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Identifying ambassador species for conservation marketing

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A R T I C L E I N F O

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A B S T R A C T

Conservation relies heavily on external funding, much of it from a supportive public. Therefore it is important to know which species are most likely to catalyse such funding. Whilst previous work has looked at the physical attributes that contribute to a species' appeal, no previous studies have tried to examine the extent to which a species' sympatriots might contribute to it's potential as flagship for wider conservation. Therefore, here we estimate ‘flexibility’ and ‘appeal’ scores for all terrestrial mammals (n = 4320) and identify which of these might serve as ambassadors (defined as both highly appealing and flexible). Relatively few mammals (between 240 and 331) emerged as ambassadors, with carnivores featuring heavily in this group (representing 5% of terrestrial mammals but 39% of ambassadors). ‘Top ambassadors’ were defined as those with both flexibility and appeal scores greater than 1 standard deviation above the mean. Less than a quarter of the 20 most endangered and evolutionary distinct species in this study were classed as ambassadors, highlighting the need for surrogate species to catalyse conservation effort in areas with such priority species. This is the first global analysis bringing together flexibility and appeal for all terrestrial mammals, and demonstrates an approach for determining how best to market species in order to achieve maximal conservation gain in a world with urgent conservation need but limited resources.

1. Introduction

Conservation efforts are needed urgently, with ever-increasing threats posed to the world's biodiversity, largely due to anthropogenic factors (Butchart et al., 2010; Dirzo et al., 2014). Addressing threats of this scale will require significant global engagement and funding, running into billions of dollars annually (Lindsey et al., 2016). This will require commitments not only from governments but also from the general public, who are increasingly being empowered to engage with specific political and social issues via the internet and online social media (Macdonald et al., 2016a). Therefore, society's delivery of biodiversity conservation in the future hinges not only on the expertise and priorities of scientists and policymakers, but also

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on the support and engagement of numerous stakeholder groups, including the electronically-connected middle classes who tend to be most open to such engagement (Balmford and Cowling, 2006; Macdonald et al., 2016a). In order to maximise the engagement of that public, and the impact of their support, conservation campaigns should carefully consider which species are likely to be highly appealing to the public.

1.1. Flagship species

The term ‘flagships’ for conservation has been widely discussed in the literature and undergone several reinterpretations (Caro and O'Doherty, 1999; Favreau et al., 2006; Heywood, 1995; Simberloff, 1998). The review of the concept by Verissimo et al. (2011) focuses clearly on the concept's usefulness for conservation marketing. This focus on conservation marketing can be applied at a range of scales, from raising awareness about a region's biodiversity among a local community (Veríssimo et al., 2014) to widespread national and international campaigns that can raise many hundreds of thousands of dollars. Being able to identify which species have the highest potential to act as flagship species is important for the success of these campaigns.

The effectiveness of campaigns depends largely upon public perceptions; from nematodes to gorillas, it is obvious that people do not view all animal species equally (Macdonald et al., 2006) and a growing number of studies is attempting to quantify their preferences. Frequently, the most high profile species are large mammals (Caro and O'Doherty, 1999; Clucas et al., 2008; Johnson et al., 2010; Macdonald et al., 2006; Smith et al., 2012), however it is important to note that while these species may dominate the headlines in the western media, they may not be so highly regarded in other regions where peoples' perceptions and experiences may differ widely (Bowen-Jones and Entwistle, 2002; Douglas and Veríssimo, 2013; Macdonald et al., 2016b). In order for marketing campaigns to be successful it is important to consider both the target audience for the campaign as well as the stated use of the flagship species, for instance the polar bear (*Ursus maritimus*) might represent a good flagship to raise international awareness about the impacts of climate change, but a grey wolf (*Canis lupus*) might not be the optimal flagship amongst the shepherding community for species reintroduction campaigns in the Scottish highlands (Barua et al., 2011; Linnell et al., 2000; Sandom and Macdonald, 2015).

Accounting for stakeholder preferences and the purpose of the flagship, a species' appeal is an important dimension of its potential to lever public support for its conservation and, indeed, for conservation marketing more widely (Kontoleon and Swanson, 2003; Veríssimo et al., 2009). It is possible that different species have certain characteristics that make them more or less likely to be successful flagships. For instance, Macdonald et al. (2015) explored the impact of characteristics such as size, rarity, orientation of eyes etc. on peoples’ preferences for different species in the context of conservation prioritisation and found that these could be used to predict respondent preferences with high reliability.

1.2. Umbrella species

As with the term “flagships”, there are many different interpretations of the term “umbrellas” (Caro, 2010), and loose terminology has hindered debates about the efficacy of the concept. However a common theme among different definitions (and types of umbrella species) is the use of one species (or group of species) to act as a surrogate for the conservation of other “background” species through their association with viable populations, protected areas or management actions (Caro, 2010). The efficacy of “umbrella” species is hotly debated in the conservation literature with some studies casting doubt on the ability of one species (or group of species) to act as surrogates for another (Roberge and Angelstam, 2004) while others find support for the idea (Branton and Richardson, 2011; Burnham et al., 2012; Fleishman et al., 2000). Recently, Di Minin and Moilanen (2014) and Di Minin et al. (2016) have shown that inclusion of charismatic flagship species can improve surrogacy strategies, and explored the capacity of Carnivores to act as surrogates for a wide range of birds, mammals, amphibians, reptiles and ecoregions. These species that combine the marketing characteristics of flagship species, and the ecological benefits of umbrella species have been termed “flagship umbrella species” (Caro, 2010) and have been considered in the context of both forest and marine conservation (e.g. (Dinerstein et al., 2010; Oviedo and Solís, 2008)).

However, a species' ability to act as a flagship-umbrella for other species is not confined to its capacity to facilitate the delivery of effective conservation on the ground. Some species may be appropriate flagships for a wide range of conservation and environmental issues, while others may be effective only in certain circumstances. In a study of how international conservation NGOs used threatened mammal species as flagship species, Smith et al. (2012) found that only a small proportion of campaigns raised funds for broader campaigns, and echoed concerns about how the flagship approach has focused funds towards a small number of species (Joseph et al., 2011); it is therefore important that they “*broaden the conservation benefits of their fundraising*”. NGOs can achieve this in several ways, for instance if a campaign raises more than a specified amount then the excess can be spent on different projects, or by using traditional flagship campaigns to secure new donors who can subsequently be approached to fund broader projects (Smith et al., 2010). Other approaches to broadening conservation fundraising have included strategies such as “biodiversity hotspots” (Myers et al., 2000) or clearly costed prioritisation strategies (Joseph et al., 2009, 2011) however while these approaches may offer a more nuanced approach to conservation prioritisation they may also lack the clear and charismatic message of conventional flagship campaigns. We therefore suggest that considering a species' “flexibility” in terms of its ability to act as a flagship for a wide number of other species. Under the appropriate circumstances, wide ranging species may have the ability to act as flagships for a wider range of issues and species. In this sense, a species’ ability as a flagship may be judged both on the appeal to the target audience of its physical and or cultural characteristics, but it may also be judged on its ability to act as a marketing flagship for a wide range of other less charismatic species.

Here, we estimate the flexibility (representing the distinctiveness and level of threat of sympatric species) and appeal (extrapolated from published charisma scores (Macdonald et al., 2015)) of 4320 terrestrial mammal species.

Species which emerge as likely to be highly appealing and highly flexible are termed ‘ambassador species’, this designation sits within the context of flagship species and reflect one element of a species' usefulness in the context of conservation marketing. This analysis is the first to suggest that a species' potential usefulness as a flagship for conservation campaign could be given added value by its ability to act as a marketing surrogate for a large number of high priority species. This analysis could inform future conservation marketing campaigns to fund conservation efforts in locations for which a charismatic species could be selected to act as flagship-umbrellas for the rest of the region's biodiversity. Such campaigns can rapidly spread through online sites and social media should they grab the attention of the general public, as evidenced by the Cecil the Lion phenomenon (Macdonald et al., 2016a).

We have selected terrestrial mammals for this first exploration of ambassador species, not only because mammals already feature conspicuously in the public's wider imagination but specifically because our earlier quantification of charisma (Macdonald et al., 2015) provides a unique opportunity to make a quantitative extrapolation to the entire taxon. The results of this study reveal not only which species are likely to generate most attention and added-value to a conservation campaign (ambassadors), but also how best to capitalise on the individual strengths of different species in the arena of conservation marketing.

2. Methods

2.1. Flexibility scores

In order to identify the extent to which a species might act as a flagship species for other mammals, we estimated a flexibility score for each species. This score was inspired by the External Threat Index developed by Cardillo et al. (2005), which represents the level of threat within a species’ distribution. The flexibility score is calculated for a given species *m1* as:

$$F_{m1} = (\%RO_{m2} * EDGE_{m2}) + (\%RO_{m3} * EDGE_{m3}) \ldots\ldots\ldots + (\%RO_{mn} * EDGE_{mn})$$

Where $\%RO_{m2}$, is the percentage of the range overlap (*%RO*) with other mammal species (m2, m3 etc.), multiplied by the EDGE (Evolutionarily Distinct and Globally Endangered; Isaac et al., 2007) score of each of those species. EDGE scores were used in order to account for both endangerment and phylogenetic diversity as measures of conservation value. Species *m1* may have a high flexibility either by overlapping with many less endangered and/or distinct species, or fewer more endangered and/or distinct species.

EDGE scores were obtained from EDGE of Existence (EDGE of Existence, 2013; Isaac et al., 2007). Range maps were obtained from the IUCN Red List (IUCN, 2010). Any part of a species range that was the result of a species introduction was removed, as were any parts of a range where the species was not believed to be extant (those classed by IUCN as extinct, possibly extinct, possibly extant and presence uncertain).

In their paper (Isaac et al., 2007) use the equation “$EDGE = ln(1 + ED) + GE * ln(2)$” (where ED indicates a score for evolutionary distinctiveness and GE is a score for global endangerment based on IUCN redlist categories) and state that “*EDGE scores are therefore equivalent to a loge-transformation of the species-specific expected loss of evolutionary history in which each increment of Red List category represents a doubling (eln(2)) of extinction risk.*” We feel that it is worth pointing out that the EDGE equation, as written by Isaac, does not result in a doubling of extinction risk with each increment of red list category, rather each increment of red list category results in a uniform increase of (ln(2) =) 0.69 with each increment of red list category. This could be solved by either using the equation “$ln(EDGE) = ln(1 + ED) + GE * ln(2)$” or by simply doubling the score given to each IUCN category (e.g. 1,2,4,8,16 as in (Dickman et al., 2015)). In any case, the specifics of the equation do not have significant implications for this paper and we chose to use EDGE scores as they remain a widely used and interesting approach to assessing conservation priority of species. It is also worth noting that Evolutionary Distinctiveness component of EDGE scores do not take account of complementarity of evolutionary history, and so, under EDGE, the conservation of two closely related species might be weighted equally to the conservation of two distantly related species, even if the latter might lead to a greater contribution to the conservation global genetic diversity.

Range maps were rasterised at a cell size of 5 min (approximately 9 km × 9 km at the equator) using packages ‘raster’ and ‘rgdal’ in R (version 2.13.1). This resolution was selected to balance the twin goals of computational expediency, and the desire to use the finest resolution possible. The degree of overlap between each individual terrestrial mammal species was computed by building a matrix of presence/absence counts for each terrestrial mammal species in every grid cell globally.

It is important to note that this metric of flexibility is designed to highlight the number and the EDGE scores of other species overlapped sympatrically across the entirety of a particular species’ range. We selected this metric in the context of marketing for conservation, because a species that overlaps a great many other species across its range has the potential to act as flagship for all of those species. Obviously, species with large spatial distributions have a greater opportunity to overlap with a greater number of more endangered or phylogenetically distinct species, but we felt that this approach was justified because these species have greater potential to act as flagships for a wide array of species than do range restricted species.

For the purposes of presenting the results, the flexibility scores were converted into standardised z-scores.

2.2. Appeal scores

Macdonald et al. (2015) employed a market research approach to identify which species, from a sample of 100 terrestrial mammals, people preferred for conservation. Over 1500 participants from five English-speaking countries across five continents (Australia, India, South Africa, UK and the USA) were presented with photos of different species in a paired test, and asked to express their preference in the context of conservation. The prevalence of online donations is increasing and so to reflect this respondents were surveyed using an online survey, and in order to reflect our interest in broad based international conservation campaigns, this was targeted towards moderately affluent, computer-literate individuals; who we felt were most likely to either donate to or be members of conservation organisations. This group of stakeholders also has the additional benefit of being comparatively easy to reach by online surveys (full details of the survey and respondent demographics can be found in Macdonald et al. (2015)).

Here, we used the same dataset of survey responses and identified a core set of attributes that could be extrapolated to all mammal species, as they were either widely available from international databases or were readily generalised at a taxonomic level. These attributes were IUCN status, body size, eye position and human threat, all of which were shown to be important in influencing peoples' preferences (they had high relative variable importance values and featured in all or almost all top models) in Macdonald et al. (2015).

Following Macdonald et al. (2015) we used an information-theoretic approach to compare models that related the various attributes to the average preference scores for each mammal accrued. The full model included IUCN status, body size, eye position and human threat, and the 'dredge' function of the 'MuMIn' function in R Version 3.0.3 was used to generate a set of candidate models with combinations of the terms in the full model. Candidate models were evaluated by comparing differences in their second-order Akaike Information Criterion (AIC_C) values and Akaike weights (ω_i).

Data collected from respondents in five countries in five continents (Australia, India, South Africa, UK, USA) were analysed collectively (all countries) and then separate full models were tested for each country's respondents in turn, as Macdonald et al. (2015) found that preference for mammals varied between respondents of different nationalities.

For each country the best performing model was identified, and the model averaged parameter estimates for each attribute (IUCN status, body size, eye position and human threat) were summed to calculate an appeal score for each of the 4320 terrestrial mammals with sufficient available data.

For the purposes of presenting the results, the appeal scores were converted into standardised z-scores.

2.3. Ambassador scores

Taking the standardised z-scores for flexibility and appeal, we define 'ambassadors' as those species that had above-mean scores for both metrics. 'Top ambassadors' were defined as those species where both the standardised flexibility and appeal scores were more than 1 standard deviation above the mean.

3. Results

3.1. Flexibility scores

The house mouse (*Mus musculus*) emerged as the species with the highest flexibility score, with its vast distribution overlapping at least part of the ranges of 1744 other mammal species (Table S1). The puma (*Puma concolor*) was the second most flexible species, overlapping 1422 species, followed by the common vampire bat (*Desmodus rotundus*) and the leopard (*Panthera pardus*). Interestingly, while having the 4th highest flexibility score, the leopard overlapped with the second largest number of other species (1701). Wide-ranging bats were disproportionately represented in the 20 most flexible species, comprising 60% of those species despite bats representing only around 20% of mammals ($p < 0.001$; hypergeometric probability distribution). Carnivores are also disproportionately represented among the most flexible species, making up 20% of the top 20 (including two of the top four) compared to only 5% in the overall sample ($p = 0.019$; hypergeometric probability distribution). On average, species overlapped with 250 other mammals, and only around a quarter of species examined ($n = 1140$, 26.4%) had above-mean flexibility scores. 43 of the species we examined overlapped with no other species at the scale of our analysis so had flexibility scores of zero, while coincidentally 43 species overlapped at least 1000 species (Table S1 supplementary information). Range restricted species, with little opportunity to overlap with many species, perform poorly on our flexibility metric, as evidenced by the island-dwelling, endemic Hershkovitz's Grass Mouse (*Abrothrix hershkovitzi*), which was the lowest-scoring mammal amongst those which exhibited any degree of overlap with other species.

3.2. Appeal scores

In all cases the full model, containing all four variables, was the best performing model, we therefore consider the effect of all four variables across each country. In general, both within and across countries, survey respondents had a preference for large species, with a high threat level, forward facing eyes, and that were potentially threatening to humans. However, it is interesting to note that in some cases the specific pattern of preferences diverged from our prior expectations (Fig. 1). For instance respondents in Australia, rather than simply preferring larger mammals, seemed to prefer species in the 1–20 kg size classes over those in the 20–40 kg class, and to prefer species in the 40–100 kg size class over those weighing between 100 and 800 kg. When we consider all countries combined, the trend was a preference for larger mammals, but species in the size range of a family pet (1–40 kg) were favoured slightly more than the next largest size class. Similarly, while in general the survey respondents preferred more threatened mammals, in the USA respondents appeared not to differentiate strongly between vulnerable and endangered species, but did show a strong preference for critically endangered species.

Combining the preference scores for each attribute of each species revealed that the Asian elephant (*Loxodonta maximus*) and the Indian water buffalo (*Bubalus arnee*) emerged as the joint highest scoring species in terms of appeal in Australia, South Africa, the UK, the USA, and all countries combined (Table S1), while the tiger (*Panthera tigris*) ranked top in India. Some species achieved consistently high appeal scores across countries – for example, 12 species occurred in the top 20 of all countries. Of these 12, eight were mega-mammals of the Cetardiodactyla, Proboscidea and Perissodactyla with their appeal primarily driven by their large size, while the remaining four were all large Carnivores (3 Asiatic bear species and the tiger). However, other species appeared much more variable in their appeal scores between countries: both the black bear (*Ursus americanus*) and brown bear (*Ursus arctos*) occurred in the top 20 in India and the USA, but were ranked joint 845th in Australia.

In general, approximately a third of mammal species were estimated to have above-mean appeal in each country (AUS = 36.4%, IND = 37.4%, RSA = 37.8%, GBR = 32.7%, USA = 37.8%, all = 37.4%; Fig. 3). When comparing the estimated appeal scores for each species with the actual survey responses from respondents, we found that the two measures showed strong agreement with R^2 values in excess of 60% in most countries (R^2: Aus: 60.7%, Ind 61.2%, RSA: 66.1%, UK: 58.2%, USA: 48.5%, All countries: 58.1%, Fig. 2). While these relatively appealing species are likely to be more popular with the kind of people usually targeted by conservation campaigns than those species with lower scores, it is unlikely that the mean represents the tipping-

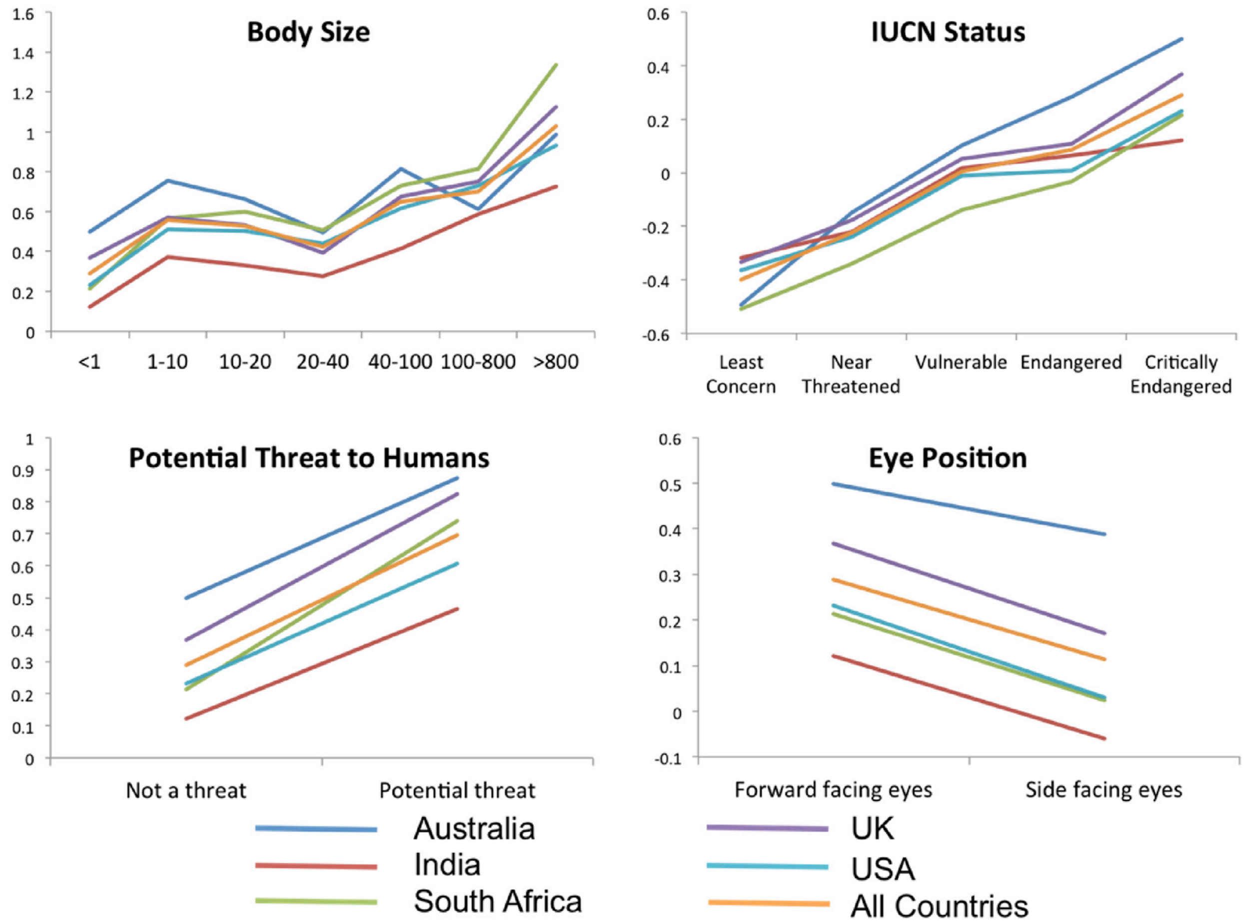

Fig. 1. Model averaged parameter estimates for each variable. Appeal scores for each species are generated by summing the appropriate parameter estimates for each variable.

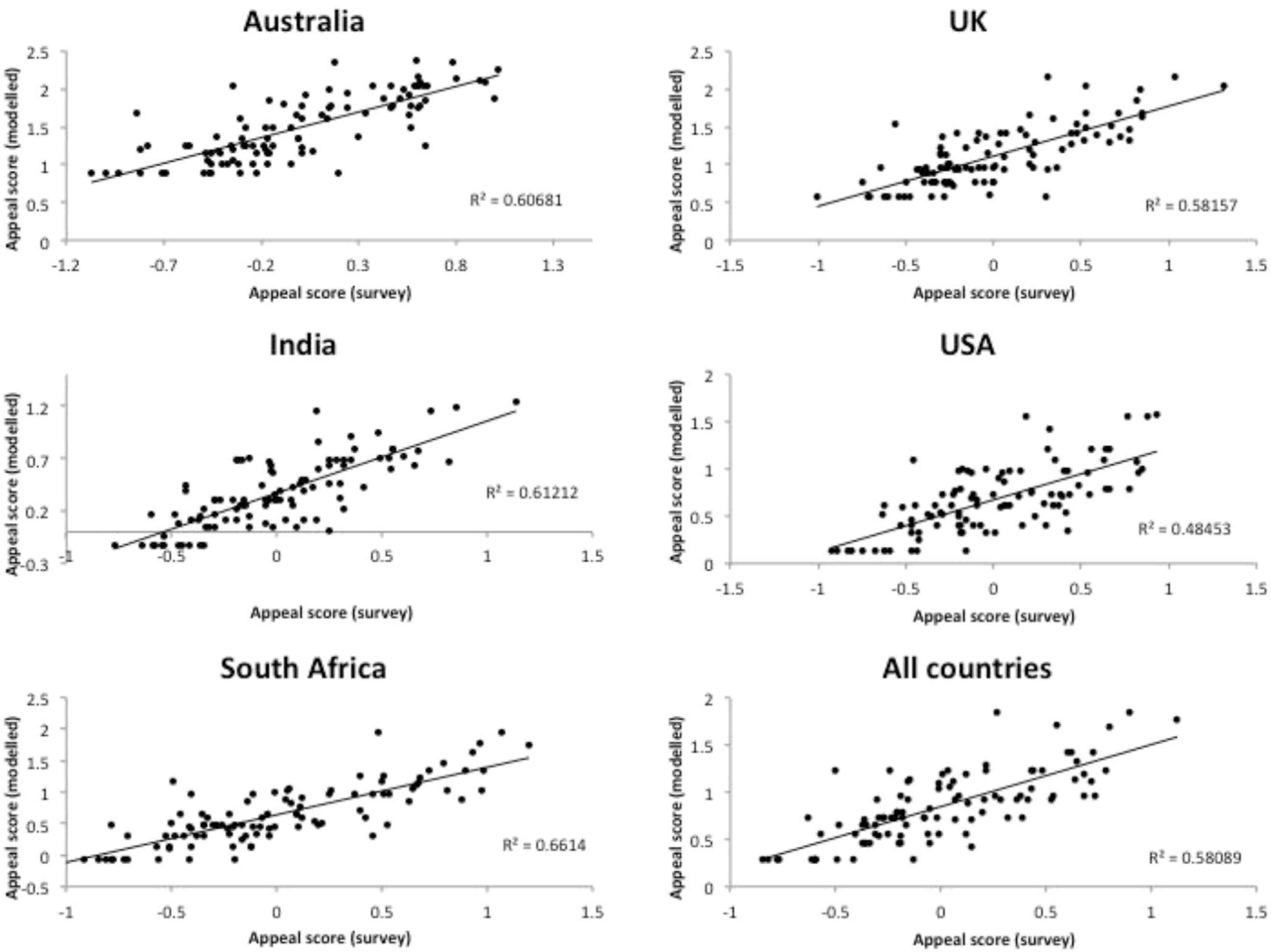

Fig. 2. Plots of modelled appeal scores vs direct survey responses from (Macdonald et al., 2015).

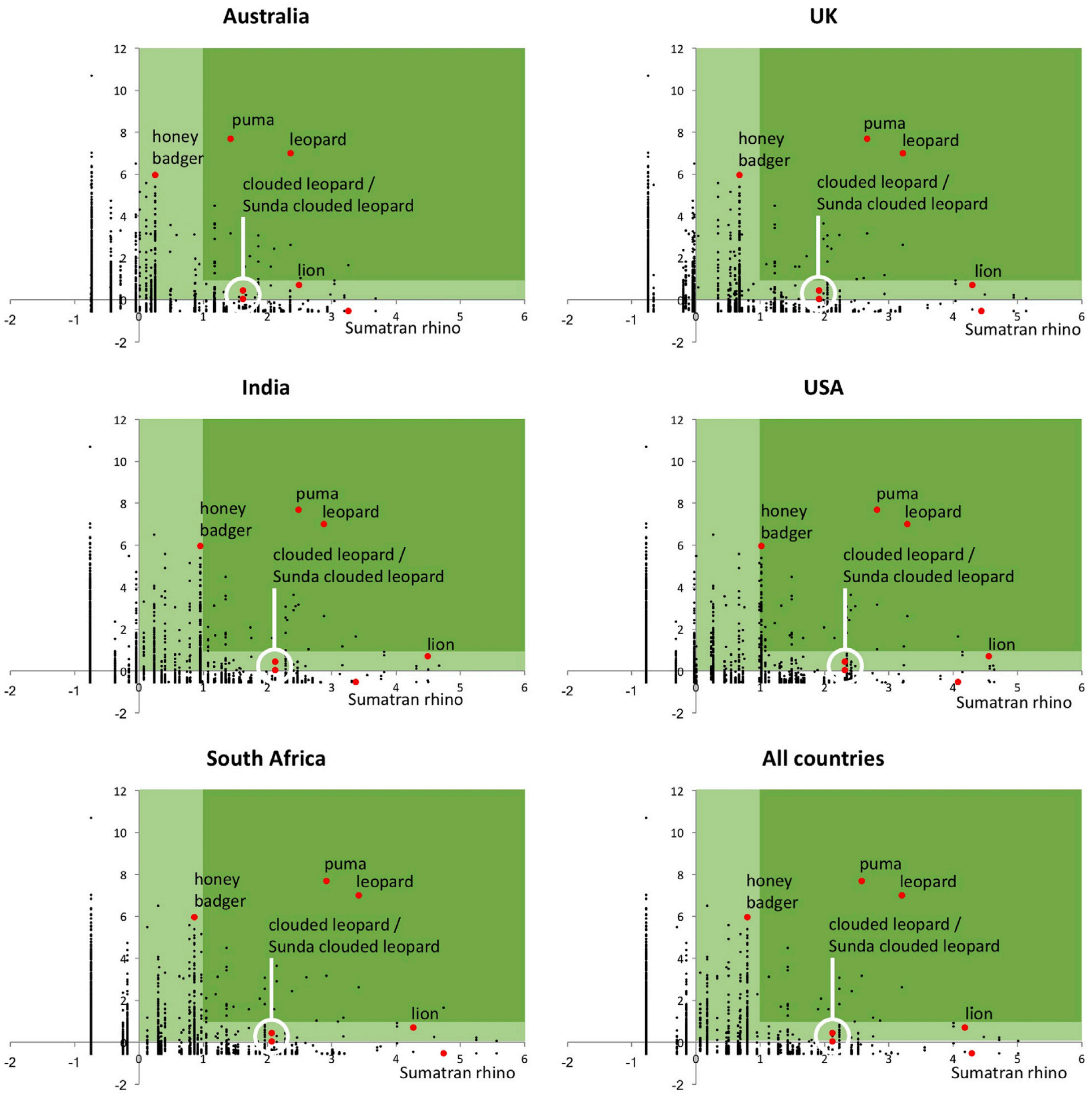

Fig. 3. The distribution of species on the axes of standardised appeal and standardised flexibility scores for each country. Appeal scores are shown on the x axis while flexibility scores are shown on the y axis; ambassador species are shaded in light green while top ambassador species are shaded in dark green. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

point of public enthusiasm. The 'top ambassador' species, which have particularly high appeal scores, may represent a more likely subset of species with which to engage the public.

3.3. Identifying ambassador and top ambassador species

Plotting flexibility and appeal scores revealed 331 potential ambassador species when using data from all countries combined. When we examined respondents from each country separately we found 256 'ambassador' species according to Australian respondents, 331 from respondents in India, 338 from South Africans, 240 from people in the UK, and 338 from those surveyed in the USA. In each country, only a very small group of species reached the criteria of being "top ambassadors", having both flexibility and appeal scores more than 1 standard deviation above the mean (Australia 23, India 32, South Africa 33, UK 26, USA 77, all countries 27; Fig. 3).

Carnivores were also particularly well represented as top ambassadors. Over 50% of all top ambassadors were Carnivores (Australia 69.6%, India 56.3%, South Africa 57.6%, UK 69.2%, USA 76.6%, all countries 66.7%), despite them only representing 5% of the sample, in all cases this is significantly more than would have been expected at random (in all cases $p < 0.001$; hypergeometric probability distribution). The puma (*Puma concolor*) was the highest ranking ambassador species from the Indian, South African, UK and USA surveys, as well as across all countries combined. The puma was the second highest ranked species from the Australian survey, while the leopard (*Panthera pardus*) was the top ranking ambassador species from the Australian respondents and ranked 2nd across the remaining countries. Both species had high flexibility scores, with their wide ranges overlapping not only a large number of species (puma: 1442, leopard: 1701), but also a large overlap with species with high EDGE scores. Both species also showed high appeal scores, with the leopard ranked in the top 50 species by respondents from all countries apart from Australia: among USA respondents it was 16th, UK and South African respondents both ranked it 17th as did all respondents combined, while Indians ranked it 22nd and Australians 78th. Similarly, the puma was ranked in the top 100 species by respondents from all countries apart from Australia (rankings were 26th in USA, 73rd in UK and South Africa, 82nd in South Africa and 490th in Australia, 29th in all countries; Fig. 3).

Ambassador species have the potential to be used as surrogates for large numbers of other valuable species in conservation marketing campaigns. Mammals identified as ambassadors from the UK survey overlapped with the highest number of other species on average (543.9), and even ambassadors identified by South African and USA respondents (which overlapped fewest species) overlapped with an average of 530 species.

In general, the species identified as potential ambassador species were not necessarily high conservation value species in their own right. Only between 16.6% (SA and USA) and 23.3% (UK) of ambassador species were considered threatened by the IUCN in comparison to between 73.2% (AUS) to 82.1% (UK) of species with above average appeal and below average flexibility (representing 23.6% of all mammals in our sample). Similarly, between 23.1 (SA and USA) and 28.9% (IND) of ambassador species were in the top quartile of EDGE scores.

Summary data for each country can be seen in Table 1, while full data for each of the 4320 species is available in the supplementary material.

4. Discussion

Worldwide, people are usually biased in terms of the species that they favour for conservation, and these biases are often influenced by both the attributes of the focal species (Macdonald et al., 2015; Veríssimo et al., 2009) as well as their cultural and experiential backgrounds (Bowen-Jones and Entwistle, 2002; Takahashi et al., 2012). Conservation marketers should therefore seek to design targeted conservation campaigns tailored to the specific stakeholder group, and appropriate to the conservation issue at hand (Barua et al., 2011). However, only a tiny proportion of the world's species are sufficiently charismatic to catch the public's attention (in this context, by 'public' we specifically refer to the politically engaged middle class likely to respond to conservation campaigns, and targeted by the survey of (Macdonald et al., 2015)), and flagship species therefore need to act not only as emblems for particular issues, but also have the potential to act as flagships for other less appealing species. While the majority of current conservation marketing campaigns seek to raise funds directly for the flagship species, 39% of campaigns either sought to raise funds for broader issues, or for the NGO itself (Smith et al., 2012). Under these circumstances it is reasonable to assume that a species would be better positioned to act as a flagship for its

Table 1
Summary data for each category in each country.

		Number of species	Proportion considered threatened by ICUN	Mean EDGE score	Proportion of species in the top quartile of EDGE scores	Mean number of species intersected	Mean z.flexibility score	Mean z.appeal score
Australia	Top Ambassador	23	52.17	3.56	56.52	783.65	2.81	1.69
	Ambassador	256	21.88	2.89	28.91	524.09	1.29	0.68
	Other	4064	23.70	2.72	24.75	233.13	−0.08	−0.04
India	Top Ambassador	32	40.63	3.34	43.75	764.53	2.53	1.91
	Ambassador	331	16.92	2.76	23.26	531.87	1.29	0.96
	Other	3989	24.14	2.73	25.14	227.01	−0.11	−0.08
South Africa	Top Ambassador	33	39.39	3.35	45.45	771.55	2.52	1.97
	Ambassador	338	16.57	2.75	23.08	530.37	1.28	0.98
	Other	3982	24.18	2.73	25.16	226.61	−0.11	−0.08
UK	Top Ambassador	26	46.15	3.47	50.00	776.81	2.71	2.03
	Ambassador	240	23.33	2.84	26.67	543.90	1.36	1.06
	Other	4080	23.60	2.73	24.90	233.11	−0.08	−0.06
USA	Top Ambassador	77	16.88	2.83	23.38	754.87	2.63	1.45
	Ambassador	338	16.57	2.75	23.08	530.37	1.28	1.03
	Other	3982	24.18	2.73	25.16	226.61	−0.11	−0.09
All countries	Top Ambassador	27	48.15	3.52	51.85	778.33	2.73	2.13
	Ambassador	331	16.92	2.76	23.26	531.87	1.29	0.91
	Other	3989	24.14	2.73	25.14	227.01	−0.11	−0.08

sympatriots than for distant species, additionally, it is reasonable to assume that species that exist in regions of high biodiversity might receive a small boost to their marketability from the high conservation priority of their environment. In this paper we propose that conservation marketers could increase the impact and flexibility of their flagship species by considering their ability to act as ambassadors for the wider community of sympatric species, and we feel that this could benefit a large number of campaigns.

Our analysis allows us to plot 4320 terrestrial mammal species against two axes, their appeal, and their flexibility (a measure of the level of threat and endemism within a species' range; Fig. 3). The ambassador concept builds on the definition of "flagship umbrella" species (Caro, 2010) to consider the potential of certain species to act as flagships for their wider community of sympatric species.

This study represents the first time so many mammals have been given comparable appeal scores based on systematic analysis of key attributes that make species attractive. We used survey data from 5 English-speaking countries, and here we present the results from each country separately in order to highlight how small differences in attitudes between different countries affects our results, we also present the results of all countries combined. Given the huge potential heterogeneity of attitudes found in a large political unit such as a country, we acknowledge it is unlikely that our country-level appeal scores are totally representative of all Australians, Indians etc., but our approach did target a broad section of society, and therefore can reveal species that could be used as emblems of broad based conservation campaigns. Furthermore, despite the differences in appeal between the five countries we surveyed, there were still clear trends that held true when we considered the respondents' scores for all countries combined. As such, the ambassador species we identified, and particularly the top ambassadors, are strong candidates for international marketing campaigns to garner support for underfunded conservation efforts. Conducting the survey online may bias the respondents towards affluence but may also increase the likelihood that they were politically engaged and able to exert political leverage regarding environmental matters (Macdonald et al., 2015). The results may not necessarily be representative of the attitudes of all potential stakeholders within each country, and they could certainly be improved with more detailed local analyses, but we feel that they are sufficiently robust to be a useful guide to conservation marketers.

In this study we used spatial data on species ranges from the IUCN (IUCN, 2010), and their endangerment and evolutionary distinctiveness from the EDGE index (Isaac et al., 2007). Both of these databases attempt to offer global coverage, and consequently both have limitations. For example the IUCN database simply provides binary data about a species' supposed distribution and has been frequently criticised for introducing both omission and commission errors (Rondinini et al., 2006). These errors have important implications for conservation planning and prioritisation, however the IUCN maps remain widely used and these omission and commission errors do not have significant implications for this analysis where we are not highlighting the specific areas that should be prioritized for conservation but are simply attempting to highlight an additional consideration for conservation marketers who are using species as flagships for conservation at broad scales. Similarly, the EDGE database produces just one of many potential measures for assessing a species' conservation priority, referring to both their endangerment and their evolutionary distinctiveness.

Our approach is global and we hope to provide food for thought for readers considering what attributes might make a species a useful flagship for conservation, however we acknowledge that the scale of our analysis necessarily means that it cannot capture fine scale local intricacies, and cultural variations in peoples' preferences. Nevertheless we consider that the broad trends remain interesting and robust.

4.1. Flexibility

The flexibility score, calculated for each species, is a measure of how many other sympatric species fall within its range, the extent of that range overlap, and the significance of those sympatric species in terms of endangerment and phylogenetic distinctiveness. High-flexibility species tended to be wide ranging habitat generalists that are able to survive in a range of habitats. The house mouse (*Mus musculus*) had the highest flexibility score, living almost everywhere that people have transported it, but clearly the house mouse is far from a symbol of conservation (and no amount of "education" or marketing spin is likely to make it one, although see (Veríssimo et al., 2017)). This illustrates the point that to qualify as an ambassador species requires a combination of attributes, hence our combination of both flexibility and appeal.

Of course, a good ambassador species should have the potential to represent all biodiversity, and not just terrestrial mammals, however extending the flexibility scores beyond mammals was beyond the scope of this analysis. Even so, it is important to note that the most flexible species in our analysis tend to be those that range widely across a diverse variety of ecosystems, it is therefore not unreasonable to assume that these species might also have the potential to act as ambassadors for the many non-mammalian species that also occur in these areas.

4.2. Appeal

Using the same dataset of survey responses as Macdonald et al. (2015) we estimate appeal for all terrestrial mammals. Following previous studies that have highlighted cultural differences in stakeholder attitudes (Bowen-Jones and Entwistle, 2002), Macdonald et al. (2015) found that analysing data from each country separately produced more robust results than treating all respondents as a single cohesive group. We therefore calculated appeal scores for all mammals based on the separate models from each country.

Overall all countries showed a similar broad trend in terms of the parameter estimates for each attribute (Fig. 1). Large, rare species with forward facing eyes and that posed a potential threat to humans had the highest appeal across all countries, and thus some species ranked consistently highly (e.g. Indian elephant and tiger), while appeal for species such as the polar bear appeared much more variable – in this case driven by Australia's uniquely low preference for species weighing between 100 and 800 kg. Interestingly, species in the 20–40 kg size range showed an unexpected dip in appeal across the all regions. R^2 values comparing the predicted appeal scores with those derived from actual survey responses were generally in the region of 60% (with only the USA exhibiting an R^2 below 50%) showing how a simple set of just 4 variables can provide robust broad scale predictions of species appeal. However, the remaining 40% of unexplained variability highlights the extent of fine scale variability in stakeholder attitudes – readers should therefore be cautious of making predictions at too fine a scale on the basis of these data.

4.3. Ambassadors

Variation in appeal scores resulted in a different suite of mammals being identified as ambassador species in each country, however certain trends are apparent. Firstly wide-ranging Carnivores are disproportionately represented among top ambassador species – unsurprisingly this supports (Macdonald et al., 2015) who found felids to be particularly popular, but is also in line with the many private companies that use large Carnivores as an emblem (e.g. Jaguar cars, Puma sports apparel, Tiger beer etc.). What is more interesting is that these species combine this high appeal with high flexibility scores, reflecting an unusually high degree of threat within their distributions.

Interestingly however, ambassador species do not necessarily have to be of high conservation priority themselves. Between 16 and 22% of ambassador species are considered threatened by the IUCN – this is similar to the IUCN 2015 Red List ‘best estimate’ that 26% of mammals globally are threatened. This was markedly different from those species with high appeal but low flexibility – around 70% of those were threatened, however these species may have less flexibility to act as flagships for other species within their range. Although conservation campaigns often focus on critically endangered species, such as the saola (*Pseudoryx ngehtinhensis*) or Western gorilla (*Gorilla gorilla*) and threat status is undoubtedly a strong component in a species' appeal, our results suggest that conservation marketers should not confine their efforts to these species alone.

5. Conclusions

This study is a first attempt to highlight a link between a species’ appeal, and their ability to act as flagship species for the potentially diverse species with which they co-occur. In this paper we build on the work of previous authors (Caro, 2010; Lorimer, 2007; Macdonald et al., 2015; Veríssimo and McKinley, 2016) and propose that species that occur in areas of high conservation priority may present added value in terms of their potential for conservation marketing. In addition to their native appeal, these species may be more marketable as a result of them living in diverse and biologically important regions.

We attempt to capture this relationship by plotting 4320 terrestrial mammal species on two axes, of appeal and flexibility and develop a unique categorisation for mammals on the basis of these two metrics such that species with high appeal and high flexibility scores are termed ambassador species to reflect the idea that these species may be effective at generating attention for wider biodiversity within their distribution.

We find that Carnivores are disproportionally likely to be classified as ambassador species, but that ambassador species are not necessarily high value conservation species themselves. While rarity is frequently a contributor to a species’ appeal (Courchamp et al., 2006; Macdonald et al., 2015), this result highlights how conservation marketers could widen their net in order to identify a wider variety of potential flagship species. In contrast, species with high appeal but low flexibility were disproportionately likely to be classified as threatened by the IUCN. This is potentially a result of the fact that range restricted species are more vulnerable to exogenous threats while at the same time they are less likely to occur with a large number of sympatric species. These species are therefore more likely to be useful emblems for conservation marketing campaigns targeting broader global issues and highlights how different approaches to conservation marketing might apply to the different categories of species.

We propose that in a world that is increasingly interconnected and influenced by viral marketing campaigns, that this new approach sheds fresh light on how species might best be marketed for conservation.

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Appendix A. Supplementary data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.gecco.2017.11.006.

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