CONSERVATION

Smaller species are not better off

Contrary to previous studies, an analysis of 7,000 plant and animal species shows that species size is unrelated to changes in their population abundance.

Brian Leung

The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) estimates that one million species are at risk of population decline and/or extinction. Yet rather than ubiquitous global biodiversity declines[1], recent analyses using available global datasets suggest that patterns of decline are nuanced. While some taxonomic groups in some geographic regions are at severe risk (for example, birds in the Indo-Pacific), others appear to have broadly improved in recent decades (for example, terrestrial birds in Europe)[2]. Likewise, individual assemblages appear to comprise winners and losers, with high species turnover in recent decades[3]. The turnover within communities may not represent 'natural' dynamics, but rather some types of species may be systematically declining more than others. Writing in *Nature Ecology & Evolution*, Terry et al.[4] explore whether species turnover is determined by species size, finding that there is no generalized link between size and abundance trends.

There are good reasons to expect differences in vulnerability between different-sized species (Fig. 1a,b). For instance, in animals, larger body size often relates to slower reproduction rates, larger home range sizes (that is, a higher chance of disruption due to fragmentation), and a higher chance of being exploited by humans[5]. These relationships, however, may differ between taxonomic groups. For instance, amphibians show little relation between body size and reproductive output[6]. Simultaneously, smaller amphibians tend to have smaller geographical distributions, and may be more prone to extinction. Thus, relationships between body size and population decline relations depend upon the exact processes affecting vulnerability. Indeed, previous analyses have shown that body size is often related to extinction risk, but that these relations varied taxonomically (for example, ref. [7]). Larger birds[8], mammals[5] and some insects[9] were more at risk, while smaller amphibians experienced higher risk[6], and fishes showed body size relations in both directions[10]. Regardless, shifts
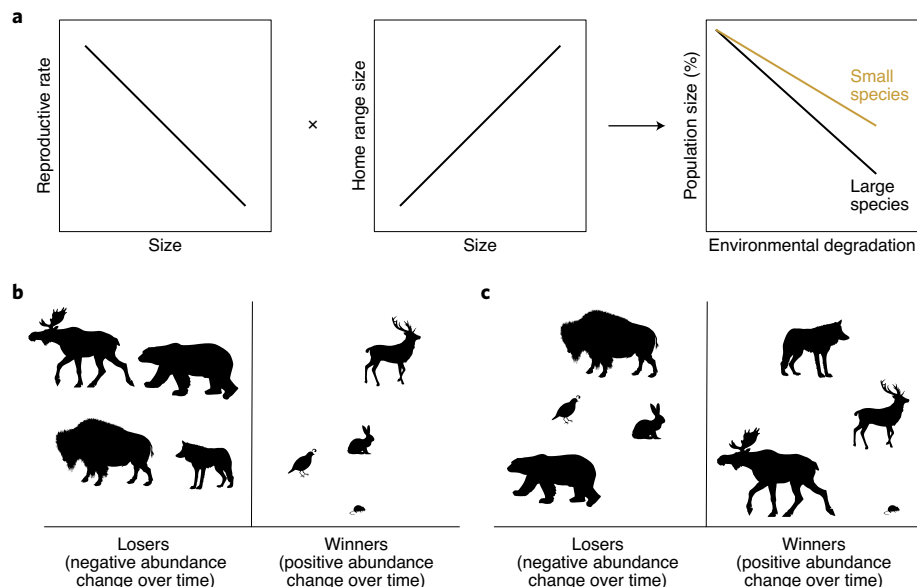

Fig. 1 | Relationships between species size and local abundance trends. a, Owing to differences in drivers of extinction risk, which vary by size (for example, home range size, reproductive rate), larger and smaller species may differentially decrease (or increase) over time as environmental conditions change. **b**, These potential size-related effects led to the prediction that trends in abundance over time would be different for larger and smaller species within a given assemblage. **c**, However, the results of Terry et al.[4] show that, across most studied groups, the 'winners' and the 'losers' were equally composed of large and small species, suggesting a lack of generalized size-abundance pattern. Note that **b** and **c** depict hypothetical results and do not reflect actual abundance trends of the example species.

in body size would potentially affect the functioning of ecosystems and the services they provide.

Terry et al.[4] provide an important complement to prior work on the relationship between size and extinction risk. Most other analyses have used International Union for Conservation of Nature (IUCN) listings (for example, 'Vulnerable' versus 'Least Concern') as their metric of risk. While IUCN listings represent the best estimate by experts, they are often not based on empirically observed changes in abundance, which are unavailable for most species. Further, larger species may be more likely to be evaluated[11] and also often have smaller population sizes, making them predisposed to IUCN

listing. By contrast, Terry et al.[4] base their analysis on empirical time series data (of more than 7,000 species including amniotes, plants and fish, from terrestrial and marine environments) using the BioTIME database[12], to explore how abundances have changed in recent decades. They focus on population trends and shifting dominance within communities, which necessarily precedes species extirpation and extinction.

Contrary to previous studies on body size and extinction risk[5–10], the results show no general relationship between size and abundance decline within communities (Fig. 1c). However, the authors point out that this does not mean that large apex species are not experiencing high anthropogenic impact, since these species represent only a

small fraction of communities. Rather, they argue that the size–risk relationships do not occur pervasively across all community assemblages. However, amniotes — mostly comprising birds and mammals in this dataset — were found to have a significant size–risk relationship, interestingly with larger species increasing in relative abundance more than smaller ones, which is in the opposite direction to previous studies[5,8]. This surprising result could have a number of mechanisms. The authors, for instance, suggest that anthropogenic dispersal limitations could be affecting smaller animals more than larger ones. Although not considered by the authors, another possible explanation may be that most of the measurements in the BioTIME database came from wealthier temperate regions, where environmental pressures are actually decreasing[13]; larger amniotes might benefit the most when anthropogenic stressors are reduced. As corollary evidence using a different time-series data set (the Living Planet Database), birds in the Nearctic and Palaearctic regions (housing the richer temperate countries) and aquatic mammals in the Palaearctic are generally increasing across populations[2] (although overall abundance of birds has declined, driven by decreases in the most abundant species[14]). While caution in interpretation would be warranted, given that multiple analyses were conducted (for different

taxonomic groups), Terry and colleagues' findings suggest interesting considerations, and highlight the need for more nuanced interpretation of biodiversity patterns and their correlates.

The patterns observed need to be interpreted in the context of interacting factors of the geographic and taxonomic composition of the data, the time periods of analyses, and how these overlap with patterns of environmental degradation. An additional issue worth considering is the choice of filtering steps: time-series with <5 years were excluded, yet previous analyses show that some of the strongest declines happen in the smallest time-series[2]. Further, because the BioTIME dataset contains mostly recent observations, (1970–current), it cannot reveal the historical population patterns, nor whether species have fully recovered (only whether they are improving). Moreover, the geographic bias of data towards wealthier nations is well known[15] and may skew the results toward time-series in which environmental conditions have improved. Separately analysing systems with increasing degradation from those where environments are improving, could help better resolve the complex biodiversity patterns. Nonetheless, viewed in reverse, the amniote results might suggest that the environmental improvements observed in certain regions[13] are having measurable effects especially for

larger species considered most at risk. This, in turn, could suggest that recent (over the past five decades) conservation actions have been worthwhile. This explanation, however, needs to be tested explicitly. ❐

Brian Leung [ID][1,2][✉]

Department of Biology, McGill University, Montreal, Quebec, Canada. [2]Bieler School of Environment, McGill University, Montreal, Quebec, Canada.
[✉]*e-mail:* brian.leung2@mcgill.ca

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