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Abstract. The main causes of biodiversity decline are related to human use of resources, which is ultimately triggered by the socioeconomic decisions made by individuals and nations. Characterizing the socioeconomic attributes of areas in which biodiversity is most threatened can help us identify decisions and conditions that promote the presence or absence of threats and potentially suggest more sustainable strategies. In this study we explored how diverse indicators of social and economic development correlate with the conservation status of terrestrial mammals within countries explicitly exploring hypothesized linear and quadratic relationships. First, comparing countries with and without threatened mammals we found that those without threatened species are a disparate group formed by European countries and Small Island Developing States (SIDS) with little in common besides their slow population growth and a past of human impacts. Second, focusing on countries with threatened mammals we found that those with a more threatened mammalian biota have mainly rural populations, are predominantly exporters of goods and services, receive low to intermediate economic benefits from international tourism, and have medium to high human life expectancy. Overall, these results provide a comprehensive characterization of the socioeconomic profiles linked to mammalian conservation status of the world's nations, highlighting the importance of transborder impacts reflected by the international flux of goods, services and people. Further studies would be necessary to unravel the actual mechanisms and threats that link these socioeconomic profiles and indicators with mammalian conservation. Nevertheless, this study presents a broad and complete characterization that offers testable hypotheses regarding how socioeconomic development associates with biodiversity.

Key words: human development; IUCN Red List; mammals; socioeconomic indicators; threats.

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INTRODUCTION

Biodiversity loss has accelerated in recent times and many voices argue that we may be entering the Earth's 6th mass extinction event (Barnosky et al. 2011). The main threats to biodiversity are human-induced and include habitat loss, fragmentation, overexploitation, spread of exotic species and diseases, pollution, and climate change (Soulé 1991, MA 2005). Understanding why distinct species and sites are vulnerable to extinction is essential to reduce biodiversity losses occurring now and those that will likely occur in the future (Hoffmann et al. 2010).

Comparative studies of extinction risk have focused on identifying differences in vulnerability at the species (or taxonomic group) level. These studies have associated species' vulnerability with a diversity of life-history and ecolog-

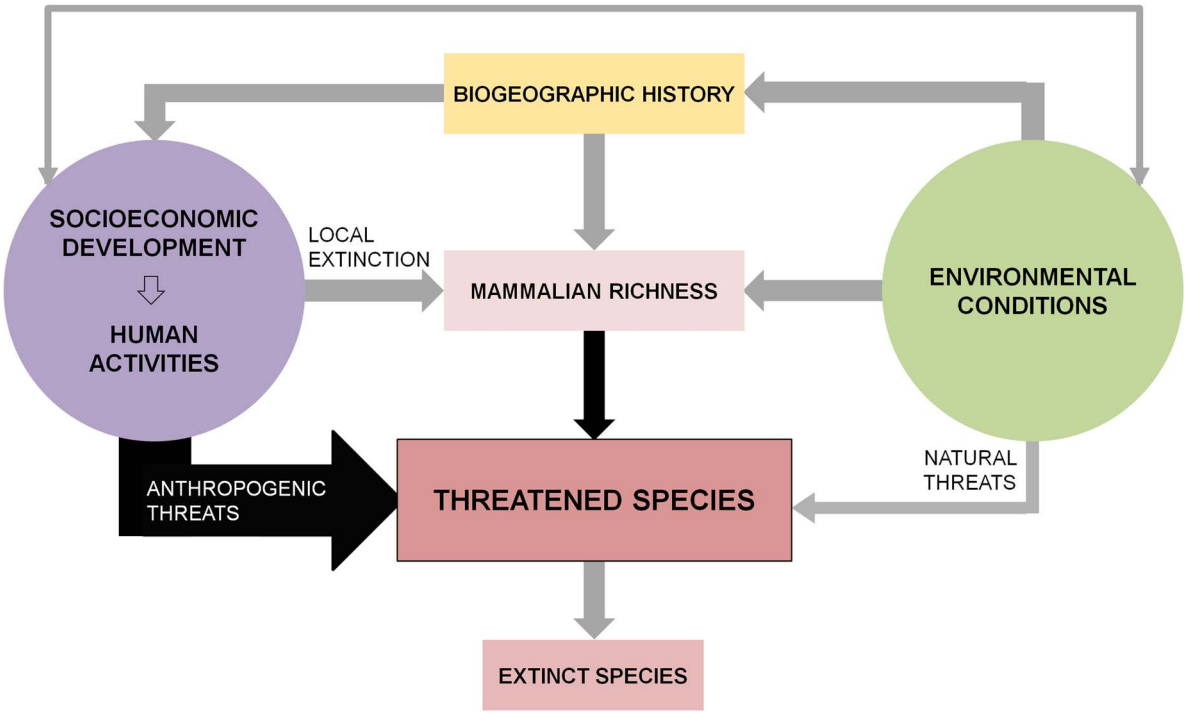

Fig. 1. Conceptual framework describing the different factors that determine directly and indirectly the number of threatened species in an area at present. Black arrows represent processes explored in this paper.

ical factors, such as body size, geographic range size, ecological and social specialization, and phylogenetic-lineage in mammals (Cardillo et al. 2008, Davidson et al. 2009, González-Suárez and Revilla 2013) and other taxa (Webb et al. 2002, Cushman 2006). However, species-focused studies have been criticized for their lack of applicability to management and for ignoring the role of distinct threats (Cardillo and Meijaard 2012, Murray et al. 2014; but see Owens and Bennett 2000, González-Suárez and Revilla 2014). An attempt to overcome these weaknesses has been to explore human activities (which are potentially manageable) occurring within each species' geographic ranges. Studies using this approach have found that more endangered species tend to overlap with mosaic villages and residential croplands, densely populated areas or with increasing human population growth (Harcourt and Parks 2003, Pekin and Pijanowski 2012).

Species' intrinsic traits make some taxa more vulnerable to extinction, but also there are inherent properties associated with particular areas that make them more likely to harbor higher numbers of threatened species. The number of threatened species on a given site directly depends on the total species richness (how many species actually occupy that area) and the threats that affect those species (Fig. 1; Essl et al. 2013). In turn, species richness is determined by historical, biogeographical and environmental conditions, as well as by human activities that may have caused past local extinctions. Threats can include natural hazards (influenced by environmental conditions, Fig. 1), but today the key threats for most species are of anthropogenic origin. For example, natural processes such as volcanoes, avalanches, or earthquakes are only considered to represent a threat for 1% of the 2551 terrestrial mammals with described threats, and these species are also at risk from anthropogenic activities (IUCN 2012a, González-Suárez and Revilla 2014). Human-related threats are associated with human activities which are mainly determined by socioeconomic development. Although analyzing the causes leading to observed development is beyond the scope of this study, it is worth noting

that development is often influenced by environmental conditions (which in turn can be modified by development) and by the biogeographic history of a given area, both of which also influence its natural biodiversity. Eventually, if conditions change or nothing is done to stop it, threatened species become extinct (Fig. 1).

Focusing on the spatial distribution of human threats, many studies have identified sensitive areas based on the correlation of different human pressure indicators and different measurements of biodiversity status. Since habitat destruction is one of the main causes of biodiversity decline, measurements of human land use are those most-commonly employed to quantify human impact (Pimm and Raven 2000). In particular, conversion to arable land appears to be a key factor associated with greater risk at a regional and global scale (Kerr and Cihlar 2004, Lenzen et al. 2009, Lotz and Allen 2013). Another widely used indicator of human pressure is human population density, an aggregated proxy which has been positively correlated with abundance of threatened species at different scales (Burgess et al. 2007, Luck 2007). Within countries, some studies have shown that economic growth, energy use, human birth rate and different measures of national income or income inequality are associated with the number of threatened species (Kerr and Currie 1995, Naidoo and Adamowicz 2001, Hoffmann 2004, Holland et al. 2009) and with other measures of environmental damage (Grossman and Krueger 1995, Bradshaw et al. 2010). More recently, transborder impacts have also been suggested as risk factors found to be associated with the conservation status of the biota in developing countries (Meyfroidt et al. 2010, Lenzen et al. 2012).

While providing some insights, most of these past studies have only evaluated a few indicators at a time (but see Hoffmann 2004, Lotz and Allen 2013), without taking into account the many diverse aspects that describe socioeconomic development. This diversity is reflected, for example, in the 800 indicators included within the World Development Indicators book (World Bank Group 2005). One reason why past studies have focused on few indicators is that aside from population data, land use cover, and a few derived economic metrics, global socioeconomic data are only available at the country level, especially for indicators related to the trade of goods and services, and human life quality (CIESIN 2005, Nordhaus 2006, Asselen and Verburg 2012). Socioeconomic data do exist for finer political units (e.g., counties, states) in some areas, but in many cases data are not gathered or made public at such fine scales. Therefore, in order to conduct a global study that captures the diverse aspects of socioeconomic development, using country resolution is the most feasible solution. Country-based analyses are also relevant for management and policy implementation because political decisions influencing biodiversity at large scales are usually enacted at this level (Forester and Machlis 1996, Chape et al. 2005). Results from these analyses can also be helpful to make countries aware of how their political, social and economic decisions may be influencing the conservation status of their biodiversity.

Here we present a comprehensive global analysis aimed to identify which indicators of socioeconomic development correlate with terrestrial mammalian conservation status at the country level. To explicitly include the diverse facets of socioeconomic development we considered indicators representing nine distinct categories defined by the World Bank (Appendix A: Table A1) including those which have been previously linked to biodiversity status within countries (see references above). Some of the explored indicators can be more directly associated with threats (e.g., percentage of arable land) or benefits (e.g., number of protected areas) to biodiversity, while others are aggregated descriptors of development (e.g., human population density) which may capture more complex or indirect associations between socioeconomic processes, threats and biodiversity. Exploring this broad suite of indicators we first identified the socioeconomic characteristics that differentiate countries with and without threatened mammals. Then, considering only countries with threatened mammals, we determined which indicators are associated with higher relative richness of threatened mammals. In both sets of analyses we explicitly explored relationships proposed by the two general hypotheses relating socioeconomic development and environmental

damage. The first hypothesis proposes a linear response, as human populations increase and become more industrialized the damages to biodiversity increase, with the greatest impacts associated with the most developed areas (e.g., Hettige et al. 2000, Clausen and York 2008). The second hypothesis proposes a quadratic relationship in which the greatest impacts occur at intermediate stages of development (inverted-U-shaped, or environmental Kuznets curve as defined by Grossman and Krueger [1995]). Initially, population growth and industrialization would be associated with increased damages to biodiversity, but as societies become more technological and educated, they would also become more environmentally concerned and reduce their impact (McPherson and Nieswiadomy 2005). Because we explored different relationships and a broad range of indicators, our results present a new global and comprehensive characterization of the key socioeconomic correlates of mammalian conservation status.

Methods

Socioeconomic indicators and species data

We used socioeconomic indicators compiled by the World Bank from different official sources grouped according to these simplified thematic categories: agriculture, economy, education, environment, health, infrastructure, labor and social protection, population and private sector (Appendix A: Table A1). These categories were used in the analyses as non-redundant blocks, as explained below. Relative indicators (percentages and per capita values) were chosen over absolute values to facilitate comparison among nations. We used information from the year with the most available data in the last decade (year 2005) and excluded indicators considered a priori as relevant but with data available for $<70\%$ of the 204 countries in our database (9 indicators out of 39; Appendix A: Table A2). As a result, no indicators from the categories education and infrastructure were included in our analyses. We did not use data imputation techniques for missing socioeconomic data because these data are not missing at random (e.g., more developed countries are more likely to have data on their development status), and the mechanisms by which data are missing can be complex and are not easily modeled (van Buuren 2012).

To assess the conservation status of terrestrial mammals we used the IUCN Red List of Threatened Species version 2012.1 (IUCN 2012b) which provides a single, global status for each species. Species defined as vulnerable, endangered or critically endangered are considered as threatened; whereas least concern or near threatened species are non-threatened. The 75 mammals classified as extinct in the wild or extinct were not included in the analyses since they cannot be classified in either category. Data deficient (DD) species were initially classified as non-threatened to define a conservative minimum estimate of threatened species per country. We then repeated the analyses considering DD species as threatened, and thus defining a maximum estimate of threatened species per country. Mammal presence within each country was determined using spatial data on the current (post 1980) global distribution of mammal species available from the IUCN (IUCN 2012b) selecting only native areas, with presence defined as extant or probably extant. We used a World Cylindrical Equal Area projection in ArcGIS 10 (ESRI 2011) and intersected species ranges ($N = 5014$) with a current global political map. All species with any portion of their range within the boundaries of a country were defined as present in that country.

Our approach to define the number of threatened species per country assumes that the global status of a species is potentially affected by human activities within each of the countries the species occupies. Ideally, mammalian status would have been defined using national assessments (to compare national socioeconomic development and status); however, this is not possible at a global scale. National assessments are not currently available for many countries and those available do not always follow standardized criteria, which prevents comparison. For example, only 23 countries have a National Red List according to the IUCN (http://www.nationalredlist.org/) and many include only partial assessments (Appendix B: Tables B1 and B2). Finally, we feel that the use of the global Red List to assess status is warranted if we consider that the responsibility of maintaining/menacing species should be shared by all countries that harbor them.

Analyses

First, we explored which socioeconomic indicators are associated with the presence (vs. absence) of threatened mammals using generalized linear models (GLMs). GLMs were fitted with the glm procedure in R (R Development Core Team 2011) using a binomial family and a logit link. Second, considering countries with ≥ 1 threatened mammal we explored which indicators are associated the number of threatened species using the glm.nb procedure in R (package MASS; Venables and Ripley 2002) with a negative binomial family and a log link. For both questions we tested linear and quadratic relationships for all indicators to account for the two main hypotheses mentioned in the introduction.

The variable selection procedure was the same for both analyses. First, we calculated pairwise Spearman's coefficients (ρ) and from any pair of highly correlated indicators ($\rho > |0.8|$) we excluded the indicator with fewer data available (7 excluded, out of 30; Appendix A: Tables A2–A4). Using non-highly correlated indicators, we followed Purvis et al. (2000) to define a minimum adequate model (MAM-based approach) for each socioeconomic category. We used this approach to maximize the use of available data, as some countries have available data for some indicators but not others and generating a complete dataset (removing all cases with any missing data) to analyze all categories at once would greatly limit the available sample size. MAMs by category were defined by starting with a full model including all indicators in the category from which the least significant variable was removed (one at a time), and then a new model (potentially with a different sample size) was fitted and evaluated. After finding a model containing only significant variables (using a conservative p value $= 0.10$) we retested the significance of previously removed variables and defined a MAM by category including any additional significant factors. Second, and in order to evaluate more systematically the relevance of the socioeconomic indicators, we determined indicator importance using an AIC_c-based approach. For this approach we were limited to the subset of countries with available data for all selected indicators in the category. We estimated variable importance for each socioeconomic indicator based on variable weights (Burnham and Anderson 2002) calculated from all possible model subsets in each category using the importance function in the MuMIn R package (Barton 2013). We considered indicators were supported if their variable weights >0.7. The final category model was defined using all variables included in the category MAM plus any additional variables identified as supported with the AIC_c-based approach. All variables included in the final category models were used to define a final global model using the same variable selection approaches (MAM- and AIC_c-based).

Model fit was estimated as the percentage of deviance explained. For the binomial model (presence of threatened mammals) we also calculated model sensitivity (true positive rate) and specificity (true negative rate; Allouche et al. 2006); setting an arbitrary 0.5 cut-off probability to define presences and absences. Furthermore, the area under the receiver operating characteristic curve (AUC) was calculated as a threshold-independent measure of model performance (Manel et al. 2001). To evaluate model predictive ability in the negative binomial model (abundance of threatened species) we calculated a standardized prediction error defined as the number of threatened species predicted minus the observed number divided by total number of mammals. Positive errors indicate that the model overestimated the number of threatened mammals, whereas negative values indicate underestimation.

In addition to the tested socioeconomic indicators, all fitted models included as control variables (additional fixed effects) a country's total land area and its total mammalian richness. Including these variables allowed us to effectively model the association of socioeconomic indicators with the presence and number of threatened mammals per country controlling for the known effects of area and richness in the response variable (we can expect more threatened mammals in large countries inhabited by more mammals). An additional control variable, the mean number of mammals shared with neighboring countries (hereafter "shared mammals"), was included to account for the singularity of a country's fauna considering that nearby countries are generally more alike than those far apart. It is important to note that the number of shared mammals does not represent endemicity per se, but addresses issues of spatial autocorrelation among neighboring countries. It

was calculated by identifying the number of species common to all pair of countries that share a border and then calculating the mean value over all neighbors for each country, standardized by the country's total mammalian richness. Harboring a higher percentage of shared mammals implies having a greater abundance of cosmopolitan species, generally less threatened but also potentially exposed to more sources of impact. Because islands have no neighboring countries, by definition they have 0% shared mammals.

Results

From the 204 countries with mammalian distribution range information and socioeconomic data, 168 host at least one globally threatened mammal (median = 6 species, range 1–177), whereas 36 countries have none (Fig. 2a; Appendix C: Tables C1 and C2). From those 36, four countries contain DD species (median = 1.5, range = 1–4) that could potentially be threatened. Indonesia, Brazil, Mexico and India are the countries with the highest number of threatened mammals (649, 625, 454 and 352 species, respectively, if DD are considered as non-threatened).

Presence of threatened species

We found that diverse socioeconomic indicators are associated with the presence (vs. absence) of threatened mammals. Tourism receipts and urban population exhibit an inverted-U relationship with the probability of having threatened mammals. On the contrary, the percentage of arable land by country relates with the response variable following a positive parabola. Population growth presents a positive linear effect on the probability of containing threatened species by country (Table 1). Countries with no threatened mammals have either high or low percentages of urban population and international tourism receipt values, intermediate percentages of their territory are devoted to arable lands (extreme values are more common in countries with threatened mammals), and exhibit relatively slow population growth rates (Fig. 3). Classifying DD species as threatened did not qualitatively change these results except that the percentage of urban population was no longer a relevant indicator (Appendix D).

The final model was fitted for the 162 countries with data: 135 with and 27 without threatened mammals. The latter group is formed by two distinct types of countries: 15 small islands included in the group of Small Islands Developing States (SIDS, as defined at the UNCED 1992) and 12 European countries (including island-countries Malta and Iceland). The countries with at least one threatened mammal form a more heterogeneous group, which we describe in the next section. The final model provided a good fit to the data, explaining 61.9% of the deviance, with 37.4% explained by the control variables (country land area, total mammalian richness and shared mammals) and 24.5% associated to the four socioeconomic variables identified as relevant. This final model also had high sensitivity (0.964, power to identify positives) and specificity (0.818, power to identify negatives); and excellent overall predictive ability (AUC = 0.968).

Abundance of threatened species

Socioeconomic indicators also correlate with threatened mammal abundance at the country level. International tourism (receipts) and life expectancy indicators follow an inverted-U relationship with the total number of threatened mammals by country, whereas the rest of selected variables linearly correlate with the response variable. In particular, the final model shows that countries with more threatened mammals have lower percentages of urban population, intermediate to high life expectancies, generate fewer imports but more exports of goods and services, and their share in exports due to expenditures by international inbound visitors (international tourism receipts) are low to intermediate (Table 2; Fig. 4). This final model highlights the importance of transborder impacts and included data from 125 countries that have between 1 and 177 threatened mammals (the full range of observed values in the World; Appendix A: Table A3), and explained 79.8% of the deviance, 72.0% corresponding to the control variables and 7.8% to the selected socioeconomic indicators. Model predictions for each country were generally accurate with only small errors in prediction representing ±0.14% of the total mammalian richness of the country. Only six countries were predicted to have considerably more threatened mammals (>0.14%) than those currently listed: Cyprus, Indonesia, Barbados, Seychelles, New

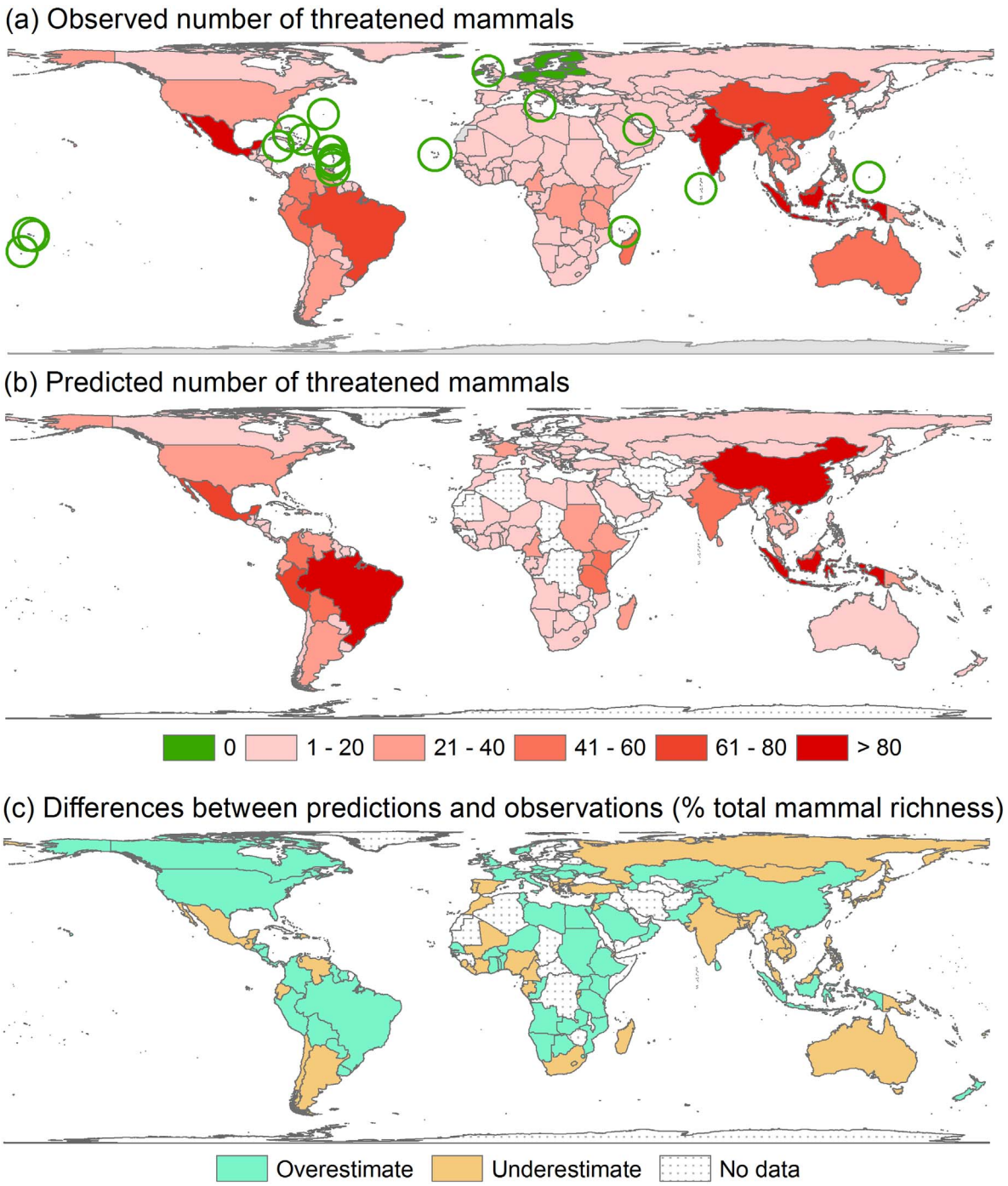

Fig. 2. Observed (a) and predicted (b) number of threatened mammal species per country. Panel (c) represents the differences between predicted and observed values divided by the total mammalian richness of the country. Both overestimated and underestimated values are within the ±0.14% range; except for Cyprus, Indonesia, Barbados, Seychelles, New Zealand and Mauritius that present overestimates >0.14%. No data indicates that selected socioeconomic indicators were not available for those countries.

Table 1. Results of the final model exploring the association of socioeconomic indicators and the probability of presence of threatened mammals by country (Data Deficient species considered as non-threatened; $N = 162$). We report the best coefficient estimate and its standard error [β (SE)] and the mean odds ratio (OR) with the 95% confidence interval (CI) for all variables included in the final model.

Variable	β (SE)	OR (95% CI)
Socioeconomic		
Urban population[2]	−0.00 (0.001)†	1.00 (0.997, 1.000)
Urban population	0.20 (0.106)†	1.22 (1.008, 1.538)
Population growth	1.85 (0.566)**	6.33 (2.282, 21.828)
Arable land[2]	0.00 (0.002)*	1.00 (1.001, 1.008)
Arable land	−0.20 (0.085)*	0.82 (0.683, 0.960)
Tourism receipts[2]	−0.01 (0.002)**	0.99 (0.991, 0.998)
Tourism receipts	0.39 (0.140)**	1.47 (1.166, 2.034)
Control		
Total mammals	0.13 (0.034)***	1.13 (1.072, 1.226)
Land area	0.00 (0.002)	1.00 (1.000, 1.000)
Shared mammals	−0.71 (1.559)	0.49 (0.021, 9.840)

[2]quadratic term; ***P <0.001; **P < 0.01; *P < 0.05; †P < 0.1.

Zealand and Mauritius (Fig. 2b and c). Results were qualitatively the same when DD species were classified as threatened although the final model included three additional indicators: annual population growth (%), CO_2 emissions and international expenditures on tourism (% imports; Appendix D).

All fitted models (Tables 1 and 2)—evaluating presence and abundance of threatened mammals—include three control variables (total mammalian richness, country land surface and shared mammals). As expected, the presence and abundance of threatened mammals are always positively associated with total mammalian richness. Once richness is taken into account, the total land area does not significantly influence the presence and abundance of threatened mammals. The percentage of shared mammals has no significant effect on the probability of presence of threatened species, but in the abundance model countries with more shared species tend to have fewer threatened mammals.

Discussion

Our results show that both presence and abundance of threatened mammalian species correlate with particular socioeconomic features at a global scale. (Appendix E provides maps representing the observed values per country for all indicators identified as relevant.) While our analyses do not evaluate how these socioeconomic conditions associate with the actual processes and threats that affect mammals, our results offer interesting follow-up questions and hypotheses regarding those aspects of socioeconomic development which could be more influential for mammalian conservation.

Interestingly, our results show two clearly distinct types of countries that lack threatened mammals: SIDS (Small Islands Developing States) and well-developed and relatively small European countries. SIDS have suffered relatively minor changes in land use judging by their low levels of arable land and urban population, but tourism constitutes an important part of their economies (Fig. 3) and also a potential threat to their biodiversity (Gössling et al. 2002, McElroy 2003). Although SIDS are characterized by economic and environmental vulnerability (Kier et al. 2009, Teelucksingh and Watson 2013), these small islands have generally low mammalian richness due to their small size and isolation (Whittaker and Fernández-Palacios 2007), thus limiting the number of potential mammals that could be at risk. Small European countries, on the other hand, have higher percentages of arable land and urban population, the result of a history of land transformation that is not reflected in the amount of mammals currently at risk at this scale (Falcucci et al. 2007, Mortelliti et al. 2010). For both groups of countries, the recent record of extinct species (post-15th century) does not seem to explain the absence of threatened species. The amount of extinct and extinct in the wild species reported by the IUCN within these countries is four species in four SIDS (one on each), and one in one European country (Appendix C: Table C1),

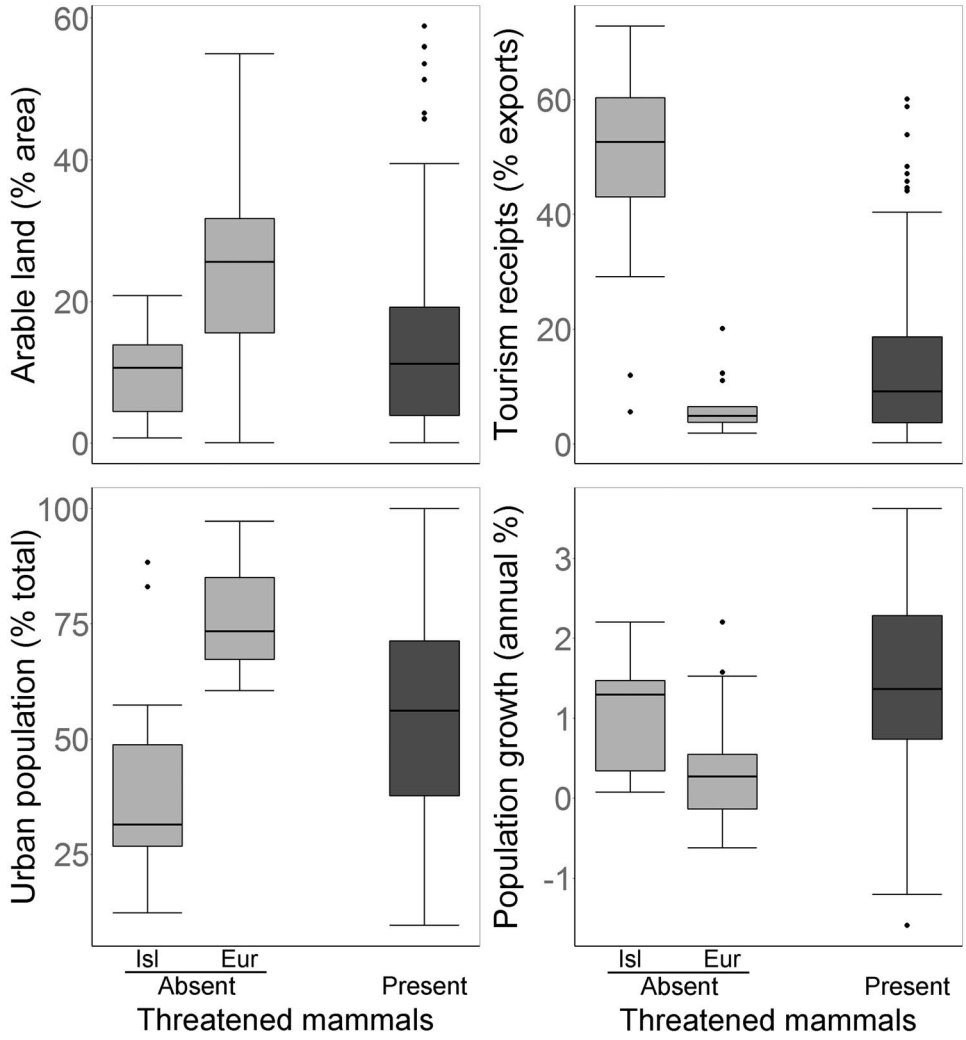

Fig. 3. Observed values for the key socioeconomic variables associated with differences in the probability of presence of threatened mammals for countries with threatened mammals (dark grey bars; present) and countries without threatened mammals (light grey bars; absent). Abbreviations are Isl, subgroup of SIDS; and Eur, subgroup of European countries.

no more than the number of extinct species in other areas. An alternative explanation for the lack of threatened species in these countries could be that their most vulnerable, and probably scarce, mammals became extinct long ago and/or that currently extant species have been extirpated (are locally extinct) from these territories (Ceballos and Ehrlich 2002, Morrison et al. 2007). Additionally, some of these countries have nowadays the resources and will to implement conservation policies to protect their remaining fauna which could reduce the number of species listed as threatened (Pullin et al. 2009). Although a priori we could expect that the lack of threatened mammals would be associated with the "most pristine" or "less humanized" countries, our results do not reflect that trend. By exploring for the first time the socioeconomic profiles of countries harboring no threatened mammals our study offers new, testable, hypotheses to explain these absences including the effects of increased conservation actions, local extirpations and ancient global extinctions.

Among countries with one or more threatened

Table 2. Results of the final model exploring the association between socioeconomic indicators and the abundance of threatened mammals by country. (Data Deficient species considered as non-threatened; $N = 125$.) We report the best coefficient estimate and its standard error [β (SE)] for all variables included in the final model.

Variable	β (SE)
Socioeconomic	
Urban population	−0.01 (0.003)***
Imports GS	−0.01 (0.004)**
Exports GS	0.01 (0.004)**
Life expectancy[2]	−0.00 (0.001)*
Life expectancy	0.17 (0.067)*
Tourism receipts[2]	−0.00 (0.031)**
Tourism receipts	0.03 (0.014)*
Control	
Total mammals	0.01 (0.000)***
Land area	0.00 (0.000)
Shared mammals	−0.92 (0.191)***

[2] quadratic term; ***P < 0.001; **P < 0.01; *P < 0.05.

mammals, we identified diverse indicators, with both linear and quadratic relationships, as associated with the number of threatened mammals (Fig. 4). All else being equal, states with a higher proportion of rural population appear to be associated with higher numbers of threatened species, which suggests that more threats could be associated with rural development than with predominantly urban countries. Future research would be necessary to explore this association, but threats associated with nations with higher proportions of rural population are probably related to land transformation for agriculture and the resulting habitat loss for many mammals, as well as side effects of land use intensity such as pollution and exotic species introductions (Laurance et al. 2014). In addition, more urbanized countries could have already lost many of their most vulnerable species and thus could present apparently better conservation status. We found that human life expectancy, an indicator of overall socioeconomic development, is also associated with mammalian conservation status; with intermediate to high life expectancies being associated with more threatened species. This non-linear relationship often described as an environmental Kuznets curve was also reported in a previous study that used another aggregated indicator, per capita income by country, which is highly correlated with life expectancy (McPherson and Nieswiadomy 2005). Finally, an interesting result from our analyses is the identified importance of trade and flux of services, goods and people among countries (Fig. 4), all of them linked to the fast globalization process we are witnessing.

Recent studies suggest that international trade is associated with 30% of global species threats (Lenzen et al. 2012) and some authors have equated the imports of certain goods to the exports of ecological impacts (Meyfroidt et al. 2010). While our results support these ideas, further research would be necessary to assess the actual impacts caused by this trade including conversion of land to exportable key crops (e.g., coffee, soybean, oils, etc), logging, and overhunting for pet trade (Lenzen et al. 2012). In the meantime, given the apparent importance of trade, we propose that land use classifications and assessments of threats should explicitly consider international trade, for example separating land use changes associated with internal production from those destined to exports. In addition to the importance of trade of goods and services we found that international tourism (visiting) is also correlated with the number of threatened mammals but with a perhaps unexpected pattern. Apparently, countries whose economies highly depend on international tourism have fewer threatened mammals than those with intermediate levels. Within this group we can find many SIDS (e.g., Netherlands Antilles, Barbados) which have high levels of tourism but, as explained above, are areas naturally poor in mammals.

By considering a diversity of indicators we also show that neither of the two proposed general hypotheses linking biodiversity and socioeconomic development is consistently supported as both linear and quadratic relationships are observed (Fig. 4). For some indicators our results suggest that the effect of development on biodiversity is non-linear supporting the hypothesis that fewer threatened mammals in more developed countries can be a consequence of the increasing environmental concern and stricter environmental regulations that often accompany socioeconomic development. In other cases, the relationships are linear with more development associated with more threatened species and no subsequent improvement. This diversity of association patterns highlight why using a single development indicator is not advisable (Moran et al. 2008, Nielsen 2011), and also advocates for

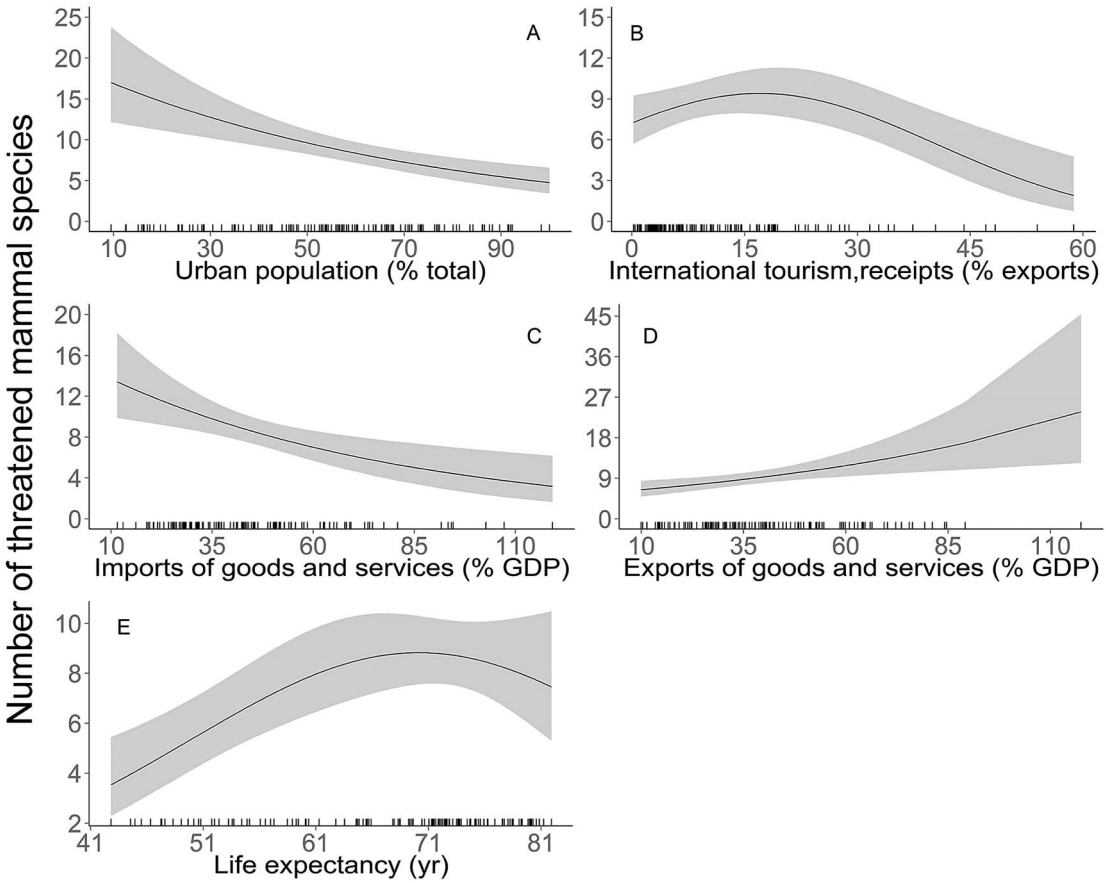

Fig. 4. Predicted relationships between key socioeconomic variables and the abundance of threatened mammals by country (DD species classified as non-threatened). Model predictions were based on the final model (Table 2) and estimated by exploring the range of observed values for each indicator while using the median observed value for other variables in the model (Median values: total mammalian richness = 130; land area = 196,800 km^2; shared mammals = 0.7646; urban population = 56.20%; international tourism, receipts = 8.56%; imports of goods and services = 42.64%; exports of goods and services = 36.45%; life expectancy = 71.38). Shadowed area represents the confidence intervals (95%). Singapur was removed from graphs C and D to facilitate visualization. Singapur has extremely high values for these two indicators (imports of goods and services (% GDP) = 200,452; exports of goods and services (% GDP) = 228,007). The distribution of the observed data for each indicator is indicated over the *x*-axis by small bars.

considering non-linear relationships when testing the relationship between socio-economic development and environmental impact.

Our results also deliver a useful message for conservation planning highlighting countries where the observed number of threatened mammals is smaller or greater than expected by their socioeconomic profile. For example countries such as Brazil or United States (countries in green in Fig. 2c) have fewer threatened mammals than predicted perhaps because they have a mechanism that is acting to decrease threats to mammals (such as effective conservation measures), and/or because they are areas naturally occupied by less susceptible species (e.g., more cosmopolitan/resilient mammals). Conversely, countries such as India or Australia (countries in brown in Fig. 2c) harbor more threatened mammals than predicted by their socioeconomic characteristics. In these countries human threats may be especially intense and fast changing (not yet be accounted for in available assessments)

and/or mammals occupying these regions are particularly sensitive (e.g., endemic or intrinsically vulnerable). Future studies that aim to disentangle the role that these mechanisms play at finer scales are important and would be useful to complement previous global prioritization scenarios (Eklund et al. 2011, Visconti et al. 2011).

Finally, we would like to discuss some limitations of our study. First, we could not explore causal relationships or establish which specific human actions associated with socioeconomic development are directly responsible for the increased vulnerability. Nevertheless, our results lead to interesting follow-up questions such as: What are the threats and processes that occur in rural countries that lead to increase mammalian vulnerability? What are the specific activities related to the exports of goods and services that are so damaging for mammals? What underlying factors make countries with high levels of international tourism less likely to contain threatened mammals? Although we do not know the answers, and often lack the data to explore the questions, our study provides guidance on key issues that need to be addressed. Second, our analyses are based on countries that comprise widely different areas (2–16,380,000 km^2) that may not be well-represented by average values of direct descriptors of land use or environmental characteristics. This could be the reason why our final models do not include indicators, other than percentage of arable land, more directly linked to local land use changes. Lotz and Allen (2013) conducted a similar country-level study of vulnerability to socioeconomic factors and identified some land use variables as relevant, including agricultural intensity and surface of protected area. Our results likely differ from those of Lotz and Allen (2013) due to methodological differences: we use a hierarchical model building approach to maximize data use, tested both linear and quadratic relationships, and analyzed countries with and without threatened species separately. In addition, Lotz and Allen (2013) evaluated a different subset of indicators using a different subset of socioeconomic indicators and also including variables that summarized ecological features of analyzed countries, highlighting the importance of careful variable selection and hypotheses driven analyses. Finally, we would like to note that the lack of socioeconomic information for some countries is likely limiting our full understanding of reality, as analyses may exclude potentially key factors for which information is simply not currently available.

In conclusion, our results provide a global comprehensive characterization of the socioeconomic profiles of countries with more (and less) threatened mammalian fauna. Future work would be necessary to identify the specific human actions that cause increased number of threatened species and thus, to provide direct management recommendations. It would also be enlightening to explore the historical processes that have triggered current conservation status. Some of those countries lacking threatened mammals may actually have lost their most vulnerable species and now appear as better preserved areas. Conversely, some of the countries with many threatened species could in fact be acting as refuges for species that were originally more widespread and now can only persist in these areas. Meanwhile, these profiles can help us identify human development issues that may be particularly worrisome but are not yet well-recognized. For example, our analyses emphasize the role of globalization for mammalian conservation status. Our attention is often focused on human activities occurring at the same site as the environmental damage, while we forget that in today's globalized world, drivers located far away may be responsible for many of the observed changes. Many developed countries have a relatively well-protected fauna; however, the impact of their activities and policies extends to other countries. The effect of transborder impacts has only been explicitly addressed recently (Meyfroidt et al. 2010, Lenzen et al. 2012), yet these impacts likely play an important role in conservation.

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Supplemental Material

Appendix A

Definition and description of biodiversity conservation status estimates and socioeconomic indicators used in the analyses

Table A1. Correspondence between categories (topics) used by the World Bank to classify socioeconomic indicators and the simplified categories used for this study.

Category	Topic (World Bank classification)
Agriculture	Environment: Land use
	Environment: Agricultural production
Economy	Economic Policy & Debt: National accounts: Growth rates
	Economic Policy & Debt: National accounts: US$ at constant 2000 prices: Aggregate indicators
	Economic Policy & Debt: Purchasing power parity
	Economic Policy & Debt: National accounts: Shares of GDP & other
	Economic Policy & Debt: National accounts: Adjusted savings & income
	Poverty: Poverty rates
	Poverty: Income distribution
	Poverty: Poverty rates
Education	Education: Inputs
	Education: Outcomes
Environment	Environment: Land use
	Environment: Biodiversity & protected areas
	Environment: Emissions
	Environment: Natural resources contribution to GDP
	Environment: Energy production & use
	Environment: Water pollution
	Environment: Freshwater
Health	Health: Mortality
	Health: Reproductive health
	Health: Health services
	Health: Disease prevention
Infrastructure	Infrastructure: Technology
	Infrastructure: Transportation
Labor and social protection	Labor & Social Protection: Migration
	Labor & Social Protection: Labor force structure
	Labor & Social Protection: Economic activity
Population	Health: Population: Structure
	Health: Population: Dynamics
	Environment: Density & urbanization
Private sector	Private Sector & Trade: Exports
	Private Sector & Trade: Travel & tourism

Table A2. List of socioeconomic indicators hypothesized to have an influence on the presence and abundance of threatened mammals by country (grouped by the categories described in Table A1). %: shows the percentage of countries with data for that indicator (2005). Reasons for excluding variables from the analyses were insufficiency of data (Ins; <70% countries with information for that variable) or high correlation with other indicators (Corr; Spearman $\rho > |0.8|$). The rest of variables (. . .) were included in the models by category.

Indicator	%	Reason for exclusion
Agriculture		
Agricultural land (% of land area)	98	. . .
Arable land (% of land area)	98	. . .
Fertilizer consumption (kg/ha of arable land)	73	. . .
Agricultural irrigated land (% of total agricultural land)	28	Ins
Economy		
GDP per capita growth (annual %)	93	. . .
GDP per capita, PPP (constant 2005 international $)	87	. . .
Agriculture, value added (% of GDP)	83	Corr. with GDP per capita
Imports of goods and services (% of GDP)	86	. . .
Exports of goods and services (% of GDP)	86	. . .
GINI index	19	Ins
Poverty gap at $2 a day (PPP) (%)	20	Ins
Poverty gap at national poverty line (%)	10	Ins
Education		
Literacy rate, adult total (% of people ages ≥15)	8	Ins
Public spending on education, total (% of GDP)	50	Ins
Research and development expenditure (% of GDP)	41	Ins
Environment		
CO_2 emissions (metric tons per capita)	94	. . .
Forest area (% of land area)	100	. . .
Mineral rents (% of GDP)	88	. . .
Terrestrial protected areas (% of total land area)	98	. . .
Total natural resources rents (% GDP)	93	. . .
Organic water pollutant (BOD) emissions (kg/day)	34	Ins
Health		
Birth rate, crude (per 1,000 people)	96	Corr. with improved sanitation facilities, fertility rate and life expectancy
Fertility rate, total (births per woman)	94	. . .
Health expenditure per capita, PPP (constant 2005 international $)	90	Corr. with improved sanitation facilities and life expectancy
Improved sanitation facilities (% of population with access)	86	Corr. with life expectancy and birth rate
Life expectancy at birth, total (years)	95	. . .
Infrastructures		
Road density (km of road/100 km^2 of land area)	38	Ins
Labor and social protection		
Labor participation rate, female (% of female population ages 15+)	90	. . .
Net migration	94	. . .
Population		
Population density (habitant/km^2)	100	. . .
Population, total	100	Corr. with land area
Population growth (annual %)	99	. . .
Rural population (% of total population)	100	Corr. with urban population
Rural population growth (annual %)	97	. . .
Urban population (% of total population)	100	. . .
Urban population growth (annual %)	99	Corr. with population growth
Private sector		
Merchandise exports to high-income economies (% of total merchandise exports)	89	. . .
International tourism, expenditures (% of total imports)	79	. . .
International tourism, receipts (% of total exports)	79	. . .

Table A3. Descriptive statistics of all variables used in the analyses grouped by modeling categories.

Name	Units	N	Median	Min–max
Response variable				
Abundance of threatened mammals	no. species	204	5.000	0.000–177.000
Control				
Land area	1000 km^2	204	103.700	0.002–16380.000
Mean shared mammals with neighboring countries	% of total richness of mammals	204	0.728	0.000–1.000
Total richness of mammmals	no. species	204	79.000	1.000–649.000
Agriculture				
Agricultural land	% of land area	200	38.420	0.473–89.020
Arable land	% of land area	199	10.720	0.043–58.870
Fertilizer consumption	kg/ha of arable land	148	69.720	0.000–2719.000
Economy				
Imports of goods and services	% of GDP	176	44.020	11.520–200.450
Exports of goods and services	% of GDP	176	39.000	5.782–228.007
GDP per capita growth	annual %	189	3.142	−5.989–25.113
GDP per capita, PPP	constant 2005 international $	177	6200.200	265.900–68319.200
Environment				
CO_2 emissions	metric tons per capita	191	2.288	0.022–64.119
Forest area	% of land area	204	30.620	0.000–94.720
Mineral rents	% of GDP	180	0.000	0.000–27.939
Terrestrial protected areas	% of total land area	199	9.448	0.000–53.750
Total natural resources rents	% of GDP	189	1.951	0.000–206.507
Health				
Fertility rate, total	births per woman	192	2.432	1.080–7.267
Life expectancy at birth, total	years	193	71.360	41.470–81.980
Labor and social protection				
Labor participation rate, total	% of total population ages 15+	180	63.850	37.300–89.400
Net migration	1000 people	187	−3.000	−2702.060–5675.799
Population				
Population density	habitant/km^2	204	74.328	0.139–16226.500
Population growth	annual %	202	1.337	−1.591–10.518
Rural population growth	annual %	197	0.459	−21.880–8.516
Urban population	% of total	203	57.400	9.500–100.000
Private sector				
International tourism, expenditures	% of total imports	162	5.462	0.226–21.024
International tourism, receipts	% of total exports	162	9.211	0.232–72.774
Merchandise exports to high-income economies	% of total merchandise exports	181	71.655	5.524–124.836

Table A4. Definitions and sources of the variables considered for analyses grouped by modeling categories, including those excluded due to their high correlation with other indicators (see Table A2). All data can be accessed on http://data.worldbank.org/. For socioeconomic variables, we provide the World Bank's definition.

Name	Definition	Source
Response variable		
Abundance of threatened mammals	The total number of mammals included in the categories critically endangered (CR), endangered (EN) and vulnerable (VU).	IUCN Red List of Threatened Species (Version 3, IUCN 2012)
Control		
Land area	A country's total area, excluding area under inland water bodies, national claims to continental shelf, and exclusive economic zones; in most cases, the definition of inland water bodies includes major rivers and lakes.	Food and Agriculture Organization, electronic files and web site
Mean shared mammals with neighboring countries	The mean number of mammals shared with bordering countries (sharing at least one border point), divided by total richness of mammals distributed within the country.	Own calculations (derived from the maps of IUCN Red List of Threatened Species (Version 3, IUCN 2012))
Total richness of mammmals	The total number of mammals whose distribution is included within the border of a country, either partially or totally.	Maps of IUCN Red List of Threatened Species (Version 3, IUCN 2012)
Agriculture		
Agricultural land	The share of land area that is arable, under permanent crops, and under permanent pastures. Arable land includes land defined by the FAO as land under temporary crops (double-cropped areas are counted once), temporary meadows for mowing or for pasture, land under market or kitchen gardens, and land temporarily fallow. Land abandoned as a result of shifting cultivation is excluded. Land under permanent crops is land cultivated with crops that occupy the land for long periods and need not be replanted after each harvest, such as cocoa, coffee, and rubber. This category includes land under flowering shrubs, fruit trees, nut trees, and vines, but excludes land under trees grown for wood or timber. Permanent pasture is land used for five or more years for forage, including natural and cultivated crops.	Food and Agriculture Organization, electronic files and web site
Arable land	Arable land includes land defined by the FAO as land under temporary crops (double-cropped areas are counted once), temporary meadows for mowing or for pasture, land under market or kitchen gardens, and land temporarily fallow. Land abandoned as a result of shifting cultivation is excluded.	Food and Agriculture Organization, electronic files and web site
Fertilizer consumption	Fertilizer consumption (100 grams per hectare of arable land) measures the quantity of plant nutrients used per unit of arable land. Fertilizer products cover nitrogenous, potash, and phosphate fertilizers (including ground rock phosphate). Traditional nutrients—animal and plant manures—are not included. For the purpose of data dissemination, FAO has adopted the concept of a calendar year (January–December). Some countries compile fertilizer data on a calendar year basis, while others are on a split-year basis. Arable land includes land defined by the FAO as land under temporary crops (double-cropped areas are counted once), temporary meadows for mowing or for pasture, land under market or kitchen gardens, and land temporarily fallow. Land abandoned as a result of shifting cultivation is excluded.	Food and Agriculture Organization, electronic files and web site

Table A4. Continued.

Name	Definition	Source
Economy		
Agriculture, value added†	Agriculture corresponds to ISIC divisions 1–5 and includes forestry, hunting, and fishing, as well as cultivation of crops and livestock production. Value added is the net output of a sector after adding up all outputs and subtracting intermediate inputs. It is calculated without making deductions for depreciation of fabricated assets or depletion and degradation of natural resources. The origin of value added is determined by the International Standard Industrial Classification (ISIC), revision 3. Note: For VAB countries, gross value added at factor cost is used as the denominator.	World Bank national accounts data and OECD National Accounts data files
Imports of goods and services	Imports of goods and services represent the value of all goods and other market services received from the rest of the world. They include the value of merchandise, freight, insurance, transport, travel, royalties, license fees, and other services, such as communication, construction, financial, information, business, personal, and government services. They exclude compensation of employees and investment income (formerly called factor services) and transfer payments.	World Bank national accounts data and OECD National Accounts data files
Exports of goods and services	Exports of goods and services represent the value of all goods and other market services provided to the rest of the world. They include the value of merchandise, freight, insurance, transport, travel, royalties, license fees, and other services, such as communication, construction, financial, information, business, personal, and government services. They exclude compensation of employees and investment income (formerly called factor services) and transfer payments.	World Bank national accounts data and OECD National Accounts data files
GDP per capita growth	Annual percentage growth rate of GDP per capita based on constant local currency. GDP per capita is gross domestic product divided by midyear population. GDP at purchaser's prices is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources.	World Bank national accounts data and OECD National Accounts data files
GDP per capita, PPP	GDP per capita based on purchasing power parity (PPP). PPP GDP is gross domestic product converted to international dollars using purchasing power parity rates. An international dollar has the same purchasing power over GDP as the U.S. dollar has in the United States. GDP at purchaser's prices is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources. Data are in constant 2005 international dollars.	World Bank, International Comparison Program database

Table A4. Continued.

Name	Definition	Source
Environment		
CO_2 emissions	Carbon dioxide emissions are those stemming from the burning of fossil fuels and the manufacture of cement. They include carbon dioxide produced during consumption of solid, liquid, and gas fuels and gas flaring.	Carbon Dioxide Information Analysis Center, Environmental Sciences Division, Oak Ridge National Laboratory, Tennessee, United States
Forest area	Forest area is land under natural or planted stands of trees of at least 5 m in situ, whether productive or not, and excludes tree stands in agricultural production systems (for example, in fruit plantations and agroforestry systems) and trees in urban parks and gardens.	Food and Agriculture Organization, electronic files and web site
Mineral rents	Mineral rents are the difference between the value of production for a stock of minerals at world prices and their total costs of production. Minerals included in the calculation are tin, gold, lead, zinc, iron, copper, nickel, silver, bauxite, and phosphate.	Estimates based on sources and methods described in "The Changing Wealth of Nations: Measuring Sustainable Development in the New Millennium" (World Bank 2011)
Terrestrial protected areas	Terrestrial protected areas are those officially documented by national authorities.	United Nations Environmental Program and the World Conservation Monitoring Centre, as compiled by the World Resources Institute, based on data from national authorities, national legislation and international agreements
Total natural resources rents	Total natural resources rents are the sum of oil rents, natural gas rents, coal rents (hard and soft), mineral rents, and forest rents.	Estimates based on sources and methods described in "The Changing Wealth of Nations: Measuring Sustainable Development in the New Millennium" (World Bank 2011)
Health		
Birth rate, crude†	Crude birth rate indicates the number of live births occurring during the year, per 1,000 population estimated at midyear. Subtracting the crude death rate from the crude birth rate provides the rate of natural increase, which is equal to the rate of population change in the absence of migration.	(1) United Nations Population Division. 2009. World Population Prospects: The 2008 Revision. New York, United Nations, Department of Economic and Social Affairs (advanced Excel tables), (2) United Nations Statistical Division. Population and Vital Statistics Report (various years), (3) Census reports and other statistical publications from national statistical offices, (4) Eurostat: Demographic Statistics, (5) Secretariat of the Pacific Community: Statistics and Demography Programme, and (6) U.S. Census Bureau: International Database
Fertility rate, total	Total fertility rate represents the number of children that would be born to a woman if she were to live to the end of her childbearing years and bear children in accordance with current age-specific fertility rates.	(1) United Nations Population Division. 2009. World Population Prospects: The 2008 Revision. New York, United Nations, Department of Economic and Social Affairs (advanced Excel tables). Available at http://esa.un.org/unpd/wpp2008/index.htm. (2) Census reports and other statistical publications from national statistical offices, (3) Eurostat: Demographic Statistics, (4) Secretariat of the Pacific Community: Statistics and Demography Programme, (5) U.S. Census Bureau: International Database, and (6) household surveys conducted by national agencies, Macro International, and the U.S. Centers for Disease Control and Prevention

Table A4. Continued.

Name	Definition	Source
Health expenditure per capita, PPP†	Total health expenditure is the sum of public and private health expenditures as a ratio of total population. It covers the provision of health services (preventive and curative), family planning activities, nutrition activities, and emergency aid designated for health but does not include provision of water and sanitation. Data are in international dollars converted using 2005 purchasing power parity (PPP) rates.	World Health Organization National Health Account database (www.who.int/nha/en) supplemented by country data
Improved sanitation facilities†	Access to improved sanitation facilities refers to the percentage of the population with at least adequate access to excreta disposal facilities that can effectively prevent human, animal, and insect contact with excreta. Improved facilities range from simple but protected pit latrines to flush toilets with a sewerage connection. To be effective, facilities must be correctly constructed and properly maintained.	World Health Organization and United Nations Children's Fund, Joint Measurement Programme (JMP) (http://www.wssinfo.org/)
Life expectancy at birth, total	Life expectancy at birth indicates the number of years a newborn infant would live if prevailing patterns of mortality at the time of its birth were to stay the same throughout its life.	Derived from male and female life expectancy at birth. Male and female life expectancy source: (1) United Nations Population Division. 2009. World Population Prospects: The 2008 Revision. New York, United Nations, Department of Economic and Social Affairs (advanced Excel tables), (2) Census reports and other statistical publications from national statistical offices, (3) Eurostat: Demographic Statistics, (4) Secretariat of the Pacific Community: Statistics and Demography Programme, and (5) U.S. Census Bureau: International Database
Labor and social protection		
Labor participation rate, total	Labor force participation rate is the proportion of the population ages 15 and older that is economically active: all people who supply labor for the production of goods and services during a specified period.	International Labour Organization, Key Indicators of the Labour Market database
Net migration	Net migration is the net total of migrants during the period, that is, the total number of immigrants less the annual number of emigrants, including both citizens and noncitizens. Data are five-year estimates. To derive estimates of net migration, the United Nations Population Division takes into account the past migration history of a country or area, the migration policy of a country, and the influx of refugees in recent periods. The data to calculate these official estimates come from a variety of sources, including border statistics, administrative records, surveys, and censuses. When no official estimates can be made because of insufficient data, net migration is derived through the balance equation, which is the difference between overall population growth and the natural increase during the 1990–2000 intercensal period.	United Nations Population Division, World Population Prospects 2008

Table A4. Continued.

Name	Definition	Source
Population		
Population density	Population density was calculated by dividing total population by land area	Own calculations (derived from World Bank)
Population, total†	Total population is based on the de facto definition of population, which counts all residents regardless of legal status or citizenship—except for refugees not permanently settled in the country of asylum, who are generally considered part of the population of their country of origin. The values shown are midyear estimates.	(1) United Nations Population Division. 2009. World Population Prospects: The 2008 Revision. New York, United Nations, Department of Economic and Social Affairs (advanced Excel tables). Available at http://esa.un.org/unpd/wpp2008/index.htm. (2) Census reports and other statistical publications from national statistical offices, (3) Eurostat: Demographic Statistics, (4) Secretariat of the Pacific Community: Statistics and Demography Programme, (5) U.S. Census Bureau: International Database, and (6) World bank estimates based on the data from the sources above, household surveys conducted by national agencies, Macro International, the U.S. Centers for Disease Control and Prevention, and refugees statistics from the United Nations High Commissioner for Refugees
Population growth	Annual population growth rate for year t is the exponential rate of growth of midyear population from year $t-1$ to t, expressed as a percentage. Population is based on the de facto definition of population, which counts all residents regardless of legal status or citizenship—except for refugees not permanently settled in the country of asylum, who are generally considered part of the population of the country of origin.	Derived from total population. Population source: (1) United Nations Population Division. 2009. World Population Prospects: The 2008 Revision. New York, United Nations, Department of Economic and Social Affairs (advanced Excel tables). Available at http://esa.un.org/unpd/wpp2008/index.htm. (2) Census reports and other statistical publications from national statistical offices, (3) Eurostat: Demographic Statistics, (4) Secretariat of the Pacific Community: Statistics and Demography Programme, (5) U.S. Census Bureau: International Database, and (6) World bank estimates based on the data from the sources above, household surveys conducted by national agencies, Macro International, the U.S. Centers for Disease Control and Prevention, and refugees statistics from the United Nations High Commissioner for Refugees
Rural population†	Rural population refers to people living in rural areas as defined by national statistical offices. It is calculated as the difference between total population and urban population.	World Bank Staff estimates based on United Nations, World Urbanization Prospects
Rural population growth	Rural population refers to people living in rural areas as defined by national statistical offices. It is calculated as the difference between total population and urban population.	World Bank Staff estimates based on United Nations, World Urbanization Prospects
Urban population	Urban population refers to people living in urban areas as defined by national statistical offices. It is calculated using World Bank population estimates and urban ratios from the United Nations World Urbanization Prospects.	World Bank Staff estimates based on United Nations, World Urbanization Prospects

Table A4. Continued.

Name	Definition	Source
Urban population growth†	Urban population refers to people living in urban areas as defined by national statistical offices. It is calculated using World Bank population estimates and urban ratios from the United Nations World Urbanization Prospects.	World Bank Staff estimates based on United Nations, World Urbanization Prospect
Private sector		
International tourism, expenditures	International tourism expenditures are expenditures of international outbound visitors in other countries, including payments to foreign carriers for international transport. These expenditures may include those by residents traveling abroad as same-day visitors, except in cases where these are important enough to justify separate classification. For some countries they do not include expenditures for passenger transport items. Their share in imports is calculated as a ratio to imports of goods and services, which comprise all transactions between residents of a country and the rest of the world involving a change of ownership from nonresidents to residents of general merchandise, goods sent for processing and repairs, nonmonetary gold, and services.	World Tourism Organization, Yearbook of Tourism Statistics, Compendium of Tourism Statistics and data files, and IMF and World Bank imports estimates
International tourism, receipts	International tourism receipts are expenditures by international inbound visitors, including payments to national carriers for international transport. These receipts include any other prepayment made for goods or services received in the destination country. They also may include receipts from same-day visitors, except when these are important enough to justify separate classification. For some countries they do not include receipts for passenger transport items. Their share in exports is calculated as a ratio to exports of goods and services, which comprise all transactions between residents of a country and the rest of the world involving a change of ownership from residents to nonresidents of general merchandise, goods sent for processing and repairs, nonmonetary gold, and services.	World Tourism Organization, Yearbook of Tourism Statistics, Compendium of Tourism Statistics and data files, and IMF and World Bank exports estimates
Merchandise exports to high-income economies	Merchandise exports to high-income economies are the sum of merchandise exports from the reporting economy to high-income economies according to the World Bank classification of economies as of July 1, 2009. Data are expressed as a percentage of total merchandise exports by the economy. Data are computed only if at least half of the economies in the partner country group had non-missing data.	World Bank staff estimates based data from International Monetary Fund's Direction of Trade database

†Variables excluded from the models due to their high correlation ($\rho > |0.8|$) with others in any category.

APPENDIX B

Number of threatened and non-threatened species per country and degree of agreement between national and global Red Lists

Table B1. Comparison between numbers of threatened species according to National vs. Global Red List, in countries with National Red Lists. The number of threatened species was calculated as the mean between the count with and without including data deficient species. Total shows the total number of species considered in each of the lists. Coinciding number (*n*) is the number of species considered as threatened in both lists. The coinciding percentage (%) is the number of coinciding threatened species over the total regionally threatened species.

	National Red List		Global Red List		Coinciding	
Country	Threatened	Total	Threatened	Total	*n*	%
Argentina	47.0	147	65.5	351	19.5	0.4
Bangladesh	13.0	50	22.0	146	2.5	0.2
Bhutan	11.5	29	29.0	154	3.5	0.3
Canada	22.0	43	3.0	140	1.0	0.0
Colombia	25.0	25	69.5	445	18.5	0.7
Estonia	1.0	12	0.0	47	0.0	0.0
Finland	3.0	8	0.0	49	0.0	0.0
France	9.5	76	24.0	305	2.5	0.3
United Kingdom	2.0	2	2.0	59	0.0	0.0
Croatia	8.5	27	3.5	79	1.5	0.2
India	59.5	213	90.0	352	28.5	0.5
Israel	43.5	71	7.0	81	5.5	0.1
Japan	10.5	16	16.5	93	5.0	0.5
Sri Lanka	55.0	119	21.0	82	22.0	0.4
Maldives	1.0	2	0.0	2	0.0	0.0
Mongolia	30.5	88	7.5	115	5.0	0.2
Norway	7.0	13	1.0	49	0.0	0.0
Nepal	20.0	89	27.0	176	5.0	0.3
New Zealand	4.0	6	2.0	3	1.0	0.3
Pakistan	11.0	82	14.0	161	2.5	0.2
Poland	9.5	17	0.0	67	0.0	0.0
Sweden	8.5	16	0.0	52	0.0	0.0
Venezuela	48.5	103	47.0	341	26.5	0.5
Mean	19.6	54.5	19.6	145.6	6.5	0.2

Table B2. Comparison between numbers of non-threatened species according to National vs. Global Red List, in countries with National Red Lists. The number of non-threatened species was calculated as the mean between the count with and without including data deficient species. Total shows the total number of species considered in each of the lists. Coinciding number (*n*) is the number of species considered as non-threatened in both lists. The coinciding percentage (%) is the number of coinciding non-threatened species over the total regionally non-threatened species.

	National Red List		Global Red List		Coinciding	
Country	Non-threatened	Total	Non-threatened	Total	*n*	%
Argentina	100.0	147	285.5	351	87.5	0.9
Bangladesh	37.0	50	124.0	146	36.5	1.0
Bhutan	17.5	29	125.0	154	17.5	1.0
Canada	21.0	43	137.0	140	16.0	0.8
Colombia	0.0	25	375.5	445	0.0	NA
Estonia	11.0	12	47.0	47	11.0	1.0
Finland	5.0	8	49.0	49	5.0	1.0
France	66.5	76	281.0	305	64.0	1.0
United Kingdom	0.0	2	57.0	59	0.0	NA
Croatia	18.5	27	75.5	79	18.0	1.0
India	153.5	213	262.0	352	138.0	0.9
Israel	27.5	71	74.0	81	27.5	1.0
Japan	5.5	16	76.5	93	5.5	1.0
Sri Lanka	64.0	119	61.0	82	59.0	0.9
Maldives	1.0	2	2.0	2	1.0	1.0
Mongolia	57.5	88	107.5	115	57.0	1.0
Norway	6.0	13	48.0	49	6.0	1.0
Nepal	69.0	89	149.0	176	68.0	1.0
New Zealand	2.0	6	1.0	3	0.0	0.0
Pakistan	71.0	82	147.0	161	71.0	1.0
Poland	7.5	17	67.0	67	7.5	1.0
Sweden	7.5	16	52.0	52	7.5	1.0
Venezuela	54.5	103	294.0	341	49.0	0.9
Mean	34.9	54.5	126.0	145.6	32.7	0.9

APPENDIX C

Table C1. List of the 36 countries containing no threatened mammal species according to IUCN Red List criteria. (TOT, total of mammalian species listed for that country by the IUCN; DD, data deficient; CR, critically endangered; EN, endangered; VU, vulnerable; LC, least concern; NT, near threatened; Non-thr (Non-threatened), addition of the species classified as least concerned and near threatened; Pred Prsc, predicted probability of harboring threatened mammals provided by the fitted model. Bold values indicate probabilities higher than 0.5, meaning that the model predicted these countries to have threatened species. Dashes indicate lack of data for the variables included in the final fitted model. Extinct in the wild (EW) and extinct (EX) species are out of the analyses. SIDS, refers to countries classified as Small Island Developing States).

Country	Code	TOT	DD	CR	EN	VU	LC	NT	EX	EW	Non-thr	PredPrsc	SIDS
American Samoa	ASM	2	0	0	0	0	1	1	0	0	2	–	No
Antigua and Barbuda	ATG	8	0	0	0	0	8	0	0	0	8	0.19	Yes
Bahamas, The	BHS	6	0	0	0	0	5	1	0	0	6	0.21	Yes
Bahrain	BHR	7	0	0	0	0	6	1	0	0	7	**0.74**	No
Belarus	BLR	62	0	0	0	0	56	6	0	0	62	0.10	No
Belgium	BEL	49	0	0	0	0	45	4	0	0	49	0.05	No
Bermuda	BMU	1	0	0	0	0	1	0	0	0	1	–	No
Cape Verde	CPV	2	0	0	0	0	2	0	0	0	2	**0.80**	Yes
Cayman Islands	CYM	5	0	0	0	0	4	1	0	0	5	–	No
Denmark	DNK	40	0	0	0	0	36	4	0	0	40	**0.60**	No
Estonia	EST	47	0	0	0	0	45	2	0	0	47	0.48	No
Finland	FIN	49	0	0	0	0	48	1	0	0	49	0.39	No
Germany	DEU	61	0	0	0	0	56	5	0	0	61	0.34	No
Grenada	GRD	13	2	0	0	0	11	0	0	0	11	0.44	Yes
Iceland	ISL	3	0	0	0	0	3	0	0	0	3	0.37	No
Ireland	IRL	21	0	0	0	0	19	2	0	0	21	0.22	No
Isle of Man	IMY	7	0	0	0	0	7	0	0	0	7	–	No
Latvia	LVA	49	0	0	0	0	46	3	0	0	49	0.10	No
Liechtenstein	LIE	56	0	0	0	0	52	4	0	0	56	–	No
Lithuania	LTU	49	0	0	0	0	45	4	0	0	49	0.10	No
Luxembourg	LUX	48	0	0	0	0	44	4	0	0	48	**0.73**	No
Maldives	MDV	2	0	0	0	0	2	0	0	0	2	0.12	Yes
Malta	MLT	8	0	0	0	0	7	1	0	0	8	0.07	No
Mayotte	MYT	1	0	0	0	0	1	0	0	0	1	–	No
Netherlands	NLD	46	0	0	0	0	42	4	0	0	46	0.11	No
Palau	PLW	1	0	0	0	0	0	1	1	0	1	–	Yes
Poland	POL	67	0	0	0	0	59	8	1	0	67	**0.85**	No
Samoa	WSM	2	0	0	0	0	1	1	0	0	2	0	Yes
San Marino	SMR	48	1	0	0	0	41	6	0	0	47	–	No
St. Kitts and Nevis	KNA	7	0	0	0	0	7	0	1	0	7	**0.69**	Yes
St. Lucia	LCA	8	0	0	0	0	8	0	1	0	8	0.01	Yes
St. Vincent and the Grenadines	VCT	12	1	0	0	0	11	0	1	0	11	0.33	Yes
Sweden	SWE	52	0	0	0	0	48	4	0	0	52	0.46	No
Tonga	TON	1	0	0	0	0	1	0	0	0	1	0.04	Yes
Trinidad and Tobago	TTO	65	4	0	0	0	60	1	0	0	61	0.32	Yes
Turks and Caicos Islands	TCA	3	0	0	0	0	3	0	0	0	3	–	No

Table C2. List of the 168 countries containing threatened mammal species according to IUCN Red List criteria. (TOT, total of species listed for that country by the IUCN; DD, data deficient; CR, critically endangered; EN, endangered; VU, vulnerable; LC, least concern; NT, near threatened; Thr (Threatened), addition of the species classified as vulnerable, endangered and critically endangered; Non-thr (Non-threatened), addition of the species classified as least concerned and near threatened; Pred Prsc (prediction of presence), predicted probability of harboring threatened mammals provided by the fitted model. Bold values indicate probabilities lower than 0.5, meaning that these countries are predicted to have no threatened species. Pred Abdc (prediction of abundance), predicted abundance of threatened mammals according to the fitted model. (A) Arrows indicate if the abundance model overestimates (↑) or underestimates (↓). Dashes indicate lack of data for the variables included in the final fitted model. Extinct in the wild (EW) and extinct (EX) species are out of the analyses. SIDS refers to countries classified as Small Island Developing States.

													Pred			
Country	Code	TOT	DD	CR	EN	VU	LC	NT	EX	EW	Thr	Non-thr	Prsc	Abdc	(A)	SIDS
Afghanistan	AFG	115	5	0	2	4	97	7	0	0	6	104	–	–		No
Albania	ALB	71	3	0	0	3	60	5	0	0	3	65	1	2.11	↓	No
Algeria	DZA	78	1	1	4	5	59	8	0	1	10	67	–	–		No
Andorra	ADO	58	0	0	0	3	49	6	0	0	3	55	–	–		No
Angola	AGO	299	16	2	2	5	262	12	0	0	9	274	1	16.63	↑	No
Argentina	ARG	351	63	7	12	15	223	31	1	0	34	254	1	29.58	↓	No
Armenia	ARM	79	3	1	2	2	62	9	0	0	5	71	1	4.95	↓	No
Aruba	ABW	3	1	0	0	1	1	0	0	0	1	1	0.79	–		Yes
Australia	AUS	270	11	7	15	22	185	30	19	0	44	215	1	19.74	↓	No
Austria	AUT	72	2	1	0	1	63	5	0	0	2	68	0.99	5.29	↑	No
Azerbaijan	AZE	84	3	0	1	4	64	12	0	0	5	76	0.96	7.37	↑	No
Bangladesh	BGD	146	4	0	6	14	113	9	0	0	20	122	1	10.54	↓	No
Barbados	BRB	6	0	0	0	1	5	0	0	0	1	5	**0.12**	2.98	↑	Yes
Belize	BLZ	111	3	0	3	2	98	5	0	0	5	103	1	5.23	↑	Yes
Benin	BEN	144	7	0	1	3	124	9	0	0	4	133	1	10.26	↑	No
Bhutan	BTN	154	6	1	9	16	108	14	0	0	26	122	–	–		No
Bolivia	BOL	397	31	2	9	10	327	18	0	0	21	345	1	56.24	↑	No
Bosnia and Herzegovina	BIH	75	2	0	0	4	62	7	0	0	4	69	0.98	4.15	↑	No
Botswana	BWA	177	2	1	1	4	162	7	0	0	6	169	1	8.87	↑	No
Brazil	BRA	625	87	9	29	37	439	24	3	0	75	463	1	130.77	↑	No
Brunei Darussalam	BRN	171	17	1	7	25	107	14	0	0	33	121	1	11.12	↓	No
Bulgaria	BGR	74	2	0	0	5	60	7	0	0	5	67	0.99	4.25	↓	No
Burkina Faso	BFA	130	6	0	2	4	111	7	0	1	6	118	1	8.69	↑	No
Burundi	BDI	202	3	1	2	10	173	13	0	0	13	186	1	8.13	↓	No
Cambodia	KHM	158	3	0	14	15	117	9	0	0	29	126	1	12.45	↓	No
Cameroon	CMR	318	22	3	16	17	248	12	0	0	36	260	1	21.37	↓	No
Canada	CAN	140	0	1	1	1	136	1	0	0	3	137	1	3.62	↑	No
Central African Republic	CAF	258	16	1	2	2	226	11	0	0	5	237	–	–		No
Chad	TCD	118	3	2	2	4	101	6	0	1	8	107	–	–		No
Chile	CHL	109	9	3	5	8	76	8	0	0	16	84	1	5.98	↓	No
China	CHN	497	43	6	28	32	362	26	0	1	66	388	1	118.27	↑	No
Colombia	COL	445	45	5	13	29	338	15	0	0	47	353	1	54.49	↑	No
Comoros	COM	6	2	0	1	1	2	0	0	0	2	2	–	–		Yes
Congo, Dem. Rep.	ZAR	446	42	4	9	13	358	20	0	0	26	378	–	–		No
Congo, Rep.	COG	244	20	2	2	6	204	10	0	0	10	214	1	14.66	↑	No
Costa Rica	CRI	169	8	0	2	2	146	11	0	0	4	157	1	9.49	↑	No
Cote d'Ivoire	CIV	224	17	1	6	12	175	13	0	0	19	188	1	15.43	↓	No
Croatia	HRV	79	1	0	0	3	67	8	0	0	3	75	1	3.72	↑	No
Cuba	CUB	33	0	3	4	3	20	3	0	0	10	23	–	–		Yes
Cyprus	CYP	21	0	0	0	2	17	2	0	0	2	19	0.97	6.15	↑	No
Czech Republic	CZE	59	0	0	0	1	52	6	0	0	1	58	0.75	3.79	↑	No
Djibouti	DJI	56	2	0	0	3	46	5	0	0	3	51	0.96	2	↓	No
Dominica	DMA	11	0	0	0	1	10	0	0	0	1	10	0.89	–		Yes
Dominican Republic	DOM	17	0	0	2	1	13	1	7	0	3	14	0.94	2.52	↓	Yes
Ecuador	ECU	346	37	1	7	30	251	20	3	0	38	271	1	26.87	↓	No
Egypt, Arab Rep.	EGY	87	4	0	1	9	70	3	0	1	10	73	1	10.47	↑	No
El Salvador	SLV	107	4	0	2	1	95	5	0	0	3	100	1	5.41	↑	No
Equatorial Guinea	GNQ	172	6	3	6	7	143	7	0	0	16	150	–	–		No
Eritrea	ERI	84	2	0	0	2	76	4	0	0	2	80	–	–		No
Ethiopia	ETH	237	16	1	6	11	193	10	0	0	18	203	1	20.95	↑	No
Fiji	FJI	6	0	1	2	1	1	1	0	0	4	2	0.63	3.87	↓	Yes
France	FRA	305	16	0	2	14	256	17	1	0	16	273	1	30.88	↑	No

Table C2. Continued.

Country	Code	TOT	DD	CR	EN	VU	LC	NT	EX	EW	Thr	Non-thr	Pred			SIDS
													Prsc	Abdc	(A)	
Gabon	GAB	183	10	1	1	7	156	8	0	0	9	164	1	8.77	↓	No
Gambia, The	GMB	94	3	0	1	1	87	2	0	0	2	89	1	3.2	↑	No
Georgia	GEO	84	1	0	2	3	67	11	0	0	5	78	0.98	5.97	↑	No
Ghana	GHA	194	16	0	2	5	161	10	0	0	7	171	1	9.45	↑	No
Gibraltar	GIB	35	0	0	0	2	27	6	0	0	2	33	–	–		No
Greece	GRC	86	5	0	0	6	69	6	0	0	6	75	1	5.38	↓	No
Greenland	GRL	6	0	0	0	1	5	0	0	0	1	5	–	–		No
Guam	GUM	1	0	0	1	0	0	0	1	0	1	0	–	–		Yes
Guatemala	GTM	166	6	2	4	7	136	11	0	0	13	147	1	11.46	↓	No
Guinea	GIN	190	11	1	6	8	152	12	0	0	15	164	–	–		No
Guinea-Bissau	GNB	100	1	0	2	3	90	4	0	0	5	94	1	–		Yes
Guyana	GUY	235	18	0	1	6	204	6	0	0	7	210	1	12.35	↑	Yes
Haiti	HTI	17	0	0	2	1	13	1	8	0	3	14	**0.32**	3.12	↑	Yes
Honduras	HND	151	5	0	4	1	132	9	1	0	5	141	1	8.86	↑	No
Hungary	HUN	66	2	0	0	1	55	8	0	0	1	63	0.97	4.32	↑	No
India	IND	352	16	7	31	44	229	25	0	0	82	254	1	53.57	↓	No
Indonesia	IDN	649	118	20	64	93	313	41	1	0	177	354	1	373.09	↑	No
Iran, Islamic Rep.	IRN	143	10	0	1	9	110	13	0	0	10	123	–	–		No
Iraq	IRQ	70	2	0	1	6	56	5	1	0	7	61	0.99	–		No
Israel	ISR	81	2	0	0	6	68	5	0	0	6	73	1	3.66	↓	No
Italy	ITA	86	2	0	0	5	71	8	1	0	5	79	1	5.62	↑	No
Jamaica	JAM	19	0	1	0	2	16	0	1	0	3	16	0.87	–		Yes
Japan	JPN	93	1	3	11	2	70	6	0	0	16	76	0.98	10.39	↓	No
Jordan	JOR	73	2	0	0	6	59	6	0	0	6	65	1	2.78	↓	No
Kazakhstan	KAZ	145	6	1	1	5	122	10	0	0	7	132	1	11.35	↑	No
Kenya	KEN	354	24	4	7	11	289	19	0	0	22	308	1	46.09	↑	No
Korea, Dem. Rep.	PRK	65	3	0	0	4	53	5	0	0	4	58	–	–		No
Korea, Rep.	KOR	48	3	0	0	4	37	4	0	0	4	41	**0.07**	2.91	↓	No
Kuwait	KWT	28	0	0	0	1	24	3	1	0	1	27	0.59	3.25	↑	No
Kyrgyz Republic	KGZ	72	1	0	1	3	63	4	0	0	4	67	0.99	6.54	↑	No
Lao PDR	LAO	214	14	4	16	19	153	8	0	0	39	161	1	18.63	↓	No
Lebanon	LBN	59	1	0	0	3	51	4	0	0	3	55	1	1.45	↓	No
Lesotho	LSO	97	0	1	1	2	88	5	0	0	4	93	0.98	1.97	↓	No
Liberia	LBR	174	13	0	5	10	134	12	0	0	15	146	1	8.28	↓	No
Libya	LBY	59	4	0	1	4	47	3	0	1	5	50	0.95	6.99	↑	No
Macedonia, FYR	MKD	68	2	0	0	4	58	4	0	0	4	62	0.74	3.51	↓	No
Madagascar	MDG	195	52	6	27	25	75	10	4	0	58	85	1	29.91	↓	No
Malawi	MWI	206	10	1	1	3	183	8	0	0	5	191	–	–		No
Malaysia	MYS	303	37	2	20	41	174	29	0	0	63	203	1	30.1	↓	No
Mali	MLI	132	6	1	2	5	112	6	0	1	8	118	1	7.09	↓	No
Mauritania	MRT	74	3	1	0	2	65	3	0	1	3	68	–	–		No
Mauritius	MUS	4	0	1	1	1	1	0	1	0	3	1	0.77	8.71	↑	Yes
Mexico	MEX	454	11	21	38	22	340	22	5	0	81	362	1	65.33	↓	No
Micronesia, Fed. Sts.	FSM	2	0	0	0	2	0	0	0	0	2	0	–	–		Yes
Moldova	MDA	59	1	0	1	1	50	6	0	0	2	56	0.76	3.55	↑	No
Monaco	MCO	43	0	0	0	1	36	6	0	0	1	42	–	–		No
Mongolia	MNG	115	1	1	3	3	101	6	0	0	7	107	1	6.7	↓	No
Montenegro	MNE	69	2	0	0	3	59	5	0	0	3	64	–	–		No
Morocco	MAR	79	1	1	3	5	59	10	0	1	9	69	1	6.71	↓	No
Mozambique	MOZ	231	9	1	2	5	205	9	0	0	8	214	1	10.22	↑	No
Myanmar	MMR	294	21	1	18	27	212	15	0	0	46	227	1	–		No
Namibia	NAM	188	1	1	1	5	172	8	0	0	7	180	1	15.3	↑	No
Nepal	NPL	176	6	0	10	14	132	14	0	0	24	146	1	16.71	↓	No
Netherlands Antilles	ANT	6	0	0	0	1	5	0	1	0	1	5	**0.2**	–		No
New Caledonia	NCL	9	1	1	2	3	2	0	0	0	6	2	0.79	–		No
New Zealand	NZL	3	0	0	0	2	1	0	0	0	2	1	**0.45**	5.52	↑	No
Nicaragua	NIC	148	5	0	2	0	133	8	0	0	2	141	1	6.57	↑	No
Niger	NER	110	3	2	1	5	93	6	0	1	8	99	1	8.62	↑	No
Nigeria	NGA	245	12	3	4	11	203	12	0	1	18	215	1	13.81	↓	No
Northern Mariana Islands	MNP	1	0	0	1	0	0	0	0	0	1	0	–	–		No
Norway	NOR	49	0	0	0	1	46	2	0	0	1	48	0.6	3.79	↑	No
Oman	OMN	43	1	0	1	3	35	3	0	0	4	38	0.93	5.48	↑	No
Pakistan	PAK	161	4	0	5	7	134	11	0	0	12	145	1	15.18	↑	No
Panama	PAN	188	15	1	2	2	157	11	0	0	5	168	1	10.99	↑	No
Papua New Guinea	PNG	249	35	11	18	10	165	10	0	0	39	175	1	33.2	↓	Yes

Table C2. Continued.

Country	Code	TOT	DD	CR	EN	VU	LC	NT	EX	EW	Thr	Non-thr	Pred			SIDS
													Prsc	Abdc	(A)	
Paraguay	PRY	179	14	0	3	5	140	17	0	0	8	157	1	9.15	↑	No
Peru	PER	455	42	2	12	36	342	21	2	0	50	363	1	70.33	↑	No
Philippines	PHL	157	24	4	9	17	88	15	0	0	30	103	1	18.49	↓	No
Portugal	PRT	53	0	0	2	3	40	8	0	0	5	48	0.96	4.29	↓	No
Puerto Rico	PRI	11	0	0	0	2	9	0	2	0	2	9	–	–		No
Qatar	QAT	18	0	0	0	1	16	1	0	0	1	17	–	–		No
Romania	ROM	77	2	0	1	4	60	10	0	0	5	70	0.85	5.27	↑	No
Russian Federation	RUS	227	10	1	6	9	181	20	0	0	16	201	1	11.73	↓	No
Rwanda	RWA	236	4	2	4	12	200	14	0	0	18	214	1	14.29	↓	No
Sao Tome and Principe	STP	7	1	0	3	0	3	0	0	0	3	3	0.95	–		No
Saudi Arabia	SAU	58	1	0	0	3	50	4	1	0	3	54	0.98	6.73	↑	No
Senegal	SEN	129	4	0	3	3	114	5	0	1	6	119	1	8.11	↑	No
Serbia	SRB	79	3	0	0	4	64	8	0	0	4	72	–	–		No
Seychelles	SYC	5	0	1	0	1	3	0	0	0	2	3	0.85	4.98	↑	Yes
Sierra Leone	SLE	141	6	0	3	3	118	11	0	0	6	129	1	5.13	↓	No
Singapore	SGP	53	1	0	3	4	39	6	0	0	7	45	0.96	5.86	↓	Yes
Slovak Republic	SVK	70	2	0	0	1	59	8	0	0	1	67	0.66	4.71	↑	No
Slovenia	SVN	68	2	0	0	1	58	7	0	0	1	65	0.95	5.69	↑	No
Solomon Islands	SLB	45	6	2	8	4	24	1	0	0	14	25	0.87	13.8	↓	Yes
Somalia	SOM	147	10	1	2	5	121	8	0	0	8	129	–	–		No
South Africa	ZAF	260	8	3	6	11	222	10	1	0	20	232	1	15.74	↓	No
Spain	ESP	89	1	1	3	6	68	10	0	0	10	78	1	5.94	↓	No
Sri Lanka	LKA	82	0	0	11	10	55	6	0	0	21	61	0.95	23.09	↑	No
Sudan	SDN	289	18	1	4	6	248	12	0	1	11	260	1	23.44	↑	No
Suriname	SUR	208	14	0	1	4	183	6	0	0	5	189	1	7.68	↑	Yes
Swaziland	SWZ	148	1	1	2	1	137	6	0	0	4	143	1	5.31	↑	No
Switzerland	CHE	71	2	0	0	1	61	7	0	0	1	68	0.97	4.21	↑	No
Syrian Arab Republic	SYR	79	2	0	0	6	65	6	0	0	6	71	1	7.91	↑	No
Tajikistan	TJK	75	2	0	1	3	63	6	0	0	4	69	0.84	5.71	↑	No
Tanzania	TZA	357	14	5	14	12	292	20	0	0	31	312	1	40.67	↑	No
Thailand	THA	265	20	0	17	27	176	25	1	0	44	201	1	31.28	↓	No
Timor-Leste	TMP	42	10	0	0	2	29	1	0	0	2	30	–	–		Yes
Togo	TGO	152	8	0	0	3	133	8	0	0	3	141	1	8.18	↑	No
Tunisia	TUN	57	2	0	2	3	45	5	0	1	5	50	0.99	5.34	↑	No
Turkey	TUR	128	8	0	1	9	98	12	0	0	10	110	1	9.9	↓	No
Turkmenistan	TKM	76	2	0	0	3	65	6	0	0	3	71	–	–		No
Uganda	UGA	349	18	1	8	14	288	20	0	0	23	308	1	38.04	↑	No
Ukraine	UKR	91	1	0	2	3	76	9	0	0	5	85	1	6.49	↑	No
United Arab Emirates	ARE	31	1	0	1	2	25	2	0	0	3	27	–	–		No
United Kingdom	GBR	59	0	0	0	2	54	3	0	0	2	57	0.62	4.83	↑	No
United States	USA	371	4	2	10	9	332	14	1	0	21	346	1	28.73	↑	No
Uruguay	URY	84	4	0	3	1	66	10	0	0	4	76	1	4.03	↑	No
Uzbekistan	UZB	82	2	1	1	4	67	7	0	0	6	74	–	–		No
Vanuatu	VUT	11	1	0	2	2	6	0	0	0	4	6	0.89	2.96	↓	Yes
Venezuela, RB	VEN	341	30	3	7	22	270	9	1	0	32	279	1	21.9	↓	No
Vietnam	VNM	252	16	9	18	21	177	11	0	0	48	188	1	26.93	↓	No
Virgin Islands (U.S.)	VIR	4	0	0	0	1	3	0	1	0	1	3	–	–		No
West Bank and Gaza	WBG	92	2	0	0	7	78	5	0	0	7	83	1	3.67	↓	No
Yemen, Rep.	YEM	52	1	0	0	2	45	4	2	0	2	49	0.95	–		No
Zambia	ZMB	255	16	1	2	4	222	10	0	0	7	232	1	9.87	↑	No
Zimbabwe	ZWE	216	6	1	1	6	195	7	0	0	8	202	–	–		No

APPENDIX D

Results of model predicting presence and abundance of threatened species by country considering data deficient species (DD) as threatened

Presence of threatened species

The variable selection procedure did not allow obtaining a global minimum adequate model (MAM), since the number of selected variables from categorical models (7 linear; 5 quadratic) was too high for the reduced sample size of countries with none threatened mammals (considering DD species as non-threatened 27 countries had zero threatened species; with DD as threatened that number is reduced to 24). Therefore, we used the selected variables for the model including DD species as non-threatened (Table 1 of the main text) and fitted it for the new set of data to check for coincident results.

This model (Table D1) explains 61.3% of the deviance: 34.2% by control variables and 27.1% by the socioeconomic indicators. Performance measures were satisfactory, but lower than in the conservative model (DD as non-threatened) (sensitivity = 0.950; specificity = 0.759; AUC = 0.967).

Abundance of threatened species

The final MAM (Table D2) includes the same variables as the MAM considering DD species as non-threatened (Table 2 of the main text) and adds three more: population growth (% annual), CO_2 emissions and international expenditures on tourism (% imports). A rapidly growing country, with relatively low CO_2 emissions and extreme (either very low or very high) levels of international tourism expenditures appears also more susceptible to harbor higher numbers of threatened mammals (Fig. D1), which generally agrees with the profile of countries described in the main text.

This model (Table D2) explains 85.3% of the deviance: 77.3% by control variables and 8.0% by socioeconomic indicators. Predictions errors are within a ± 0.33% of total mammal richness per country, with four countries being estimated over this value: Indonesia, Seychelles, New Zealand and Mauritius.

Table D1. Results of the final model exploring the effect of socioeconomic indicators on the probability of presence of threatened mammals by country (N = 162). We report the best coefficient estimate and its standard error [β (SE)] and the mean odds ratio (OR) with the 95% confidence interval (CI) for all variables in the final model.

Variable	β (SE)	OR (95% CI)
Socioeconomic		
Urban population^2	−0.00 (0.001)	1.00 (0.998, 1.001)
Urban population	0.06 (0.118)	1.06 (0.832, 1.332)
Population growth	1.22 (0.570)*	3.40 (1.196, 11.597)
Arable land^2	0.00 (0.002)*	1.00 (1.001, 1.008)
Arable land	−0.24 (0.095)*	0.78 (0.633, 0.929)
Tourism receipts^2	−0.01 (0.002)**	0.99 (0.990, 0.998)
Tourism receipts	0.42 (0148)**	1.53 (1.198, 2.160)
Control		
Total mammals	0.13 (0.037)***	1.14 (1.074, 1.244)
Land area	0.00 (0.000)	1.00 (1.000, 1.000)
Shared mammals	−0.81 (1.638)	0.44 (0.017, 11.033)

^{2}squared-root transformation; ***P < 0.001; **P < 0.01; *P < 0.05.

Table D2. Results of the final model exploring the effect of socioeconomic indicators on the abundance of threatened mammals by country (N = 127). We report the best coefficient estimate and its standard error [β (SE)] for all variables in the final model.

Variable	β (SE)
Socioeconomic	
Urban population	−0.01 (0.003)†
Imports GS	−0.01 (0.004)**
Exports GS	0.01 (0.004)**
Life expectancy^2	−0.00 (0.000)*
Life expectancy	0.16 (0.062)**
Tourism receipts^2	−0.00 (0.000)***
Tourism receipts	0.03 (0.013)*
Tourism expenditures^2	0.00 (0.002)*
Tourism expenditures	−0.08 (0.041)†
Population growth	0.15 (0.054)**
CO_2 emissions	−0.04 (0.014)**
Control	
Total mammals	0.01 (0.000)***
Land area	0.00 (0.000)
Shared mammals	−0.74 (0177)***

^{2}squared-root transformation; ***P < 0.001; **P < 0.01; *P < 0.05, †P < 0.1.

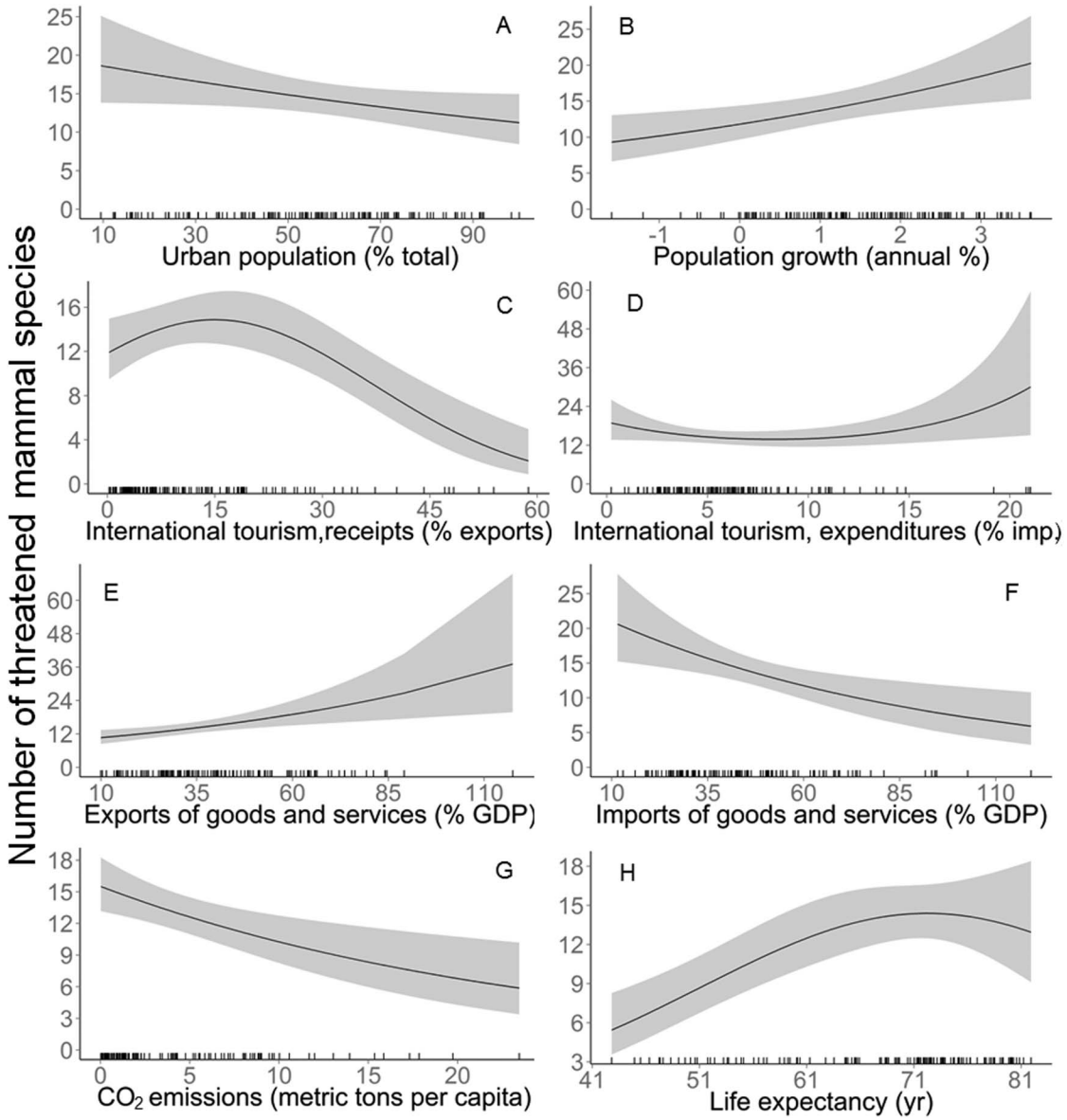

Fig. D1. Predicted relationships between key socioeconomic variables and the abundance of threatened mammals by country (DD species classified as threatened). Model predictions were based on the final model (Table D2) and estimated by exploring the range of observed values for each indicator while using the median observed value for other variables in the model (median values: total mammal richness = 129; land area = 192,530 km^2; percentage of shared species = 0.759; urban population = 55.90%; population growth = 1.32%; international tourism, receipts = 9.18% exports; international tourism, expenditures = 5.43% imports; exports of goods and services = 36.45% GDP; imports of goods and services = 42.64% GDP; CO_2 emissions = 1.872 metric tons per capita; life expectancy = 71.38). Shadowed area represents the confidence intervals (95%). Singapur was removed from graphs E and F to facilitate visualization, given the extremely high values it presents for these two indicators (imports of goods and services (% GDP) = 200.452; exports of goods and services (% GDP) = 228.007). Kuwait was removed from graph G (CO_2 emissions = 35.42 metric tons/capita).

Appendix E

Geographic representation of the estimated values for all variables included in any final model. We show values for all countries with data available on the World Bank database even those not included in the final models (due to missing data on some of the selected variables).

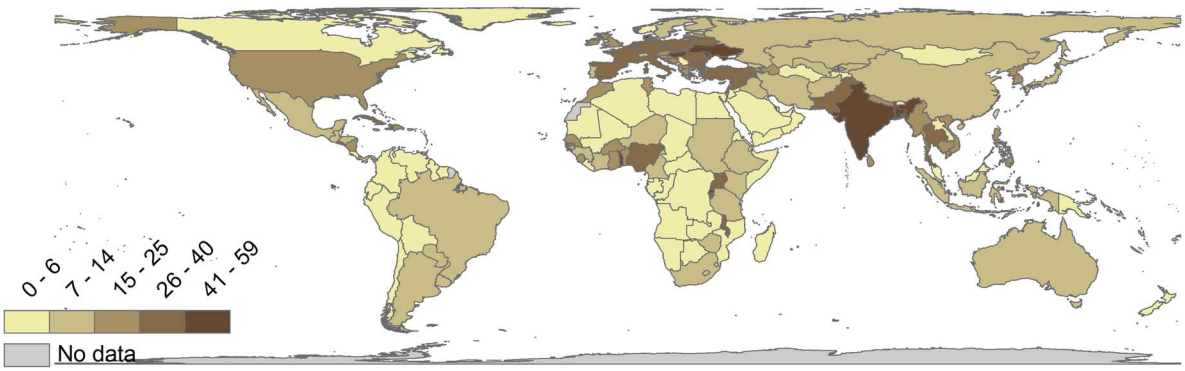

Fig. E1. Arable land (% total land).

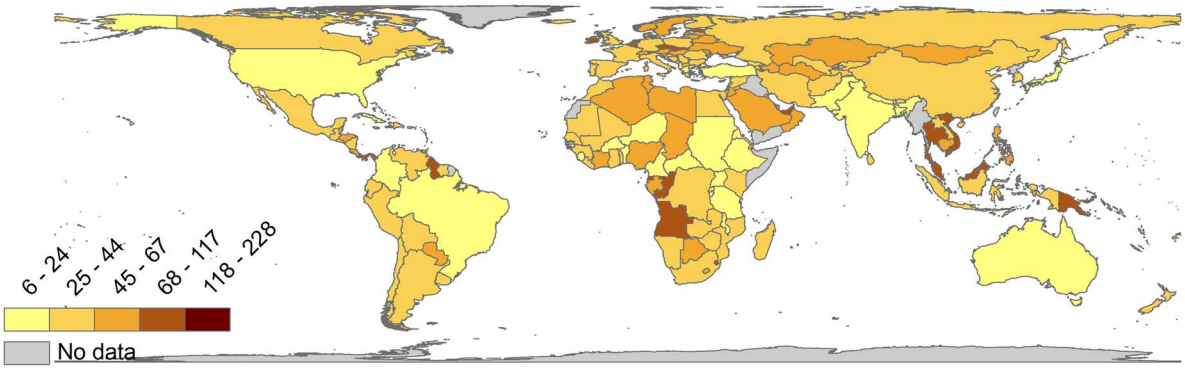

Fig. E2. Exports of goods and services (% GDP).

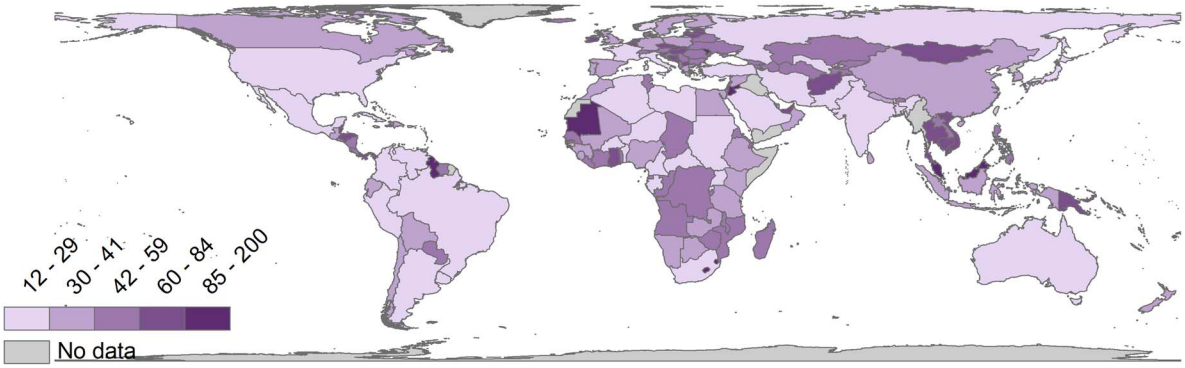

Fig. E3. Imports of goods and services (% GDP).

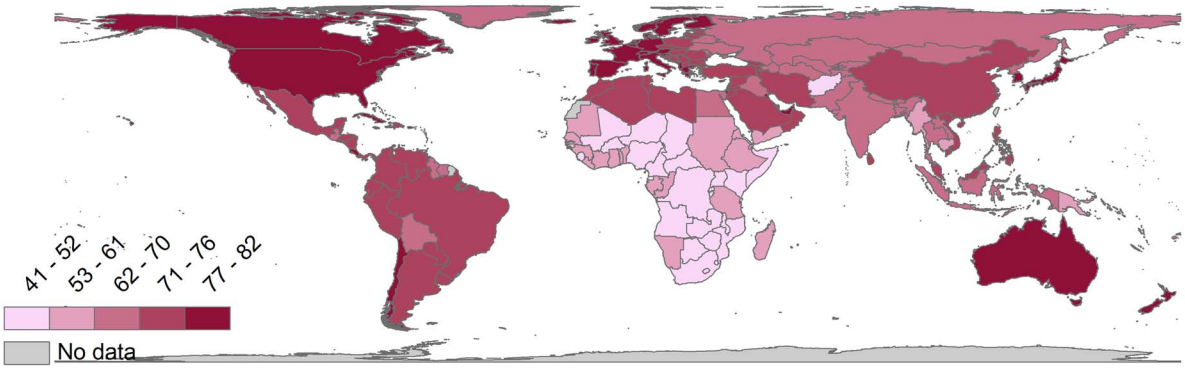

Fig. E4. Life expectancy (years).

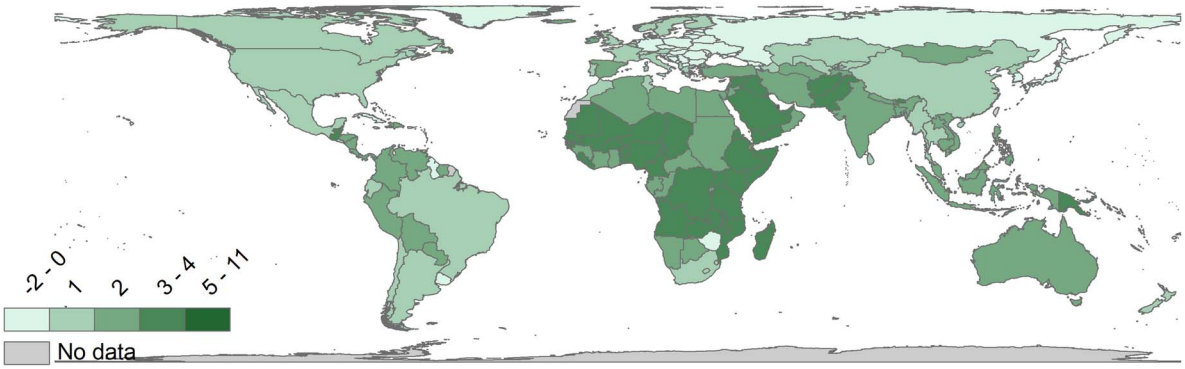

Fig. E5. Population growth (annual %).

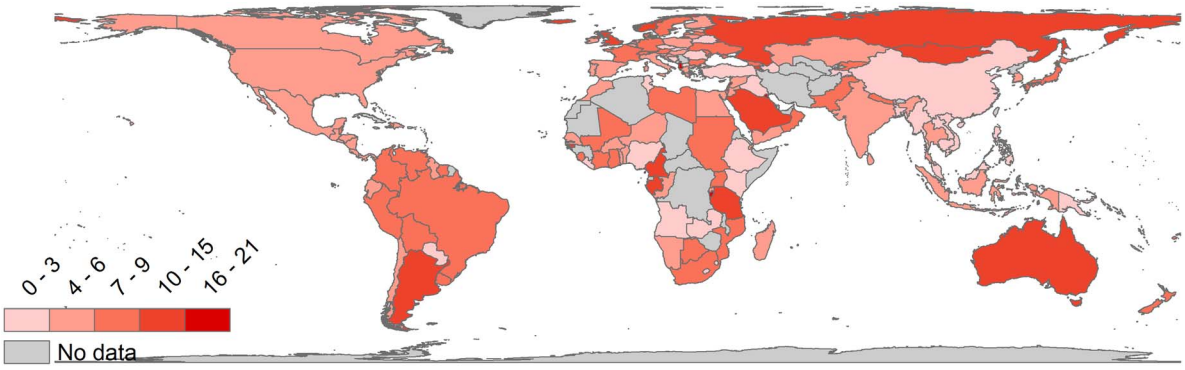

Fig. E6. International tourism, expenditures (% imports).

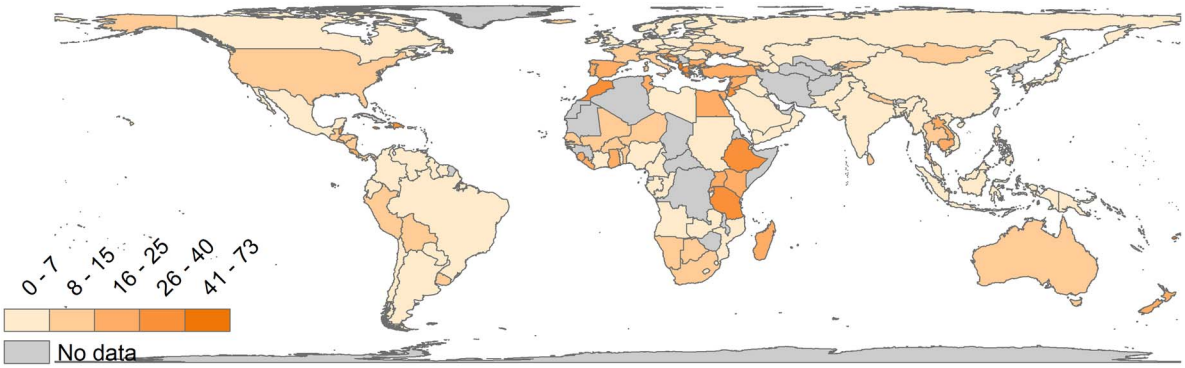

Fig. E7. International tourism, receipts (% exports).

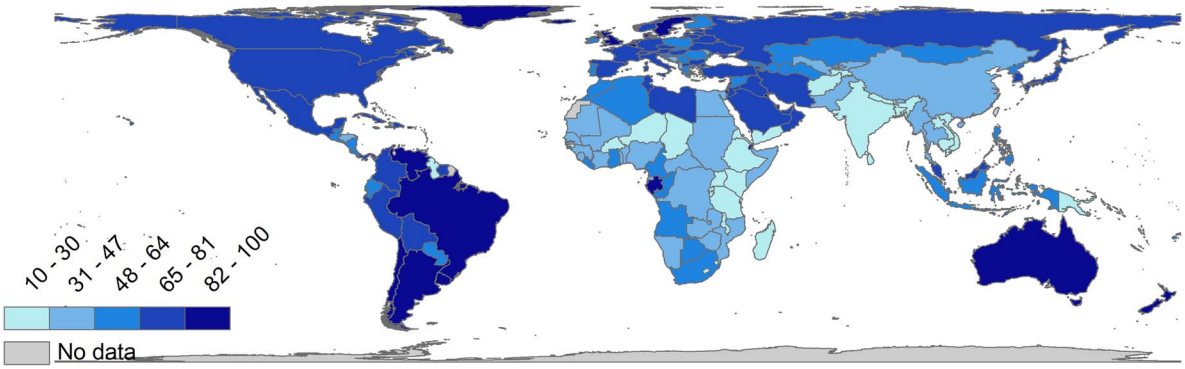

Fig. E8. Urban population (% total).

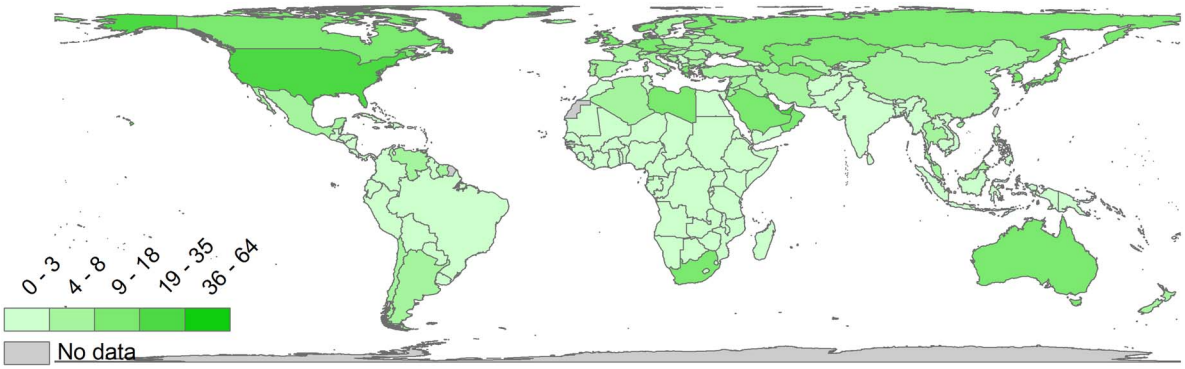

Fig. E9. CO_2 emissions per capita (metric tons per capita).