Conserving the World's Megafauna and Biodiversity: The Fierce Urgency of Now

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In our recent perspective article, we noted that most (approximately 60 percent) terrestrial large carnivore and large herbivore species are now threatened with extinction, and we offered a 13-point Declaration designed to promote and guide actions to save these iconic megafauna (Ripple et al. 2016). In their commentary, Ford and colleagues worry that a focus on saving megafauna might undermine efforts to conserve biodiversity more broadly. We believe that all dimensions of biodiversity are important and that efforts to conserve megafauna are not in themselves sufficient to halt the dispiriting trends of species population losses in recent decades. From 1970 to 2012, a recent global analysis showed a 58 percent overall decline in vertebrate population abundance (WWF 2016). Bold and varied approaches are necessary to conserve what remains of Earth's biodiversity, and our Declaration in no way disputes the value of specific conservation initiatives targeting other taxa. Indeed, the evidence is clear that without massively scaling up conservation efforts for all species, we will

fail to achieve internationally agreed upon targets for biodiversity (Tittensor et al. 2014).

However, megafauna remain strong candidates—and we believe the strongest candidates—to serve as "umbrellas" for conservation of many species and ecosystems (Caro 2010). This is because megafauna typically have large habitat requirements relative to those of other species; therefore, conserving megafauna necessitates conserving large tracts of landscapes and the diversity of species and ecosystem processes they contain (Kerley et al. 2003b). As such, efforts to protect the world's rapidly dwindling megafauna populations should be viewed as complementary to, not in conflict with, conservation of other species across the taxonomic and body-size spectra.

Biodiversity is not evenly distributed on planet Earth, and some countries house far greater concentrations of biodiversity than others. Indeed, most of the world's terrestrial species diversity can be found in the top 17 most biodiverse countries (Mittermeier et al. 1997). These 17 countries support populations of at least two-thirds of all nonfish vertebrate species and three-quarters of all higher plant species (Mittermeier et al. 1997). A surprising number of threatened megafauna species are also found within these biodiversity-rich countries (figure 1), underscoring the fundamental compatibility of targeted efforts to conserve ecosystems containing both megafauna and biodiversity as a whole. Accordingly, significant cobenefits should arise from future conservation efforts in countries that are rich in both threatened megafauna and overall biodiversity in areas where the distribution of megafauna overlaps significantly with the distribution of many other species.

Abundant evidence shows that many megafauna populations are strong interactors whose loss causes direct and indirect effects on other species and ecosystem functions (Beschta and Ripple 2009, Estes et al. 2011, Dirzo et al. 2014, Ripple et al. 2014, 2015). In many instances, megafaunal extinction will cause disproportionate ecological disruption relative to the loss of other, smaller animals. This is due not only to the large body size of megafauna but also to the limited functional redundancy both within megafaunal guilds (e.g., Pringle et al. 2014) and between megafauna and other animals. For example, jaguars (*Panthera onca*) are the sole nonhuman predators of adult tapirs (*Tapirus* spp.) in Latin America, only lions (*Panthera leo*) routinely kill African buffalo (*Syncerus caffer*) and giraffe (*Giraffa camelopardalis*) across Africa, and gray wolves (*Canis lupus*) and bears (*Ursus* spp.)

alone are responsible for the vast majority of predation on large herbivores in most Holarctic regions. The accumulated (and in our view unequivocal) evidence that megafauna frequently fulfill unique and far-reaching functional roles does not imply that other species should be ignored or that taxon-centric programs should necessarily supersede systems-based approaches; it simply underscores the critical importance of not allowing relict megafaunal populations to vanish.

Without passing judgment on the appropriateness of conservation triage—a complicated topic beyond the scope of this article—we appreciate that funding for conservation is finite and that great care is needed when considering resource allocation. But it would be a mistake to assume that the conservation funding has already peaked and hence that allocation decisions are a zero-sum game. Our call to develop new funding mechanisms is rooted in the evidence that large animals evoke strong emotional responses in many people, providing powerful routes to develop new conservation funders and leaders (Batt 2009, Clayton and Myers 2009). We are not the first to call for additional conservation resources to achieve conservation gains. Even with increased investment, however, careful prioritization will still be necessary to inform decisions about which areas to protect and which actions to undertake for particular species (e.g., McCarthy et al. 2012). Although trade-offs are inevitable, we welcome all ethical efforts to grow the resource base for biodiversity conservation at large, so that such tradeoffs may be fewer and less painful. Although funding for conservation is often not easily substitutable among causes or from one conservation target to another, evidence suggests that much of the current public support for conservation might diminish if megafauna species were made less of a focus (Kerley et al. 2003a). One way to increase conservation gains is to focus on megafauna species with special public appeal, using them to create support and funding that could also help less charismatic species (Macdonald et al. 2015).

For these reasons, we believe that megafauna, with their unique socioeconomic and cultural values and ability to harness public and political support, have the power to lift many conservation boats (Macdonald et al. 2015). For example, in Africa, several countries have set aside vast tracts of land for conservation and have a firm political commitment to preserving those lands. This is due in part to appreciation of the megafauna they contain as well as to notions of the importance of preserving natural heritage for future generations (see the Ugandan Constitution; *www.ulii.org/node/23824*). In other cases, political assistance for conservation is

mostly the product of popular support. Because of their charisma, megafauna have more potential than most taxa to engender that kind of support. If we cannot manage to muster the political will to save even the widely appreciated megafauna, then our prospects seem grim.

Our Declaration was necessary because, despite being among the most cherished species by the public, many megafauna populations and species are steadily sliding toward extinction. We have yet to implement mechanisms that will save these species, and so our Declaration highlights the urgent need to raise additional support and identify alternative approaches—especially those that integrate support to and from local communities and that consider the rights of future generations and broader society. Our rallying call is certainly not "Megafauna to the exclusion of all else," but could perhaps better be framed with reference of Dr. Martin Luther King Jr.'s famous lines: "We are now faced with the fact that tomorrow is today. We are confronted with the fierce urgency of now. In this unfolding conundrum of life and history, there 'is' such a thing as being too late. This is no time for apathy or complacency. This is a time for vigorous and positive action."

Megafauna need immediate attention, and, yes, other species do as well. As concerned conservation scientists, we invite everyone to join the effort to confront the fierce necessity of "how?" in the fierce urgency of now.

References cited

Batt S. 2009. Human attitudes towards animals in relation to species similarity to humans: a multivariate approach. Bioscience Horizons 2: 180–190.

Beschta RL, Ripple WJ. 2009. Large predators and trophic cascades in terrestrial ecosystems of the western United States. Biological Conservation 142: 2401–2414.

Caro T. 2010. Conservation by Proxy: Indicator, Umbrella, Keystone, Flagship, and Other Surrogate Species. Island Press.

Clayton S, Myers G. 2009. Conservation Psychology. Understanding and Promoting Human Care for Nature. Wiley-Blackwell.

Dirzo R, Young HS, Galetti M, Ceballos G, Isaac NJB, Collen B. 2014. Defaunation in the Anthropocene. Science 345: 401–406.

Estes JA, et al. 2011. Trophic downgrading of planet Earth. Science 333: 301–306.

[IUCN] International Union for Conservation of Nature. 2015. The IUCN Red List of Threatened Species. Version 2015.2. IUCN.

Kerley GIH, Geach BGS, Vial C. 2003a. Jumbos or bust: Do tourists' perceptions lead to an under-appreciation of biodiversity? South African Journal of Wildlife Research 33: 13–21.

Kerley GI, Pressey RL, Cowling RM, Boshoff AF, Sims-Castley R. 2003b. Options for the conservation of large and medium-sized mammals in the Cape Floristic Region hotspot, South Africa. Biological Conservation 112: 169–190.

Macdonald EA, Burnham D, Hinks AE, Dickman AJ, Malhi Y, Macdonald DW. 2015. Conservation inequality and the charismatic cat: *Felis felicis*. Global Ecology and Conservation 3: 851–866.

McCarthy DP, et al. 2012. Financial costs of meeting global biodiversity conservation targets: Current spending and unmet needs. Science 338: 946–949.

Mittermeier RA, Gil PR, Mittermeier CG. 1997. Megadiversity: Earth's Biologically Wealthiest Nations. Agrupacion Sierra Madre.

Pringle RM, Goheen JR, Palmer TM, Charles GK, DeFranco E, Hohbein R, Ford AT, Tarnita CE. 2014. Low functional redundancy among mammalian browsers in regulating an encroaching shrub (*Solanum campylacanthum*) in African savannah. Proceedings of the Royal Society B 281: 20140390.

Ripple WJ, et al. 2014. Status and ecological effects of the world's largest carnivores. Science 343: 1241484.

Ripple WJ, et al. 2015. Collapse of the world's largest herbivores. Science Advances 1: e1400103–e1400103.

Ripple WJ, et al. 2016. Saving the world's terrestrial megafauna. BioScience 66: 807–812.

Tittensor DP, et al. 2014. A mid-term analysis of progress toward international biodiversity targets. Science 346: 241–244.

[WWF] World Wide Fund for Nature. 2016. Living planet report 2016: Risk and resilience in a new era. (10 November 2016; *http://awsassets.panda.org/downloads/lpr_living_planet_report_2016.pdf*)

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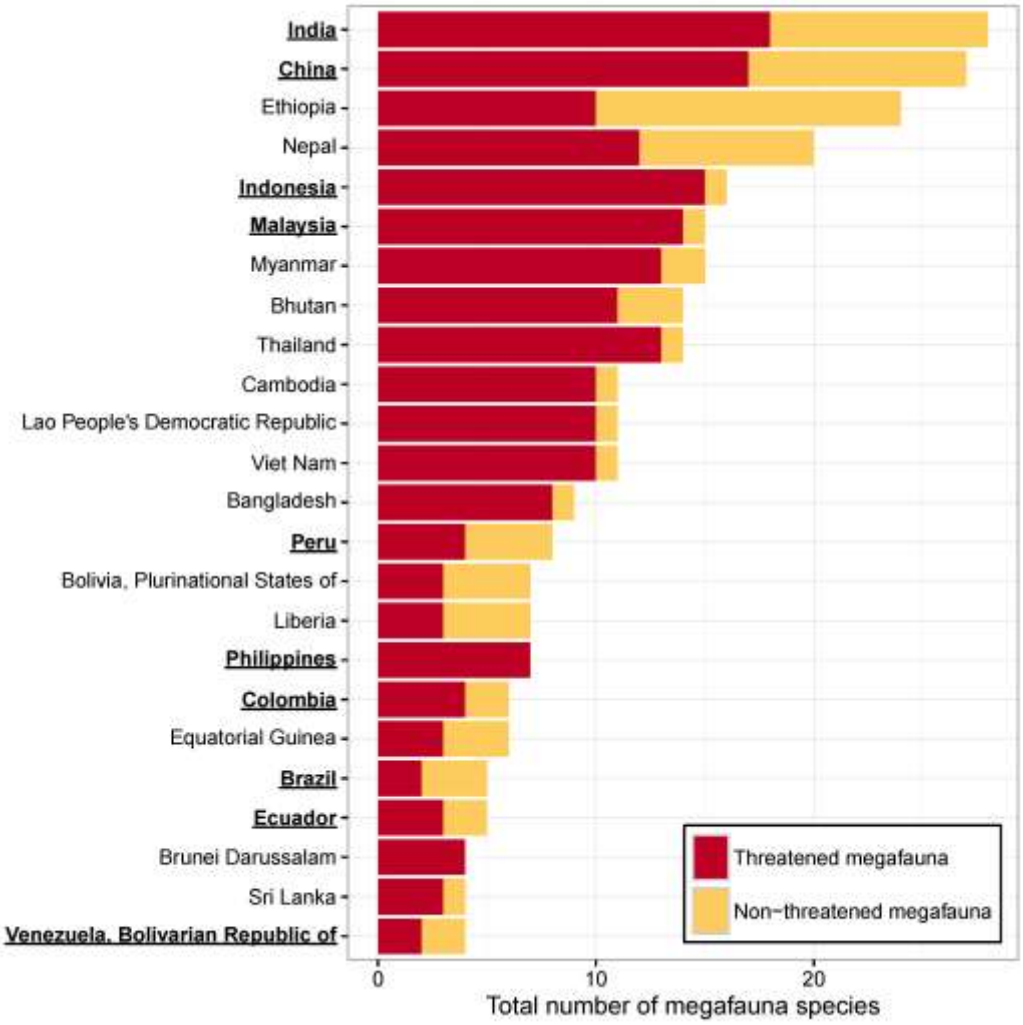

Figure caption

Figure 1. Number of mammalian terrestrial megafauna species found in countries with at least four megafauna species overall and at least 40 percent of their megafauna threatened; countries underlined with bold labels are biodiversity-rich countries (Mittermeier et al. 1997). Each species was treated as present in a country if it was listed as *native* to that country on its IUCN Red List species fact sheet page (IUCN 2015). Threatened megafauna are those with IUCN Red List status V*ulnerable*, E*ndangered*, or C*ritically Endangered*. Of the 17 biodiversity-rich countries, more than half (10) appear in this figure. Many of the other countries listed in the figure also have relatively high levels of biodiversity because they are located at low latitudes where productivity and biodiversity are high. Megafauna in this figure are terrestrial carnivores greater than or equal to 15 kilograms in size and herbivores

greater than or equal to 100 kilograms in size as defined in Ripple and colleagues (2014, 2015).