decades and that this loss would reach two thirds by 2020. According to the IUCN Red List, over 39% of all assessed species are threatened with extinction, and many taxonomic groups that have not been adequately assessed could be even more heavily threatened. A recent study on vertebrates showed that biodiversity loss is also acute at the population level [30]. Overall, nearly two thirds of the 27 world’s largest carnivores (≥15 kg) and of the 74 world’s largest herbivores (≥100 kg) are threatened with extinction [31,32]. Not all threatened species benefit from the conservation effort of the ten most charismatic animals, and many are at least as likely to be lost in a geologically extremely short time.

**Lack of scientific knowledge**

The above results should not hide another dreadful point: science knows incredibly little about these large, familiar and culturally ubiquitous species. In most cases, even basic information such as global population size is not known with certainty. Population sizes of lions and tigers have been the topic of heated debates among experts for years. The last estimates of the largest land mammal, elephant, are based on only 62% of its possible range: no population estimates are available for the remaining 38% [33]. Asian elephant population estimate (of 40-50,000) is qualified by experts as “no more than a
crude guess”, dating from 2003, and yet is still the only available [5]. There are no reliable continent-wide estimates of leopard population size in Africa, and the most commonly cited estimate of over 700,000 leopards in Africa is known to be flawed [34]. In India, current estimates are based on pugmark censuses, a methodology which has been criticized as inaccurate [34]. For polar bears, nine out of 19 populations have insufficient data to provide an assessment of current trends and no information at all is available on abundance for the Arctic Basin population [35].

References

1. Walston J, Robinson JG, Bennett EL, Breitenmoser U, da Fonseca G a B, Goodrich J, et al. Bringing the tiger back from the brink-the six percent solution. PLoS Biol. 2010;8: 6–9. doi:10.1371/journal.pbio.1000485
2. Ranganathan J, Chan KMA, Karanth KU, Smith JLD. Where can tigers persist in the future? A landscape-scale, density-based population model for the Indian subcontinent. Biol Conserv. 2008;141: 67–77. doi:10.1016/j.biocon.2007.09.003
3. Riggio J, Jacobson A, Dollar L, Bauer H, Becker M, Dickman A, et al. The size of savannah Africa: A lion’s (Panthera leo) view. Biodivers Conserv. 2013;22: 17–35. doi:10.1007/s10531-012-0381-4
4. Blanc J. Loxodonta africana. IUCN Red List Threat Species 2008. 2008;8235. doi:http://dx.doi.org/10.2305/IUCN.UK.2008.RLTS.T12392A3339343.en
5. Choudhury A, Lahiri Choudhury DK, Desai A, Duckworth JW, Easa PS, Johnsingh AJT, et al. Elephas maximus. IUCN Red List Threat Species 2010. 2008; doi:e.T7140A12828813
6. Muller Z, Bercovitch F, Brand R, Brown D, Brown M, Bolger D, et al. Giraffa camelopardalis. IUCN Red List Threat Species 2016. 2016; 1–8. doi:10.1126/science.194.4268.933
7. Jacobson AP, Gerngross P, Lemeris Jr. JR, Schoonover RF, Anco C, Breitenmoser-Würsten C, et al. Leopard (Panthera pardus) status, distribution, and the research efforts across its range. PeerJ. 2016;4: e1974. doi:10.7717/peerj.1974
8. Swaisgood R, Wang D, Wei F. Ailuropoda melanoleuca. IUCN Red List Threat Species 2016. 2016; doi:10.2305/3503982
9. Kang D, Li J. Premature downgrade of panda’s status. Science (80-. ). 2016;354: 295–295. doi:10.1126/science.aaj1963
10. Durant S, Mitchell N, Ipavec A, Groom R. Acinonyx jubatus, cheetah. IUCN Red List Threat Species 2015. 2015; doi:10.1644/1545-1410(2005)771[0001:AJ]2.0.CO;2
11. Durant SM, Mitchell N, Groom R, Pettorelli N, Ipavec A, Jacobson AP, et al. The global decline of cheetah Acinonyx jubatus and what it means for conservation. Proc Natl Acad Sci. 2016;114: 201611122. doi:10.1073/pnas.1611122114
12. Horev A, Yosef R, Tryjanowski P, Ovadia O. Consequences of variation in male harem size to population persistence: Modeling poaching and extinction risk of Bengal tigers (Panthera tigris). Biol Conserv. 2012;147: 22–31. doi:10.1016/j.biocon.2012.01.012
13. Kenney J, Allendorf FW, Mcdougal C, Smith JLD. How much gene flow is needed to avoid inbreeding depression in wild tiger populations? Proc R Soc.
14. Linkie M, Chapron G, Martyr DJ, Holden J, Leader-Williams N. Assessing the viability of tiger subpopulations in a fragmented landscape. J Appl Ecol. 2006;43: 576–586. doi:10.1111/j.1365-2664.2006.01153.x

15. Creel S, M’soka J, Dröge E, Rosenblatt E, Becker M, Matandiko W, et al. Assessing the sustainability of African lion trophy hunting, with recommendations for policy. Ecol Appl. 2016; doi:10.1002/eap.1377

16. Bauer H, Chapron G, Nowell K, Henschel P, Funston P, Hunter LTB, et al. Lion (Panthera leo) populations are declining rapidly across Africa, except in intensively managed areas. Proc Natl Acad Sci U S A. 2015;112: 14894–9. doi:10.1073/pnas.1500664112

17. Riggio J, Caro T, Dollar L, Durant SM, Jacobson AP, Kiffner C, et al. Lion populations may be declining in Africa but not as Bauer et al. suggest. Proc Natl Acad Sci. 2015;113: 201521506. doi:10.1073/pnas.1521506113

18. Lopes AA. Organized crimes against nature: Elephants in southern africa. Nat Resour Model. 2015; 86–107. doi:10.1111/nrm.12058

19. Goswami VR, Vasudev D, Oli MK. The importance of conflict-induced mortality for conservation planning in areas of human-elephant co-occurrence. Biol Conserv. Elsevier Ltd; 2014;176: 191–198. doi:10.1016/j.biocon.2014.05.026

20. Chase MJ, Schlossberg S, Griffin CR, Bouché PJC, Djene SW, Elkan PW, et al. Continent-wide survey reveals massive decline in African savannah elephants. PeerJ. 2016;4: e2354. doi:10.7717/peerj.2354

21. Li R, Xu M, Wong MHG, Qiu S, Li X, Ehrenfeld D, et al. Climate change threatens giant panda protection in the 21st century. Biol Conserv. Elsevier Ltd; 2015;182: 93–101. doi:10.1016/j.biocon.2014.11.037

22. Tuanmu M-N, Viña A, Winkler J a., Li Y, Xu W, Ouyang Z, et al. Climate-change impacts on understorey bamboo species and giant pandas in China’s Qinling Mountains. Nat Clim Chang. Nature Publishing Group; 2013;3: 249–253. doi:10.1038/nclimate1727

23. Amstrup SC, Marcot BG, Douglas DC. A Bayesian Network Modeling Approach to Forecasting the 21st Century Worldwide Status of Polar Bears. Geophys Monogr. 2008;180: 213–268.

24. Durner G, Douglas D, Nielson R, Amstrup S, McDonald T, Stirling I, et al. Predicting 21-century polar bear habitat distribution from global climate models. Ecol Monogr. 2009;79: 25–58. doi:10.1890/07-2089.1

25. Plumptre AJ, Nixon S, Vieilledent G, Nishuli R, Kirkby A, Williamson EA, et al. Status of Grauer’s Gorilla and Chimpanzees in Eastern Democratic Republic of Congo: Historical and Current Distribution and Abundance. New York; 2015.

26. Plumptre A, Robbins M, Williamson EA. Gorilla beringei. IUCN Red List Threat Species 2016. 2016;

27. Reed DH, O’Grady JJ, Brook BW, Ballou JD, Frankham R. Estimates of minimum viable population sizes for vertebrates and factors influencing those estimates. Biol Conserv. 2003;113: 23–34. doi:10.1016/S0006-3207(02)00346-4

28. Traill LW, Bradshaw CJA, Brook BW. Minimum viable population size: A meta-analysis of 30 years of published estimates. Biol Conserv. 2007;139: 159–166. doi:10.1016/j.biocon.2007.06.011
29. World Wildlife Fund. Living Planet Report 2016: Risk and resilience in a new ear. 2016.
30. Ceballos G, Ehrlich PR, Dirzo R. Biological annihilation via the ongoing sixth mass extinction signaled by vertebrate population losses and declines. Proc Natl Acad Sci. 2017; 1–8. doi:10.1073/pnas.1704949114
31. Ripple WJ, Newsome TM, Wolf C, Dirzo R, Everatt KT, Galetti M, et al. Collapse of the world’s largest herbivores. Sci Adv. 2015;1: e1400103–e1400103. doi:10.1126/sciadv.1400103
32. Ripple WJ, Estes J a, Beschta RL, Wilmers CC, Ritchie EG, Hebblewhite M, et al. Status and ecological effects of the world’s largest carnivores. Science (80- ). 2014;343: 1241484. doi:10.1126/science.1241484
33. Thouless CR, Dublin HT, Blanc JJ, Skinner DP, Daniel TE, Taylor RD, et al. African Elephant Status Report 2016. An update from the African Elephant Database. 2016.
34. Henschel P, Hunter L, Breitenmoser U, Purchase N, Packer C, Khorozyan I, et al. Panthera pardus. IUCN Red List Threat Species 2008. 2008;
35. Wiig O, Atwood T, Laidre K, Lunn N, Obbard M, Regehr E, et al. Ursus maritimus. IUCN Red List Threat Species 2015. 2015; doi:e.T22823A14871490.
Materials and Methods

Charismatic species ranking

We used four different sources to assess which species the public found the most charismatic. First, an Internet survey was conducted through social networks using a specifically designed website, asking respondents about their choice of the 10 wild species they considered the most charismatic. The survey was available in English, French, Spanish and Italian and we collected answers from a total of 4,522 respondents from 69 countries. Second, the same survey was conducted with children ~10 years old in three primary schools in England, Spain and France. The schoolteachers first explained the term “charismatic” as attracting or appealing or preferred, and pupils were given 10-15 minutes to provide the 10 wild species. We collected 224 useable complete questionnaires. Third, we collected the names of all identifiable wild animal species displayed on the home page of the official web sites of major zoos from the 100 largest cities in the world (https://en.wikipedia.org/wiki/World's_largest_cities accessed on 16-04-2012). Fourth, we recorded the names of all identifiable animal species (excluding imaginary, extinct or domestic ones) featured on the cover of the English versions of all the animated movies ever produced by Disney and Pixar. Full details of the methods are given here [1]. We then combined the four lists into one, giving them equal weight, which provided our ranking of the most charismatic species.

Estimation of the values in Tables 1 and S1

The range size of each species has been calculated with the geospatial data provided by the IUCN [2]. In order to estimate the percentage of range coverage by protected areas, we combined species range size with data provided by Protected Planet that lists worldwide information on protected areas [3]. The index of fragmentation we proposed is simply the ratio of perimeter to range size of each species. In addition, we assessed suitable habitat in the global range size using LandCover data [4]. To do so, we separated natural from non-natural (anthropogenized) habitat and determined the corresponding surface. For these species, classes corresponding to anthropogenized or unavailable lands were 11, 14, 20, 30, 170, 190, 200, 210 and 220 (see [4] for details). All analyses have been conducted with QGis 2.18.1 and RStudio 0.99.853 software. For the latter, packages “geosphere”, “maptools”, “raster”, “rgdal”, “rgeos”, “proj4” and “shapefiles” have been used.

References:
1. Albert C, Luque GM, Courchamp F. The twenty most charismatic species. PLoS One. 2017;Submitted.
2. IUCN. The IUCN Red List of Threatened Species. In: 2017 [Internet]. [cited 4 Feb 2017]. Available: http://www.iucnredlist.org
3. IUCN, UNEP-WCMC. The World Database on Protected Areas (WDPA) [Internet]. 2016 [cited 4 Nov 2016]. Available: www.protectedplanet.net
4. Arino O, Perez R, Julio; J, Kalogirou V, Bontemps S, Defourny P, et al. Global Land Cover Map for 2009 (GlobCover 2009). 2012. doi:10.1594/PANGAEA.787668