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RESEARCH ARTICLE

Does animal charisma influence conservation funding for vertebrate species under the US Endangered Species Act?

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Abstract
The US federal government spent 6 billion dollars to protect endangered species in 2013. The previous studies have shown that federal funding allocated under the Endangered Species Act is not necessarily based on the priority a species has been assigned by the Fish and Wildlife Service. This paper asks whether this continues to be the case using more recent data from 2013. It analyzes what factors affect total species funding by various federal agencies under the Endangered Species Act, and particularly examines the role of animal charisma using the number of Google results per species as a proxy. Results show that, while federal priority ranking had no effect on funding, charisma had a significant effect, suggesting biased funding for some species of animals.

Keywords Charisma · Endangered species · Funding · Value · Priority rank

Abbreviations
ESA Endangered Species Act
FWS Fish and Wildlife Service
NOAA National Oceanic and Atmospheric Administration
OLS Ordinary Least Squares

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ST Reproductive Technologies, LLC EX2008
Smaxtec, Inc. v. ST Reproductive Technologies, LLC; No. IPR2024-00875
1 of 13

1 Introduction

The world is currently experiencing a heightened rate of species extinction which has been considered reminiscent of historical mass extinctions (Barnosky et al. 2011). Extinction risks differ among species, with some species facing higher risks than others, i.e., endangered species. The need to save endangered species has been justified on both moral and utilitarian grounds. Man-made changes to the planet have greatly contributed to this current trend which leads to a moral argument for efforts to save endangered species. Another moral argument is that maintaining species is part of protecting a long evolutionary process (Rolston 1985). The loss of a species also risks significant utilitarian losses to humans. In the context of protected species, which may not be hunted and processed into commodities, people still may find value in conserving species in a variety of other ways; for example, recreationally, by providing information, or simply through the pleasure gained from knowing a species exists (Norton 2014). Species are also constituent parts of valuable ecosystems and should not be valued individually out of context. Protecting species can be important in maintaining the ecological integrity of an area (Fortin et al. 2005), with effects such as making an ecosystem more stable in the face of shocks, as well as unintuitive ecological benefits for humans, such as controlling zoonotic diseases (Levi et al. 2012). However, simply maintaining the existence of a species, while ignoring population density, may not be enough to maintain the ecological processes which they take part in (Valiente-Banuet et al. 2015). Factors such as how asynchronous they are with other species in the environment can cause some species to have greater effects on ecosystem stability than others (Blüthgen et al. 2016). Despite this, the ecological effects of losing a species are hard to predict with the current information, suggesting the need for a broad conservation approach to conserve not just the species, but the ecosystems that they are part of.

In USA, the need to protect endangered species has long been recognized and legislated by the US Congress with the Endangered Species Act (ESA) of 1973. The act lists vulnerable species, and is intended to halt and reverse trends towards their extinction through legal protections and resource allocation. The ESA is enforced by the Fish and Wildlife Service (FWS) and National Oceanic and Atmospheric Administration (NOAA). Initially, decisions for listing were not based on any specific scientific criteria until 1982, when Congress passed an amendment to the ESA which prohibited favoritism in listing species. This resulted in a high correlation for most taxonomic clades between level of endangerment and probability of listing (Cash 1997). However, unbiased listing is not enough to ensure unbiased protection. The amount of funding received affects whether being listed has a positive effect on recovery (Ferraro et al. 2007; Miller et al. 2002). In fact, being listed with low funding can actually harm a species' recovery. For example, banning development of the habitat of a listed species can create a perverse incentive for landowners to prematurely develop their land (Lueck and Michael 2003). It is, therefore, important to consider which characteristics of a species influence funding and ask whether these are the factors which we want determining conservation outcomes.

ST Reproductive Technologies, LLC EX2008
Smaxtec, Inc. v. ST Reproductive Technologies, LLC; No. IPR2024-00875
2 of 13

A crucial factor for determining funding for conservation of an endangered species under the FWS is its priority ranking (NOAA 2012). The priority ranking of a species is calculated based on the degree of threat (high, medium, and low), recovery potential (high and low) and degree of taxonomic distinctiveness (monotypic genus, species, and subspecies). The previous research suggests that the priority ranking does not have a significant effect on actual funding for vertebrates (Mahoney 2009; Restani and Marzluff 2002), though evidence to the contrary exists (Metrick and Weitzman 1998). In contrast, attributes such as whether a species is considered a higher form of life form have correlated positively with funding (Metrick and Weitzman 1996). A theorized, but previously untested factor that could bias the funding, and, therefore, conservation outcomes for a species, is charisma (Mahoney 2009; Metrick and Weitzman 1998). According to the Oxford Dictionary, charisma is defined as "compelling attractiveness or charm that can inspire devotion in others" (n.d.) and it is usually associated with a human quality. Although there is no set definition in the context of animal species, it has been used, nonetheless, in this context. Lorimer (2006) defines it as some combination of fame, societal perceptions of the animal, esthetics, and potential to generate satisfaction. We do not hope to nail down a definition in this paper, but think whatever the exact determinants of charisma are, which could vary from beautiful coloration to being associated with a popular cartoon, charisma will increase the likelihood that any given person will devote some time or effort towards the animal. The general US population's perceived charisma of a species has the potential to translate into funding misallocation through the effect of lobbying for more popular species, regardless of attributes like ecological value or greater need.

This paper examines whether charisma and the priority ranking affect the total amount spent on a per species basis by the U.S. Federal Government in 2013 (USFWS 2013). This was done using an econometric approach with cross-sectional data which should be sufficient to assess the effects these variables have, while avoiding the need to account for differences in budgets, political climate, or organizational structural over time. In this study, we use the number of Google hits for a specie's common name as a proxy for charisma. Different societies may have different views on which species are charismatic, with likely components of charisma varying, e.g., Tanzanian vs. British school children's negative vs. positive views on large African mammals (Bowen-Jones and Entwistle 2002). Therefore, we used searches resulting from Google set for the region of the US, which should largely be made up of websites aimed, at least, in part, towards American interests. The Internet has previously been used as a proxy for charisma with numbers of pictures of African species posted to certain social media sites being used to address tourism potential (Willemen et al. 2015). Furthermore, including a charisma variable in our regression approach should also correct for any omitted variable bias resulting from not doing so and improve the model's estimation of correlated variables' effects.

ST Reproductive Technologies, LLC EX2008
Smaxtec, Inc. v. ST Reproductive Technologies, LLC; No. IPR2024-00875
3 of 13

2 Materials and methods

2.1 Econometric approach

To assess whether charisma and the priority ranking affect the total amount spent on a per species basis by the U.S. Federal Government in 2013, we developed the following model that included additional covariates that could influence expenditure per species, to correct for their potential confounding effect on *Google hits* and *priority rank* which are the factors of interest:

$$\begin{aligned}\text{Log(Fed_spent)}_i = {} & \beta_0 + \beta_1\text{priority_rank} + \beta_2 \log(\text{Google_hits}) + \beta_3\text{Conflict} \\ & + \beta_4\text{global_rank} + \beta_5\text{bird} + \beta_6\text{reptile} + \text{B}_7\text{amphibian} + \beta_8\text{mammal} \\ & + \beta_9\text{land_dummy} + \beta_{10}\log(\text{length}) + \beta_{11}\text{endemic} + \beta_{12}\text{conflict} \times \log(\text{Google_hits}) + \mu_i.\end{aligned}$$

To estimate the model, we used both Ordinary Least Squares (OLS) and the MM robust regression [Stata 13, program from Jann (2010) based on the model advanced by Yohai (1987)] chosen for combining high efficiency with a high breakdown point (Yu and Yao 2017). The MM robust regression was run as a model robust to outliers such as highly charismatic species as a comparison to the OLS model. We ran diagnostic tests in the form of a White test, to check for homoscedasticity of errors, and a RESET test confirming the correct functional form. Scatter plots were used to decide whether to take natural logarithms of variables for this model, and this was done for the dependent variable of per species federal budget spending as well as species length and the number of Google hits to form the model.

The *priority rank* is the measure of priority compiled by the FWS for the federal government and by which ESA funding is meant to be determined and should theoretically have a negative significant effect, since the higher the ranking, the lower is the rank number (one being the highest), and the more federal funding the species is supposed to receive. Also included is the dummy variable *Conflict*, a legally required designation added by the FWS along with the priority ranking that identifies whether a species' conservation is in conflict with economic activities, potentially increasing the cost of conservation.

The number of *Google hits* as proxy for species´ charisma should be highly and positively correlated with how charismatic an animal is, with more popular animals having more material published online about them. This should hold for the two definitions of charisma previously mentioned. If it is an animal which inspires some devotion, then said devotion should increase the probability of including it on a website.

It is possible that the presence of a species in multiple websites and Google searches is due to negative reasons. Since these potential negative social-economic factors, other than charisma, can also increase funding, we added an interaction variable between *Conflict* and *Google hits* to control for conflicts effecting *Google hits*. We predict well-publicized instances of conflict will positively affect funding. *Google hits* should also contain information concerning the amount generally known about a species. However, one could argue that this is inextricably linked to

ST Reproductive Technologies, LLC EX2008
Smaxtec, Inc. v. ST Reproductive Technologies, LLC; No. IPR2024-00875
4 of 13

charisma, with more charismatic animals getting studied more, as well as interesting facts making animals more charismatic. Since all the species on the list are endangered, it is unlikely that large numbers of *Google hits* are caused by websites considering them pests, other than for issues of economic conflict which are controlled for. Even if the previous assumption was untrue, any factor which systematically increases Internet coverage but decreases funding would bias our model against a significant positive result, and so, their omission would not detract from such a result being evidence for charisma.

Spending on land purchases for habitat conservation was added to other federal funding to create the dependent variable, despite this first type of spending being a sunk cost and the second a variable cost. Since the data are a snapshot of 2013 and any strategy for habitat purchasing would likely only be clear over a longer period of time, whether a species receives this funding in 2013 would not imply priority over one which does not. Not including land spending would fail to control for any effect which it may have on other spending, yet doing so as a dependent variable would likely result in endogeneity. As a result, we have land spending as part of total spending and control for whether a species happened to receive it in 2013 with a dummy variable, *Land dummy*, to avoid omitted variable bias while preventing endogeneity.

Global rank is an outside ranking by the independent Nature Conservancy NatureServe conservation status system meant to capture worldwide threat level to a species and is expected to be negative (G1 is most endangered; G5 least) as more endangered species could get more funds.

In this model, we included dummies for the different vertebrate clades as these have factored into funding in the previous studies (Mahoney 2009; Metrick and Weitzman 1998), with *bird*, *reptile*, *amphibian*, and *mammal* as dummy variables for belonging to each respective clade, with *fish* excluded to prevent perfect collinearity. We theorize that once charisma is controlled for these should no longer be significant.

Length is maximum length of a species which has previously been found to have a positive effect on funding; perhaps, larger animals are costlier to conserve, or charismatic mega fauna simply get more funds. The dummy variable *Endemic* for whether species were endemic (only found in the US) was included to control for a preference toward uniquely American species.

2.2 Data

Overall, in 2013, the federal government spent $6,019,884,024.00 on endangered species protected by the Fish and Wildlife Service, only $1,519,466,060.00 of which was not spent on buying land. Table 1 provides a description of variables and summary of the data found. Spending data were obtained from the FWS Federal and State endangered and threatened species expenditures report from 2013 (USFWS 2013) for which all data were publicly available. Any species for which the FWS did not compile a priority ranking was removed from the sample. This means most marine animals are excluded from the analysis.

ST Reproductive Technologies, LLC EX2008
Smaxtec, Inc. v. ST Reproductive Technologies, LLC; No. IPR2024-00875
5 of 13

Table 1 Data summary

Variable	Description	Obs	Mean	Std. dev.	Min	Max
Federal spending	Total federal spending on an individual endangered species ($)	265	2983417	1.86e+07	214	2.91e+08
Priority rank	Fish and Wildlife Services recovery priority number from 1(high) to 18 (low)	265	5.45283	3.385696	1	17
Conflict	1 if conservation conflicts with economic activities according to Fish and Wildlife Services, 0 otherwise,	265	0.4679245	0.4999142	0	1
Global rank	Global endangerment score from 0 (presumed extinct) to 5 (not threatened globally)	265	2.475472	1.551015	0	5
Bird	1 if bird, 0 otherwise	265	0.2415094	1.551015	0	1
Reptile	1 if reptile, 0 otherwise	265	0.0981132	0.2980305	0	1
Amphibian	1 if amphibian, 0 otherwise	265	0.0792453	0.2706323	0	1
Mammal	1 if mammal, 0 otherwise	265	0.1924528	0.3949727	0	1
Land dummy	1 if a species got federal spending buying land, 0 otherwise	265	0.309434	0.463135	0	1
Google hits	Number of Google hits (2002–2012) for the species common name	265	432,571	1,842,034	91	1.66e+07
Length	Maximum length reached by the animal including tail (m)	265	0.4996226	0.8277923	0.02	6.1
Endemic	1 if only found in the US, 0 otherwise	265	0.6150943	0.4874937	0	1
Conflict × log(Google hits)	Interaction variable for conflict and log(google hits)	265	4.727348	5.380213	0	16.62491

Google hits were the number of websites Google returned for a search of a species' common name as found on the ESA funding report (USFWS 2013). This was done for websites dated within the decade prior to the spending decisions made for 2013, to make the variable exogenous. To obtain *Google hits*, (a) under Google's 'Settings' menu, 'Search Settings' was chosen, and 'Region Settings' was set to 'United States', (b) also under 'Search Settings', 'Private Results' were set to 'Use Private Results,' and (c) under Google's 'Tools' menu, 'Any Time' was chosen, and then, 'Custom Range' and the range of dates for search results were set to between January 1st 2002 and December 31st 2012. The variable is the cumulative number of websites over this time period and, therefore, was not reflective of chance interest when the data happened to be collected. One pitfall emerged for Puma and Jaguar which share names with well-known brands. However, the same method was used in these cases for consistency as there is no way to tell if there might be other animals under similar if less well-known circumstances. These also only represented two data points and neither was a highly influential point which would greatly change the regression (Bollen and Jackman 1990).[1] It could also be argued that animals with companies named after them are highly charismatic. *Google hits* ranged from 91 to 16.6 million hits.

The FWS recovery priority rank upon which funding decisions are meant to be made was obtained from the latest copy that we could find of the Report to Congress on the Recovery of Threatened and Endangered Species which was from 2011 to 2012 (USFWS 2012). This ranges from 1 to 18 with 1 being the highest priority.

In the case of subspecies of the same species, the data sets were pooled together, with funding added together and rankings averaged across subspecies (all subspecies made up 16% of the data and averaging was only done for 10 data points). This was done to avoid mischaracterizing charisma, in case specific sub species names were less recognizable than the species' names, assuming that subspecies are about as charismatic as the general species. In addition, we had no way of reliably separating out subspecies which are recognizably different from the other members of the species from those which are not. Doing this precluded using variables, such as whether a species was limited to an island, or the degree of threat and likelihood of recovery as individual variables outside of the *priority rank*, since all were dummy variables which varied between listed subspecies and could not be averaged to represent the general situation of a species.

The *Global rank* number was obtained from Natureserve (http://explorer.natureserve.org/servlet/NatureServe?init=Species) and ranges from G5 (secure) to G1 (critically imperiled) with two other categories GH and GX which represent possibly and presumed extinct species. If there were multiple subspecies with different rankings in the endangered species list, these were averaged. Maximum length was used to calculate *length*. Average length may have been a better measurement for size, but, unfortunately, was not available for all the species in the data set. *Length*

[1] We checked that neither was a highly influential point on the regression by checking if they had a Cook's distance, which measures the effect of deleting a given data point, greater than 4 divided by the sample size (4/265) (Bollen and Jackman 1990), which they did not.

ST Reproductive Technologies, LLC EX2008
Smaxtec, Inc. v. ST Reproductive Technologies, LLC; No. IPR2024-00875
7 of 13

Table 2 Results for the ordinary least squares and MM robust regression models of log (federal spending)

	Ordinary least squares		MM robust regression	
	Coefficient	Robust std. error	Coefficient	Robust std. error
Constant	9.263***	0.885	9.683***	1.056
Priority_rank	0.021	0.038	0.039	0.046
log(Google_hits)	0.282***	0.090	0.225**	0.110
Conflict	2.402***	0.914	2.367**	0.984
Gobal_rank	−0.074	0.100	−0.118	0.117
Bird	0.557*	0.329	0.658	0.426
Reptile	−0.399	0.391	−0.275	0.425
Amphibian	−0.344	0.550	0.325	0.685
Mammal	−0.600	0.490	−0.435	0.579
Land_dummy	2.332***	0.255	2.189***	0.283
log(Length)	0.416***	0.137	0.466***	0.152
Endemic	0.075	0.258	0.246	0.317
Conflict × log(Google hits)	−0.129	0.092	−0.109	0.101

OLS regression ($n=265$, $R^2=0.5227$) and MM robust regression ($n=265$, efficiency 85%, breakdown point = 0.5)

*Sig at 10%, **sig at 5%, and ***sig at 1%

ranged from 0.02 m to 6.1 m. The *length* data and the data on whether a species was *endemic* to the US were gathered when possible from the encyclopedia of life (http://eol.org/) with 11 missing data points being filled in from any source where an estimate could be found (sources available upon request).

3 Results

Diagnostic tests indicated evidence of a correctly specified functional form,[2] but with problems of heteroscedasticity[3] which were corrected using heteroscedasticity consistent standard errors in the estimated regressions.

Results show that *priority rank* remained insignificant, indicating that funding decisions are still not being made on the basis of the FWS classification system of priority (Table 2). However, the *Google hits* proxy variable for charisma was highly significant with a 1% increase in the number of *Google hits* on a species predicted by OLS, leading to a 0.282% increase in spending on a species if not in conflict with economic activities, or 0.153% if in conflict with them. This is evidence for an effect

[2] The RESET test did not reject the null that the model is correctly specified ($F(3,249)=0.55$, $p=0.6499$).

[3] We rejected a null of homoskedasticity using a degree-of-freedom conserving form of the White test, indicating that heteroskedasticity is a threat to efficiency ($F(2,262)=5.25$, $p=0.0058$).

of charisma on funding as proxied by *Google hits*, although the exact underlying relationship is unclear given that we do not know the structure of how charisma and *Google hits* are related. The *conflict* × *log*(*Google hits*) interaction variable was not significant. *Length* was also highly significant with a positive coefficient consistent with the previous studies (Mahoney 2009). The *land* dummy was also significant to a 1% level with an unsurprisingly positive coefficient, as species which have land bought for them get more money. It indicates that species which had spending on land had 929% more spent on them[4] than those which did not. The only significance that was found for any of the clades was positive for *birds* at the 10% level.

Finally, unlike previous studies, the *global* rank now has a negative coefficient, though it was insignificant. However, it is conceivable; this is largely down to the land dummy which distinguishes species receiving an additional type of spending. The robust regression results were broadly similar to OLS, suggesting that outliers did not drive outcomes for many variables. The only difference was that neither *conflict* × log(*Google hits*) interaction term nor a species being a *bird*, both intended as control variables, continued being significant under the model.

4 Discussion

By controlling for charisma with the proxy of *Google hits,* we can get a clearer idea of the effects on funding of the other variables such as *priority rank*. *Priority rank* was insignificant suggesting that while an animal's charisma to humans effected it's funding, a carefully researched and constructed priority did not, even with charisma controlled for. This could be explained by differing funding strategies, with many of the regional offices of the FWS having approaches which differ from putting money towards highest priority species, such as focusing on animals which are about to recover (USGAO 2005).

The model predictably suggests that larger animals receive more funding, not only because they are charismatic mega fauna but also, perhaps, because larger animals require more funding independent of human interest and knowledge. This conclusion was further supported by the significant MM robust regression which excludes an effect caused solely by mega fauna. *Length* is also a major predictor of extinction threat as would be expected from the literature (Dirzo et al. 2014), and this variable could be collinear with *priority ranking*, perhaps, factoring into *priority ranking's* insignificant result.

Birds were the only vertebrate class to be found to be significant, and only weakly in the OLS. This could have been due to controlling for general differences in charisma between vertebrate classes, as well as controlling for endemism, a trait more likely in certain classes than others. Classes where species tend to have more limited ranges are more likely to be the controlled for by the endemic variable.

[4] We get this from (100(exp(2.332) − 1), since the variable is a dummy and the model has a logged-dependent variable.

ST Reproductive Technologies, LLC EX2008
Smaxtec, Inc. v. ST Reproductive Technologies, LLC; No. IPR2024-00875

Unlike the previous research (Mahoney 2009; Metrick and Weitzman 1998), we found that *Global* rank was not significant. Some of the reasons for this could be that we controlled for charisma, whether a species is *endemic*, as well as the *land* dummy which were previously not included in regressions in the literature. The models strengthen the argument that charisma is important in determining funding level within the federal government. This suggests that funding may not be well allocated due to a charisma bias, irrespective of any strategies for funding such as triage (Gerber 2016). Lowell and Kelly (2016) found that the FWS may be more vulnerable to government pressure, and base decisions on less scientific evidence than NOAA, perhaps, due to having less information available about many of their species. The funding in the data also includes funds from a multitude of other federal agencies, such as the Office of Surface Mining or the Army (USFWS 2013), which are not focused on conservation. These factors could leave open room for charisma to be more important in decision-making. However, while funding the conservation of particular vertebrate species based on charisma does not necessarily serve to best protect ecological processes, does not allocate resources to species at higher risk, and results in humans picking which species get to live or die, there may also be some benefits to this approach. The ESA states that wildlife is of "esthetic, ecological, educational, historical, recreational, and scientific value to the Nation and its people" (NOAA 2012). Protecting species based on charisma reflects several of these values (i.e., esthetic and historical) and, therefore, how certain species might be prioritized in a society with limited resources and will to spend on conservation. One type of intervention that increases with funding is an increase in educational awareness that could lead to the most charismatic animals having the best educational material, helping to make them even more appealing then underfunded and less charismatic species (Luther et al. 2016). Congressional earmarks (Schwartz 2008) going towards these species as well as independent groups lobbying harder for these species are likely two of the causal mechanisms to making charisma a significant factor. Still the ESA does not set out to choose which species are more worth saving.

This kind of choice making also ignores several of the other arguments for protecting species, notably ecological arguments. Ecologically important species need not be charismatic nor do single species approaches best preserve ecosystems. Certainly, focusing a conservation approach around charismatic species is not based on empirical research (Ducarme et al. 2013). Strategies to use species protection to protect ecological processes revolve around using surrogate species which serve three major purposes: locating areas for conservation, monitoring environmental changes, and public relations (Caro 2010). Only the last of these is necessarily best served using charismatic species. Charismatic species may help to locate and protect areas for conservation or indicate changes in the environment, but, if money spent due to charisma achieves these goals, it is accidental. Spending based on ecological impact may occur, but, as it is not controlled for, it would be a component of the error of the models. However, money spent on charisma is not going towards an evidence-based strategy of preserving a wide array of species, and, therefore, ecosystems.

Charisma's linkage to funding can be understood as a way of maximizing certain types of human utility, such as protecting esthetically pleasing species, but even from this perspective, there is no justification for priority ranking not playing a role

ST Reproductive Technologies, LLC EX2008
Smaxtec, Inc. v. ST Reproductive Technologies, LLC; No. IPR2024-00875
10 of 13

in funding. Ignoring likelihood of recovery and endangerment level could prioritize a charismatic species over a non-charismatic one in greater need or with greater potential to be saved. It also ignores the taxonomic distinctiveness of the protected species or subspecies, thereby trying to capture how unique the evolutionary history and potential evolutionary future may be (Winter et al. 2013).

We should consider the limits of *Google hits* as a proxy for charisma. Including *Google hits,* controls for the variation in funding explained by variation in *Google hits* caused by variation in charisma, but does not control for situations where the variation of charisma does not affect website creation, so that part of charisma may still be omitted and even biasing other variables. This is still better than omitting charisma entirely. It is also possible that part of the variation in *Google hits* explaining variation in funding is caused by something other than charisma. If this affects funding negatively, it only makes the significant result less likely, but a factor increasing *Google hits* and funding might mean that the predicted funding increase is not caused by charisma. Even with these limitations, it is interesting that *Google hits* has predictive power for funding and raises questions about how funding should be allocated.

We would also be careful about the statements of external validity to other years with different contexts such as the contributing agencies budgets. However, it is worth noting that the priority ranking which was deemed insignificant in the previous studies (Simon et al. 1995) remains so, providing evidence for the unimportance of stated priority on actual spending. We cannot make conclusions on whether this or other trends would be improved or exacerbated by a larger or a smaller overall federal budget for endangered species; for example, if agencies with lower budgets spent more carefully. This is an interesting further direction of research.

5 Conclusion

We provided evidence for the role of an animal's charisma in the US Government federal funding decisions. This result suggests a bias in funding, whereas biases in decisions to list species under the ESA were previously deemed unacceptable. This could place less charismatic species in jeopardy or unnecessarily slow recovery, thereby jeopardizing ecological integrity.

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ST Reproductive Technologies, LLC EX2008
Smaxtec, Inc. v. ST Reproductive Technologies, LLC; No. IPR2024-00875
11 of 13

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ST Reproductive Technologies, LLC EX2008
Smaxtec, Inc. v. ST Reproductive Technologies, LLC; No. IPR2024-00875
12 of 13

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ST Reproductive Technologies, LLC EX2008
Smaxtec, Inc. v. ST Reproductive Technologies, LLC; No. IPR2024-00875
13 of 13