

Conserving Megafauna or Sacrificing Biodiversity?

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In their recent contribution, Ripple and colleagues (doi:10.1093/biosci/biw092) highlight the issue of large (more than 15 kilograms) terrestrial mammal (i.e., *megafauna*) declines, with the intent to “attract the public and media attention that this issue requires to galvanize opinion, catalyze action, and establish new funding mechanisms.” At the heart of this argument are the twin assertions that, compared with other taxa, terrestrial megafauna are (a) more imperiled and (b) more ecologically impactful. We agree that many species of large mammals are declining, that such declines could potentially alter ecosystems, and that new ways of thinking about this problem are needed to prevent extinctions. However, the formulation of their “declaration” suggests five questions that potentially undermine broader efforts to conserve biodiversity. We hope that our Viewpoint will help promote a net conservation gain for nature—megafauna and other forms of biodiversity—in a world of limited financial resources, public attention, and political will.

1. Will funding megafauna conservation help fund other species?

Declaration points 3 and 4 of Ripple and colleagues’ box 1 suggest that megafauna exemplify the public’s engagement in nature and that they are symbols of wilderness. We agree with Ripple and colleagues that megafauna are often more easily recognized than many other species are and that this could potentially be helpful in rallying public attention toward broader conservation objectives. This strategy has long been the position of many conservation nongovernmental organizations (Clucas et al. 2008). However, conservation campaigns promoting

“flagship” species tend to direct the majority of funds exclusively toward the flagship species (Smith R et al. 2012). In many cases, these flagship species are megafauna (Clucas et al. 2008), which suggests that the strategies used to promote the conservation of megafauna are, as practiced, inadequate for the conservation of other species.

2. Do megafauna need more attention?

We agree with Ripple and colleagues that more research on some species of megafauna could provide insights that are useful for conservation. However, the knowledge gaps in megafauna ecology are relatively thin cracks compared with the chasms of knowledge that exist for the vast majority of species—many of which we have yet to identify, let alone understand their natural history, biology, or conservation status (Wilson EO 1987, Costello et al. 2013, Donaldson et al. 2016). Indeed, studies have documented systematic biases toward large mammals in social media (Roberge 2014), in popular media (Clucas et al. 2008, Sergio et al. 2008), and in conservation research (Clark and May 2002) and fundraising (Smith R et al. 2012). This bias means that most animals and plants at risk of extinction receive far less funding than larger, warm-blooded vertebrates do, even if those larger species are less imperiled (Brodie 2009, Donaldson et al. 2016). We extend declaration point 8 of Ripple and colleagues to include raising funds for and awareness of other taxa whose status is at risk.

3. Do megafauna play a distinct role in the ecosystem?

The argument that megafauna have a distinct role in the ecosystem and that their impacts cascade to affect other

organisms or abiotic processes (declaration point 3) glosses over at least four important issues. First, although it is true that megafauna can precipitate trophic cascades in some systems, not all ecological communities possess the conditions necessary for such cascades to occur (Heupel et al. 2014, Ford and Goheen 2015, Ford et al. 2015). In order for megafauna species (or any other consumer) to trigger trophic cascades, there must be a series of strong and sequential pairwise interactions whereby consumers limit resources (Shurin et al. 2002, Schmitz 2010). It is not known how commonly this structure occurs in ecological communities comprising megafauna (Ford and Goheen 2015). Second, bottom-up control of ecological communities can also be strong (Schmitz 2010) such that arguments for conserving species that trigger knock-on effects could just as readily be directed toward primary producers. Efforts to conserve species in lower trophic levels could then facilitate megafauna conservation. Third, if the justification for increased conservation of megafauna is their potential role as ecosystem engineers, then it follows that other ecological engineers should receive increased support for conservation. Megafauna do not exclusively engineer ecosystems—consider the engineering roles of rodents (Wright et al. 2002, Davidson et al. 2012), fish (Moore 2006), and invertebrates (Hastings et al. 2007). Fourth, there remain questions about functional redundancy among megafauna and smaller species (Keesing 2000, Rosenfeld 2002, Maclean et al. 2011, Pringle et al. 2014, Veblen et al. 2016). High redundancy would

suggest that the loss of individual species (or even guilds) may not have cascading effects or that the ecological role of some species—including megafauna—may not be distinct. Together, these four points suggests that megafauna are either as ecologically distinct as any other taxonomic group or that the evidence for megafauna distinction is highly uncertain. In either case, ecological distinction *per se* is not a compelling argument to support the primacy of megafauna conservation.

4. Is a declaration to conserve megafauna counterproductive? The answer to this question depends on the extent to which the “new funding mechanisms” and attention sought for megafauna are additive or compensatory. We argue that resources and attention are extendable but ultimately finite. Therefore, Ripple and colleagues’ suggestion to increase funding for megafauna would likely detract from resources potentially available for other species. In some jurisdictions, dedicated funds for megafauna conservation (e.g., for harvestable populations) are the result of policies targeting the enhancement of certain species for the benefit of user groups (e.g., recreational hunting opportunities). Such policies can be altered to include or exclude nonmegafauna taxa, but these policies typically are not designed to make the resource pie bigger. Consequently, increasing the attention and resources for megafauna could imperil the conservation of other species by drawing an even larger share of limited resources. Conversely, if substantially greater resources do become available for conservation, one could readily argue that they should be disproportionately allocated to smaller animal, plants, and microbes, if only to partially level the playing field.

5. Are megafauna more imperiled than other species? One explanation for the observed declines

in many megafaunal populations is the attention directed toward them—the declines are noticed precisely because people are paying attention. For taxa with a lower research profile, there often are not enough data available to document species occurrence, let alone population trends (Costello et al. 2013, Donaldson et al. 2016). Indeed, in spite of taxonomic bias in the assessment process (Donaldson et al. 2016), the International Union for Conservation of Nature reports that none of the 15 species (not subspecies) known to have gone extinct in the wild between 1984 and 2004 are megafauna (Baillie et al. 2004). We agree with Ripple and colleagues that megafauna are declining in many areas, but declines are not exclusive to megafauna, nor are they necessarily steeper. Moreover, the declines in abundance or diversity of other taxa are staggering and include insectivorous passerines (Parody et al. 2001), native pollinators (Potts et al. 2010), medicinal plants (Shanley and Luz 2003), amphibians (Stuart et al. 2004), bats (Blehert et al. 2009), coral (De’ath et al. 2012), phytoplankton (Boyce et al. 2010), and marine (Worm et al. 2009) and freshwater fish (Bruton 1995). The impact of these declines threatens livelihoods and human well-being (Salafsky and Wollenberg 2000) in a way that the loss of many megafauna, although tragic, simply may not have. To further illustrate our point, we note that Ripple and colleagues suggest that we are just learning about the ecological role of megafauna. However, we have comparatively little knowledge about the natural history, ecology, or conservation status of human-gut microbiota—species that literally shape our internal and external ecosystems—in an era of widespread antibiotic use (Blaser and Falkow 2009). Finally, smaller species are also subject to illegal trade, perhaps more so than megafauna (Smith KF et al. 2009). For these reasons, it is

difficult to argue for the prioritization of megafauna conservation in a world of competing social, physical, and environmental needs.

Moving forward: What is the best way to promote an agenda of conservation for megafauna and other species? We reiterate our agreement that the conservation of megafauna is important, that many species are facing decline, and that new ways of thinking about the problem are needed to offset these declines. In this way, Ripple and colleagues’ declaration is commendable for its spirit, its intention, and its calls to change “business-as-usual” practices—we agree wholeheartedly. However, for many in the conservation community, “business as usual” is, in fact, the overrepresentation of megafauna in research, funding, and media attention. Unfortunately, Ripple and colleagues’ declaration risks further increasing this disparity. One could see a similar declaration (needlessly) developed for virtually every taxonomic group (e.g., freshwater fish, insects, amphibians, or plants). All but a few words in Ripple and colleagues’ declaration would need to be replaced for it to be relevant to these other taxonomic groups. Indeed, were their declaration positioned more broadly (for conservation of biodiversity rather than a specific taxonomic group), it might have greater influence across diverse taxa and among a broader audience of conservationists.

We briefly highlight three emerging approaches to conservation that could provide a more objective and comprehensive approach to allocation and prioritization than what was suggested by Ripple and colleagues. First, a common-threats approach (Donaldson et al. 2016) may help unify and direct funding toward the sources of decline for both megafauna and other species. For example, habitat loss is a significant threat to many species in the tropics (Brooks et al. 2002), and efforts to prevent the conversion of native rainforest into agriculture could produce broad,

community-wide conservation gains (Brodie and Giordano 2013). Such an approach, as Ripple and colleagues advocate (declaration points 5 and 10), would need to address the impacts of conservation on the livelihoods and cultures of local people. Second, accounting and optimization approaches provide a transparent means of quantifying the effectiveness of conservation spending (Wilson KA et al. 2006, Joseph et al. 2009). This approach allows society to compare the unit cost of increasing the population growth rate for different species of conservation concern, thereby grounding management decisions in objective criteria. Indeed, Czech and colleagues (1998) suggest that, relative to birds and mammals, plants and amphibians may offer a more productive investment in conservation funding. Third, shifting the focus from *taxa per se* to the conservation or restoration of landscape-scale systems and processes could be another means of addressing the declines of both megafauna and other species. For example, the “umbrella-species” utility of megafauna (Fleishman et al. 2001)—often used as an indicator of ecological condition or conservation planning—could be shifted toward a focus on umbrella *processes*. In this way, the presence of renewal processes such as fires (Bowman and Legge 2016) and floods (Hauer et al. 2016) would potentially confer persistence for a host of species, including megafauna (Sensenig et al. 2010, Palmer and Ruhl 2015).

We believe that an inclusive approach to conservation is needed. Such an approach would coordinate resources, research efforts, policy changes, and the mitigation of common threats for a host of ecological process and taxa. We embrace the spirit of Ripple and colleagues’ declaration, but we believe that the conservation benefits arising from its adoption will have a much greater impact if they are not targeted at the taxonomic group that is arguably the most well-studied and well-funded one on Earth.

References cited

- Baillie J, Hilton-Taylor C, Stuart SN. 2004. International Union for Conservation of Nature (IUCN) Red List of Threatened Species: A Global Species Assessment. IUCN.
- Blaser MJ, Falkow S. 2009. What are the consequences of the disappearing human microbiota? *Nature Reviews Microbiology* 7: 887–894.
- Bleher DS, et al. 2009. Bat white-nose syndrome: An emerging fungal pathogen? *Science* 323: 227–227.
- Bowman DM, Legge S. 2016. Pyrodiversity—Why managing fire in food webs is relevant to restoration ecology. *Restoration Ecology* 24: 848–853. doi:10.1111/rec.12401
- Boyce DG, Lewis MR, Worm B. 2010. Global phytoplankton decline over the past century. *Nature* 466: 591–596.
- Brodie JF. 2009. Is research effort allocated efficiently for conservation? Felidae as a global case study. *Biodiversity and Conservation* 18: 2927–2939.
- Brodie JF, Giordano A. 2013. Lack of trophic release with large mammal predators and prey in Borneo. *Biological Conservation* 163: 58–67.
- Brooks TM, et al. 2002. Habitat loss and extinction in the hotspots of biodiversity. *Conservation Biology* 16: 909–923.
- Bruton MN. 1995. Have fishes had their chips? The dilemma of threatened fishes. *Environmental Biology of Fishes* 43: 1–27.
- Clark JA, May RM. 2002. Taxonomic bias in conservation research. *Science* 297: 191–192.
- Clucas B, McHugh K, Caro T. 2008. Flagship species on covers of US conservation and nature magazines. *Biodiversity and Conservation* 17: 1517–1528.
- Costello MJ, May RM, Stork NE. 2013. Can we name Earth’s species before they go extinct? *Science* 339: 413–416.
- Czech B, Kausman PR, Borkhataria R. 1998. Social construction, political power, and the allocation of benefits to endangered species. *Conservation Biology* 12: 1103–1112.
- Davidson AD, Detling JK, Brown JH. 2012. Ecological roles and conservation challenges of social, burrowing, herbivorous mammals in the world’s grasslands. *Frontiers in Ecology and the Environment* 10: 477–486.
- De’ath G, Fabricius KE, Sweatman H, Puotinen M. 2012. The 27-year decline of coral cover on the Great Barrier Reef and its causes. *Proceedings of the National Academy of Sciences* 109: 17995–17999.
- Donaldson MR, Burnett NJ, Braun DC, Suski CD, Hinch SG, Cooke SJ, Kerr JT. 2016. Taxonomic bias and international biodiversity conservation research. *FACETS* 1 (art. 105).
- Fleishman E, Blair RB, Murphy DD. 2001. Empirical validation of a method for umbrella species selection. *Ecological Applications* 11: 1489–1501.
- Ford AT, Goheen JR. 2015. Trophic cascades by large carnivores: A case for strong inference and mechanism. *Trends in Ecology and Evolution* 30: 725–735.
- Ford AT, Goheen JR, Augustine DJ, Kinnaird MF, O’Brien TG, Palmer TM, Pringle RM, Woodroffe R. 2015. Recovery of African wild dogs suppresses prey but does not trigger a trophic cascade. *Ecology* 96: 2705–2714.
- Hastings A, Byers JE, Crooks JA, Cuddington K, Jones CG, Lambrinos JG, Talley TS, Wilson WG. 2007. Ecosystem engineering in space and time. *Ecology Letters* 10: 153–164.
- Hauer R, Locke H, Dreitz VJ, Hebblewhite M, Lowe WH, Muhlfeld CC, Nelson CR, Proctor MF, Rood SB. 2016. Gravel-bed river floodplains are the ecological nexus of glaciated mountain landscapes. *Science Advances* 2 (art. e1600026).
- Heupel MR, Knip DM, Simpfendorfer CA, Dulvy NK. 2014. Sizing up the ecological role of sharks as predators. *Marine Ecology Progress Series* 495: 291–298.
- Joseph LN, Maloney RF, Possingham HP. 2009. Optimal allocation of resources among threatened species: A project prioritization protocol. *Conservation Biology* 23: 328–338.
- Keesing F. 2000. Cryptic consumers and the ecology of an African savanna. *BioScience* 50: 205–215.
- Maclean JE, Goheen JR, Doak DF, Palmer TM, Young TP. 2011. Cryptic herbivores mediate the strength and form of ungulate impacts on a long-lived savanna tree. *Ecology* 92: 1626–1636.
- Moore JW. 2006. Animal ecosystem engineers in streams. *BioScience* 56: 237–246.
- Palmer MA, Ruhl J. 2015. Aligning restoration science and the law to sustain ecological infrastructure for the future. *Frontiers in Ecology and the Environment* 13: 512–519.
- Parody JM, Cuthbert FJ, Decker EH. 2001. The effect of 50 years of landscape change on species richness and community composition. *Global Ecology and Biogeography* 10: 305–313.
- Potts SG, Biesmeijer JC, Kremen C, Neumann P, Schweiger O, Kunin WE. 2010. Global pollinator declines: Trends, impacts and drivers. *Trends in Ecology and Evolution* 25: 345–353.
- 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 (art. 20140390).
- Roberge JM. 2014. Using data from online social networks in conservation science: Which species engage people the most on Twitter? *Biodiversity and Conservation* 23: 715–726.
- Rosenfeld JS. 2002. Functional redundancy in ecology and conservation. *Oikos* 98: 156–162.

- Salafsky N, Wollenberg E. 2000. Linking livelihoods and conservation: A conceptual framework and scale for assessing the integration of human needs and biodiversity. *World Development* 28: 1421–1438.
- Schmitz O. 2010. *Resolving Ecosystem Complexity*. Princeton University Press.
- Sensenig RL, Demment MW, Laca EA. 2010. Allometric scaling predicts preferences for burned patches in a guild of East African grazers. *Ecology* 91: 2898–2907.
- Sergio F, Caro T, Brown D, Clucas B, Hunter J, Ketchum J, McHugh K, Hiraldo F. 2008. Top predators as conservation tools: Ecological rationale, assumptions, and efficacy. *Annual Review of Ecology Evolution and Systematics* 39: 1–19.
- Shanley P, Luz L. 2003. The impacts of forest degradation on medicinal plant use and implications for health care in eastern Amazonia. *BioScience* 53: 573–584.
- Shurin JB, Borer ET, Seabloom EW, Anderson K, Blanchette CA, Broitman B, Cooper SD, Halpern BS. 2002. A cross-ecosystem comparison of the strength of trophic cascades. *Ecology Letters* 5: 785–791.
- Smith KF, Behrens MD, Schloegel LM, Marano N, Burgiel S, Daszak P. 2009. Reducing the risks of the wildlife trade. *Science* 324: 594–595.
- Smith R, Verissimo D, Isaac N, Jones K. 2012. Identifying Cinderella species: Uncovering mammals with conservation flagship appeal. *Conservation Letters* 5: 205–212.
- Stuart SN, Chanson JS, Cox NA, Young BE, Rodrigues AS, Fischman DL, Waller RW. 2004. Status and trends of amphibian declines and extinctions worldwide. *Science* 306: 1783–1786.
- Veblen KE, Porensky LM, Riginos C, Young TP. 2016. Are cattle surrogate wildlife? Savanna plant community composition explained by total herbivory more than herbivore type. *Ecological Applications* 26: 1610–1623. doi:10.1890/15-1367.1
- Wilson EO. 1987. The little things that run the world (the importance and conservation of invertebrates). *Conservation Biology* 1: 344–346.
- Wilson KA, McBride MF, Bode M, Possingham HP. 2006. Prioritizing global conservation efforts. *Nature* 440: 337–340.
- Worm B, et al. 2009. Rebuilding global fisheries. *Science* 325: 578–585.
- Wright JP, Jones CG, Flecker AS. 2002. An ecosystem engineer, the beaver, increases species richness at the landscape scale. *Oecologia* 132: 96–101.

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