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Sport hunting associated with favourable conservation status of mammals

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Here we analysed use and trade data for terrestrial mammal species worldwide and found that sport hunted species were more likely to have stable or increasing populations and less likely to be listed as threatened compared with non-sport hunted species. Species hunted for food were not more likely to have decreasing populations or be listed as threatened compared with those not hunted for food. These results suggest that sport hunting is linked with more favourable conservation status of mammal species and can be a component of sustainable wildlife management.

Globally, millions of people rely on hunting and consuming wild animals (that is, 'wild meat') for economic and food security[1]. Alongside cultural practices and taste preferences, cheaper production costs and increased nutritional value of wild compared with captive-reared animals can create high demand for wild meat[1]. This demand often leads to overexploitation, with more than 300 mammal species identified as at risk of extinction due to human hunting, primarily for meat[2]. Curtailing these declines is hindered by limited wild meat alternatives, cultural values and the lack of enforceable regulatory frameworks governing wild animal harvests in many regions[3].

Hunting wildlife for sport or recreation as a primary motivation irrespective of use as food, hereafter 'sport hunting', also represents a consumptive use of wild animals. In contrast to wild meat harvest, sport hunting is generally highly regulated[4]. Revenues generated from sport hunting in regions including Asia and sub-Saharan Africa are often returned to local communities, funding public needs such as infrastructure and healthcare, creating an economic incentive for conservation[4,5]. Sport hunting is considered an important conservation tool in many areas and has been responsible in part for the recoveries of imperilled mammal species including argali (*Ovis ammon*) and rhinos (*Ceratotherium simum* and *Diceros bicornis*)[4].

Considering the different conditions that often (but not always)[6] characterize wild meat harvest compared with sport hunting, there may be divergent impacts on species conservation statuses with important management implications. We analysed terrestrial mammal species accounts from the International Union for Conservation of Nature (IUCN) Red List[7] to examine relationships between the conservation status of species and their use for sport hunting and food. Species could be hunted for sport, used for food, both or neither. We hypothesized that sport hunted species (regardless of whether they were used for food) would have more favourable conservation statuses (that is, current population trend not decreasing and categorized in a non-threatened IUCN Red List category (Near Threatened or Least Concern)) compared with non-sport hunted species. We predicted that species hunted for food (regardless of sport hunting status) would have less favourable conservation statuses (that is, more likely to have a declining current population trend and to be categorized in a threatened IUCN Red List category (Vulnerable, Threatened, Endangered or Critically Endangered)) than those not killed for food. Furthermore, we predicted that body size would be positively correlated with poorer conservation statuses because larger species tend to be hunted for food and sport[8,9].

Our dataset consisted of 1,677 species, of which 161 were hunted for sport and 1,104 were hunted for food. After excluding species with unknown population trends and those listed as Data Deficient on the Red List, our sample size for the population trend model was 1,286 species (food only = 767, sport only = 34, both food and sport = 109, neither = 376) and for the Red List model was 1,613 species (food only = 945, sport only = 37, both food and sport = 121, neither = 510). Among the species hunted for food, 55% were in a threatened category and 76% had a decreasing population trend (Fig. 1). Moreover, 34% of the species hunted for sport were listed in a threatened category and 62% had a decreasing population trend.

Sport hunted species were less likely to be threatened ($\beta = -0.91$, 95% confidence interval (CI) −1.46 to −0.40) and have a decreasing population trend ($\beta = -0.67$, 95% CI −1.19 to −0.14) compared with species that were not sport hunted (Fig. 1). We found no effect of species being killed for food on threatened status ($\beta = -0.23$, 95% CI −0.54 to 0.10) or population trend ($\beta = 0.26$, 95% CI −0.06 to 0.58). There was a positive relationship between body mass and threatened status ($\beta = 0.65$, 95% CI 0.39 to 0.80) and body mass and decreasing population trend ($\beta = 0.39$, 95% CI 0.12 to 0.59). There was no effect of trophic level on

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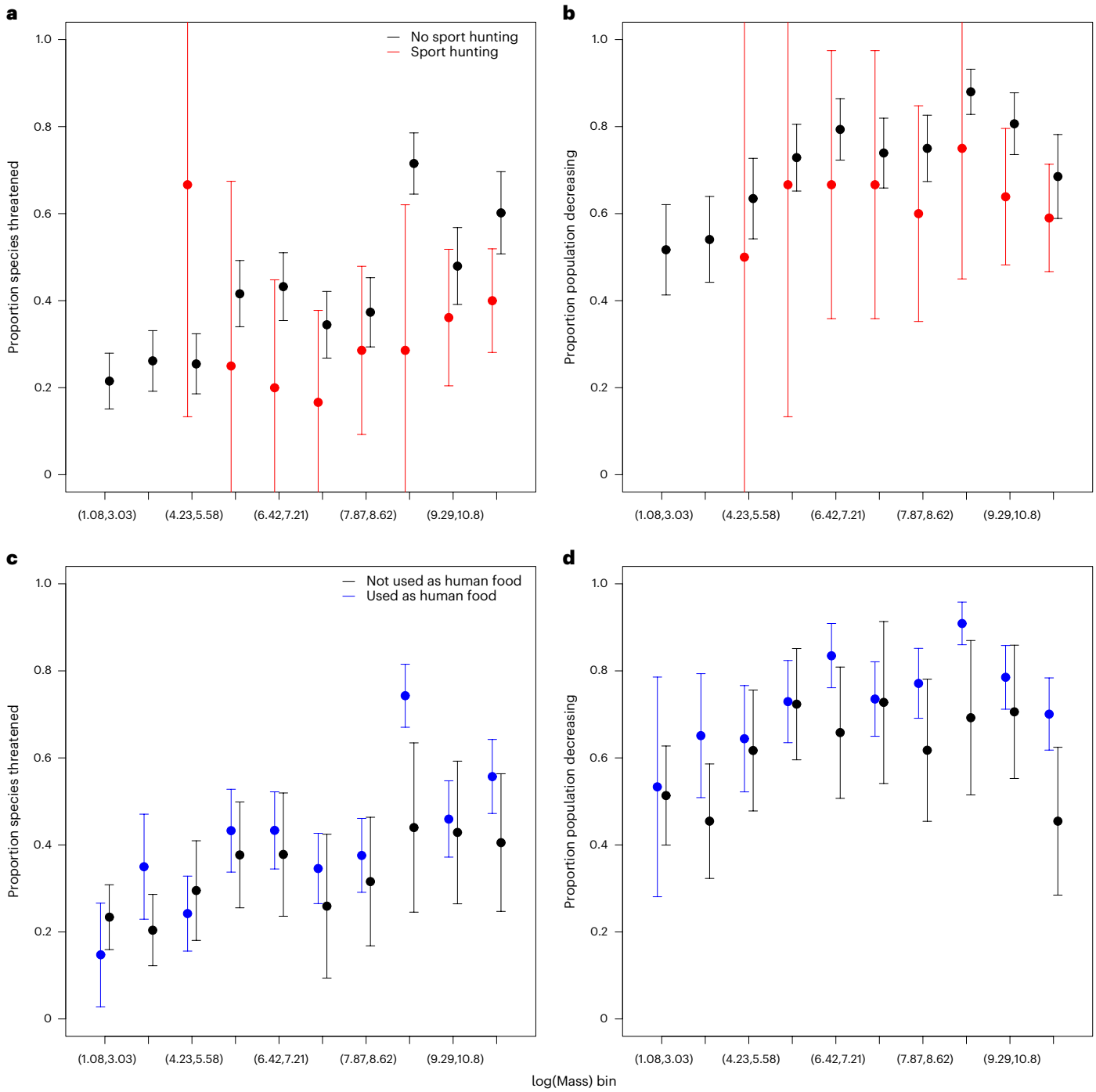

Fig. 1 | Association of mammal species population trends and threatened status with use for food and sport hunting. a–d, Proportions of species binned by body mass that were threatened based on sport hunting status (**a**), had a decreasing population based on sport hunting status (**b**) were threatened based on use as human food (**c**) and had decreasing populations based on use as human food (**d**). Samples sizes (number of species) are as follows: 158 sport hunted, 1,455 not sport hunted (**a**); 143 sport hunted, 547 not sport hunted (**b**); 1,066 used for human food, 547 not used for human food (**c**); 876 used for human food, 410 not used for human food (**d**). Error bars represent the 95% CIs with the mean in the centre.

population trend or threatened status. The greatest spatial overlap of sport hunted species geographic ranges occurred in southern and eastern Africa, whereas those of species hunted for food overlapped to the greatest extent in western and central Africa and southeast Asia (Fig. 2).

Revenue generation from sport hunting is contingent on healthy populations of harvested species, which can promote effective wildlife management, and may be partially responsible for the improved conservation status of sport hunted animals that we observed[10]. Alternatively, species that are threatened are unlikely to be allowed to be sport hunted in the first place. Income generated from sport hunting can also fund antipoaching initiatives, further augmenting its positive contribution to species conservation[10]. Sport hunted species may also inadvertently benefit from the large tracts of quality habitat required for sport hunting. For example, the total land area maintained for sport hunting in sub-Saharan Africa is more than double that of national parks[10]. Despite removal of some individuals through sport hunting,

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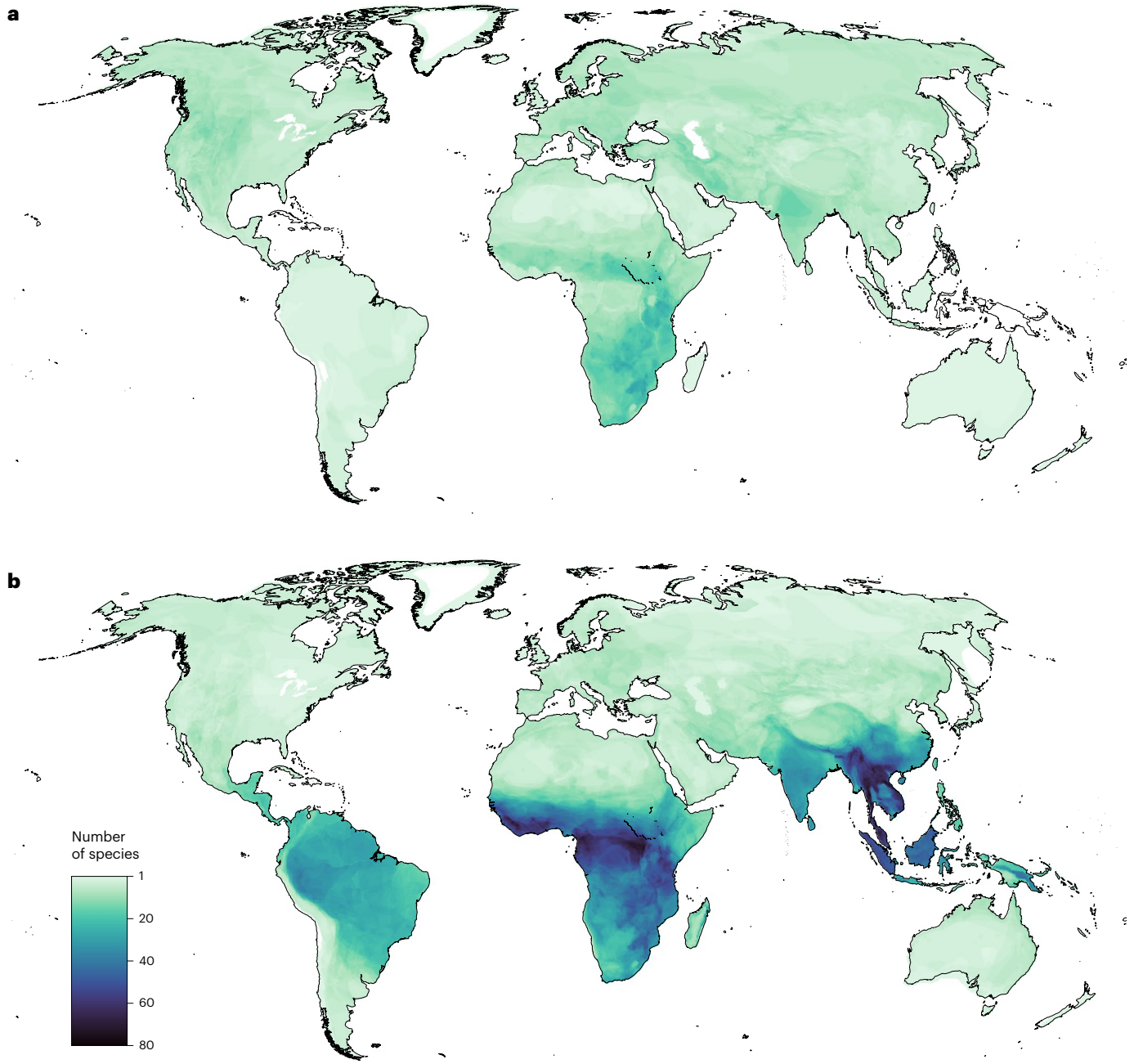

Fig. 2 | Species ranges of mammals used for food and sport hunting. a,**b**, Geographic ranges of species hunted for sport (**a**) or food (**b**). Species range shapefiles from ref. 7.

there may be a net benefit to the population through preventing habitat loss, which is a primary threat to mammals globally[11].

Rural households may not only rely on wild meat for subsistence but can also profit economically by trapping wild animals to supply urban demand[1,12]. Wild meat consumption in some urban cultures is a status symbol, creating intense social pressures to provide and consume it[12]. Consequently, there is less likely to be public interest in conservation of wild meat animals compared with sport hunted animals[12]. These disparate motivations may account for the differing association of population trends and threatened status with species harvested for food compared with sport hunting. Indeed, household consumption and commercial gain were nearly 20 times more likely to be the impetus for illegal wildlife killings compared with trophy killing[13].

Considering these factors, it is somewhat surprising that wild meat hunting was not associated with poorer conservation status compared with species not used for food as we predicted. However, in some regions higher-level impacts such as habitat loss are the primary drivers of extinction, with harvest becoming a factor only at certain thresholds of habitat loss[11]. Furthermore, some wild meat markets have reached post-depletion sustainability, in which species prone to overexploitation have been extirpated, leaving behind species that can be harvested sustainably[14]. Thus, the negative effects of wild meat on conservation status may be masked by the prior removal of species most subject to the negative impacts of wild meat harvest.

Species of all body masses were hunted for food, but those hunted for sport were mostly >20 kg (Fig. 1). Only large species typically provide desirable trophies for sport hunters, whereas mammals of all body

masses can provide food. In Nigeria, consumption of rodents as wild meat was more associated with food security than that of larger carnivores or ungulates[15]. Further, unregulated wild meat harvest can lead to extirpation of larger-bodies species, resulting in a shift to hunting smaller species[8]. However, such downgrading of target animal body size is unlikely for sport hunting, given that it is driven by recreation rather than necessity and managed for sustainability.

Although hunting for food and for sport are classified as distinct motivations in our analysis, hunting is undoubtedly multifunctional. Sport hunters, for example, may consume the meat from kills or donate it to local communities[16]. There may also be elements of sport in wild meat hunting such as the presence of codes, taboos and rituals[6]. Other factors that we were unable to account for include spatial variation in the use of food or sport hunting across species' geographic ranges, which may differ between native and introduced ranges. In addition, trends in conservation statuses could be driven by anthropogenic factors not included in our analyses such as habitat loss, vehicle mortality or disease.

Our results indicate that, at the species level, sport hunting globally is associated with improved conservation status of mammals. Sustainably managed sport hunting could also contribute to the United Nations Sustainable Development Goals[17]. For example, meat from sport hunting can be provisioned to rural communities, helping to achieve goals 2 and 3 of improving food security and promoting general well-being[18]. Sport hunting may also contribute to goals 1 and 8 of ending poverty and promoting economic growth by providing valuable economic benefits to local communities[5]. Through land preservation and management of game populations, sport hunting may also contribute to goal 15 of promoting sustainable use of terrestrial ecosystems and halting biodiversity loss[10].

Sport hunting has been criticized on numerous fronts, including the ethics of killing animals. The killing of wildlife by humans is, however, unavoidable[19], and recreational hunting can promote environmental stewardship[20]. Indeed, we found that sport hunting was associated with improved species conservation status, despite the losses of individual animals to sport hunting. Paradoxically, the killing of wildlife, when regulated, targeted and intentional, may be a tool in their conservation. Sport hunting has been detrimental in instances where harvest quotas were not based on reliable population estimates and local communities were excluded[21]. In addition to well-informed harvest quotas, effective sport hunting systems should equitably integrate Indigenous communities by considering access and property rights, including them in decision-making and ensuring benefit-sharing[21]. When these criteria are met, sport hunting may be a component of sustainable wildlife management, which may have additional benefits of generating revenue, promoting environmental stewardship and protecting biodiversity.

Methods

We downloaded information for extant terrestrial mammal species accounts from the IUCN Red List version 2024-1[7]. We extracted the following information from species accounts: IUCN Red List Category; the current population trend; the use and trade text description; and uses coded in the IUCN Use and Trade Classification Scheme[22], specifically the following codes: 1. Food—human ('food or beverages for human consumption'); 15—Sport hunting/specimen collecting ('collection and preservation of dead specimens for personal pleasure'). Completing the use and trade scheme is not compulsory for Red List assessors. We excluded species from analysis we considered to not have been assessed, defined as there being both no information in the use and trade text description and no uses coded. We included species where the text stated there were no known uses for the species, considering them not used for food or sport hunting. We generated 1-km-resolution maps of the geographic ranges of species used for both purposes (Fig. 2) using spatial data from the Red List. We extracted trophic level (herbivore, omnivore or carnivore) and mean adult body mass from the COMBINE database[23]. We obtained 100 phylogenetic tree samples for mammals from VertLife[24].

We fitted two phylogenetic logistic regression models using the phylolm package[25] in R 4.3.2[26], one modelling species threatened status (1 = critically endangered, endangered or vulnerable, 0 = near threatened or least concern) and one modelling species population decreasing trend (1 = decreasing, 0 = stable or increasing)[27]. We excluded species in the data-deficient Red List category from the threatened status model (final sample size 1,613 species) and species with unknown population trends from the population decreasing model (final sample size 1,286). These sample sizes respectively represent about 28% and 22% of the roughly 5,800 extant terrestrial mammals classified by the IUCN. To address our predictions, both models included species-specific binary covariates for sport hunting status (0 = not sport hunted, 1 = sport hunted) and human food use (0 = not used for human food, 1 = used for human food). Our dataset contained species used for both sport hunting and food, only one of these uses and neither use, allowing us to separate the effects of sport hunting and food use on conservation outcomes in models. Both models also included a categorical covariate for diet (1 = herbivore, 2 = omnivore, 3 = carnivore) and the natural log of body mass (standardized to have mean 0 and standard deviation 1). We fitted each model using a bootstrapping approach, performing 50 bootstrap fits for each of the 100 phylogenetic tree samples, for a total of 5,000 bootstrapped model fits. For each model parameter, we calculated the mean of the bootstrap sample estimates as the point estimate and a 95% CI using the distribution of bootstrap samples. We concluded that a covariate had a statistically significant relationship with the response variable if the 95% CI around the corresponding parameter did not include 0.

Our analysis has limitations that are important to acknowledge. We were only able to consider population trends at the species level, and individual populations can become extirpated even if the species overall is not declining. Completing the use and trade scheme is not compulsory for Red List assessors, so some species used for food or sport hunting may not be coded as such in the species accounts. Furthermore, sport hunting and specimen collection are included in the same use category, so it was not possible to distinguish between these two use types for each species.

Reporting summary

Further information on research design is available in the Nature Portfolio Reporting Summary linked to this article.

Data availability

Data were provided by the IUCN at https://www.iucnredlist.org, and the final dataset is available via Zenodo at https://doi.org/10.5281/zenodo.15837586 (ref. 27).

Code availability

Code is available via Zenodo at https://doi.org/10.5281/zenodo.15837586 (ref. 27).

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Author contributions

J.E.H., K.F.K. and J.L.B. designed the research. J.L.B. acquired funding. J.E.H. and K.F.K. analysed data and generated figures. J.E.H. wrote the initial draft of the manuscript, and all co-authors contributed to the discussion, editing and approval of the paper.

Competing interests

The authors declare no competing interests

Additional information

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☒	☐ For null hypothesis testing, the test statistic (e.g. *F*, *t*, *r*) with confidence intervals, effect sizes, degrees of freedom and *P* value noted *Give P values as exact values whenever suitable.*
☒	☐ For Bayesian analysis, information on the choice of priors and Markov chain Monte Carlo settings
☒	☐ For hierarchical and complex designs, identification of the appropriate level for tests and full reporting of outcomes
☐	☒ Estimates of effect sizes (e.g. Cohen's *d*, Pearson's *r*), indicating how they were calculated

Our web collection on statistics for biologists contains articles on many of the points above.

Software and code

Policy information about availability of computer code

Data collection	No software was used for data collection.
Data analysis	Analysis was carried out using the phylom package in R version 4.3.2

For manuscripts utilizing custom algorithms or software that are central to the research but not yet described in published literature, software must be made available to editors and reviewers. We strongly encourage code deposition in a community repository (e.g. GitHub). See the Nature Portfolio guidelines for submitting code & software for further information.

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Data are available from https://doi.org/10.5281/zenodo.15837585 from the International Union for Conservation of Nature at https://www.redlist.org.

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Reporting on sex and gender	N/A
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Population characteristics	N/A
Recruitment	N/A
Ethics oversight	N/A

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Ecological, evolutionary & environmental sciences study design

All studies must disclose on these points even when the disclosure is negative.

Study description	We fit phylogenetic logistic regression models based on mammal species use information provided in the International Union for Conservation of Nature Red List
Research sample	All terrestrial mammals fitting our criteria
Sampling strategy	All terrestrial mammals fitting our criteria
Data collection	Data was provided by the International Union for Conservation of Nature Red List
Timing and spatial scale	N/A
Data exclusions	N/A
Reproducibility	N/A
Randomization	N/A
Blinding	N/A

Did the study involve field work? ☐ Yes ☒ No

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Materials & experimental systems

n/a	Involved in the study
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☒	☐ Eukaryotic cell lines
☒	☐ Palaeontology and archaeology
☒	☐ Animals and other organisms
☒	☐ Clinical data
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☒	☐ Plants

Methods

n/a	Involved in the study
☒	☐ ChIP-seq
☒	☐ Flow cytometry
☒	☐ MRI-based neuroimaging

Plants

Seed stocks	N/A
Novel plant genotypes	N/A
Authentication	N/A