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REPLY TO KALINKAT ET AL.:
Smallest terrestrial vertebrates are highly imperiled

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Kalinkat et al. (1) discuss the biodiversity crisis in their reply to our article "Extinction risk is most acute for the world's largest and smallest vertebrates" (2). We agree with Kalinkat et al. (1) that small freshwater species tend to have elevated extinction risk, an issue that we highlight in our paper (2). Specifically, 41% (36 of 87) of freshwater vertebrate species with body masses ≤ 0.001 kg are listed as threatened compared with 29% (1,578 of 5,428) threatened for all freshwater vertebrate species. However, small vertebrates that use terrestrial habitats exclusively or in combination with freshwater habitats also have a greatly elevated risk of extinction (figure S3 in ref. 2). Indeed, our data show that 59% (76 of 128) of terrestrial vertebrate species with body masses ≤ 0.001 kg are threatened compared with 16% (1,965 of 12,015) for all terrestrial vertebrate species. Similarly, 35% (36 of 102) of the vertebrates with body mass ≤ 0.001 kg that use both terrestrial and freshwater habitats are threatened compared with 19% (527 of 2,842) threatened for all terrestrial/freshwater vertebrates.

Interestingly, the smallest marine vertebrates have relatively low extinction risk (figure S3 in ref. 2), perhaps because, relative to land, humans have thus far had less severe impacts on the quality of their habitats, and likely because small marine vertebrates have larger ranges, on average, than small freshwater or terrestrial vertebrates. These marine taxa could face greater extinction risk in the future, however, due to intensified harvest of small marine vertebrates [e.g., forage fish (3)] and the acceleration of climate change and associated ocean warming and acidification (4). In contrast, the smallest bony fishes, amphibians, and reptiles have elevated extinction risk (figure S3 in ref. 2). Notably, all of the smallest amphibians (≤0.001 kg body mass; mostly frogs and salamanders, n = 200) are linked to terrestrial or terrestrial/freshwater habitat. Similarly, all of the smallest reptiles (≤0.001 kg body mass; mostly geckos, n = 30) are terrestrial inhabitants. Unfortunately, the plights of both the smallest freshwater and smallest terrestrial species have received relatively little research attention compared with that of the large-bodied species (5) (figure S5 in ref. 2). These terrestrial minifauna need our immediate scientific and conservation attention and, yes, freshwater species do as well.

1 Kalinkat G, Jähnig SC, Jeschke JM (2017) Exceptional body size–extinction risk relations shed new light on the freshwater biodiversity crisis. *Proc Natl Acad Sci USA*, 10.1073/pnas.1717087114.
2 Ripple WJ, et al. (2017) Extinction risk is most acute for the world's largest and smallest vertebrates. *Proc Natl Acad Sci USA* 114:10678–10683.
3 Pinsky ML, Jensen OP, Ricard D, Palumbi SR (2011) Unexpected patterns of fisheries collapse in the world's oceans. *Proc Natl Acad Sci USA* 108:8317–8322.
4 Perry AL, Low PJ, Ellis JR, Reynolds JD (2005) Climate change and distribution shifts in marine fishes. *Science* 308:1912–1915.
5 Carrizo SF, et al. (2017) Freshwater megafauna: Flagships for freshwater biodiversity under threat. *Bioscience* 67:919–927.

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The authors declare no conflict of interest.

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