

Short report

Challenging taxonomic bias in flagship conservation: public perceptions of reptile and amphibian charisma

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Keywords: charisma, conservation, education, flagship species, taxonomic bias, zoos

Article history:

Received: 18 Jun 2026

Accepted: 28 Oct 2026

Published online: 31 Oct 2026

Abstract

Charismatic species play a central role in conservation communication, yet flagship campaigns remain dominated by a narrow subset of large-bodied mammals. This reliance risks reinforcing taxonomic bias at a time when reptiles and amphibians are among the most threatened vertebrate groups globally. We assessed whether reptiles and amphibians can elicit affective responses associated with public engagement, challenging assumptions that charisma is restricted to traditional flagship taxa. Using an online survey, we examined relationships between species awareness, affective evaluation, and stated willingness to engage with conservation-relevant contexts across ten reptile and amphibian species representing contrasting charismatic traits. Positive affective evaluation was a strong predictor of engagement across taxa, whereas familiarity alone was a weaker and less consistent driver. These findings suggest that conservation strategies may underestimate the appeal of non-mammalian species and that broadening flagship selection could help reduce taxonomic bias. For zoos, these findings highlight opportunities for reptiles and amphibians to play a greater role in conservation education, interpretation, and public engagement, alongside the emphasis on charismatic mammals.

Introduction

Charismatic species play a central role in conservation communication, fundraising and public engagement (Krause 2017). Since the mid-twentieth century, conservation campaigns have relied heavily on a narrow subset of large-bodied mammals, often carnivores or primates, as flagship species to mobilise public support (Smith et al. 2012; Albert et al. 2018). While effective, this strategy has contributed to persistent taxonomic bias in conservation priorities, whereby mammals receive disproportionate attention and resources relative to other vertebrate groups (Ducarme et al. 2013; Colleony et al. 2017). This imbalance is increasingly problematic given that reptiles and amphibians now represent some of the most threatened vertebrate taxa globally (Luedtke et al. 2023).

The concept of nonhuman charisma offers a useful framework for understanding why certain species dominate conservation narratives. Lorimer (2007) describes charisma as emerging through three interrelated facets: ecological (detectability and encounter rate), aesthetic (visual appearance and behaviour), and corporeal (emotional responses elicited during encounters). In practice, conservation discourse has often equated charisma with large body size, a tendency reinforced by the widespread use of the term 'charismatic megafauna' (Carr 2016; Prokop et al. 2024). However, empirical evidence suggests that size alone does not fully explain public preferences, and that traits such as colouration, neotenic features and perceived vulnerability can also elicit positive affect and conservation concern (Albert et al. 2018; Berti et al. 2020). Despite this, reptiles and amphibians remain

underrepresented in both conservation campaigns and public-facing institutions. Amphibians, for example, comprise the most threatened vertebrate class, yet large mammals often dominate within species selected as conservation flagships (Brereton and Brereton 2020; Luedtke et al. 2023). Negative cultural associations, particularly fear and perceptions of danger, are frequently cited as barriers to public support for herpetofauna (Prokop et al. 2024). Nevertheless, emerging evidence suggests that such perceptions are neither universal nor immutable, and may be shaped by framing, familiarity and exposure (Hausmann et al. 2017; Musah et al. 2021).

Critically, few studies have empirically examined whether reptiles and amphibians can elicit affective responses consistent with flagship species potential, or whether conservation communication strategies may underestimate their appeal by assuming low public likeability. Where public perception has been assessed, research has often focused on individual taxa (e.g., snakes) or on zoo visitation patterns, rather than addressing broader implications for conservation messaging and taxonomic bias (Moss and Esson 2016; Whitworth 2012). Here, we present an exploratory perception-based study assessing public responses to a diverse set of reptile and amphibian species selected to represent contrasting traits associated with charisma, including size, colouration, familiarity and perceived danger. Using an online survey, we examine relationships between species awareness, affective evaluation, and stated willingness to engage with conservation-relevant contexts. By testing whether positive affect predicts engagement across taxa typically excluded from flagship roles, this study aims to document variation in charismatic potential within traditionally underrepresented taxa.

Methods

Ethical compliance

This study received ethical approval from the University Centre Askham Bryan Ethics Board (approval number: UCABEB0115). Participation was voluntary and anonymous, and informed consent was obtained prior to survey completion.

Study design and species selection

We conducted an exploratory online survey to assess public perceptions of reptile and amphibian species with respect to affective evaluation, familiarity, and stated willingness to engage in a conservation-relevant context. Species were purposively selected to represent contrasting combinations of traits previously associated with nonhuman charisma, including body size, colouration, perceived danger, and familiarity (Whitworth 2012; Albert et al. 2018; Prokop et al. 2024). The final set comprised ten species spanning reptiles and amphibians, including both commonly recognised taxa (e.g., Komodo dragon *Varanus komodoensis*, king cobra *Ophiophagus hannah* and lesser-known species (e.g., golden mantella *Mantella aurantiaca*, Annam leaf turtle *Mauremys annamensis*), as well as species differing in size, pigmentation and cultural associations and the final survey was pilot tested to ensure all traits were encompassed within the selected species. This trait-based approach was intended to test whether positive affect and engagement could emerge across taxa typically excluded from flagship conservation roles, rather than to compare species exhaustively.

Survey instrument and procedure

The survey was distributed via non-taxon specific online animal-interest-based forums on the social media platforms Reddit and Facebook between 6-30 January 2022. Recruitment materials did not reference reptiles or amphibians specifically, to minimise targeted self-selection and avoid bias towards reptile and

amphibian species. Participants were required to specify their age range (from 18 years+) and confirm that they were over 18 years of age in order to participate in the survey.

Participants gave their informed consent and were then shown the same set of photographs of each species and asked to respond to the same set of questions for all ten species. Items assessed: (1) self-reported awareness of the species, (2) affective evaluation, operationalised as a combined measure of likeability and interest, (3) likelihood of visiting species in a zoo-based educational context, and (4) perceived descriptive attributes selected from a predefined list of adjectives. They were also asked three additional questions relating to reptile and amphibian engagement at the end of the survey.

Affective evaluation was measured using a 5-point Likert scale ranging from “dislike / not interested” (1) to “like / interested in learning more (5). While likeability and interest are conceptually distinct, they were combined here to capture a general affective response relevant to engagement with conservation messaging. Previous studies indicated that affective responses and interest are often closely linked in shaping conservation-related attitudes and behaviours (Cox and Gaston 2015; Sweet et al. 2023). Nonetheless, we acknowledge this as a limitation and treat the measure as indicative rather than diagnostic. The full survey can be viewed in Supplementary Material S1.

Statistical modelling strategy and analysis

Data were obtained from 98 participants who rated ten reptile and amphibian species on five-point ordinal scales measuring awareness, feelings and stated likelihood of visiting the species in a zoo. The feeling measure incorporated respondents' assessments of likeability and interest. The analytical dataset comprised 973 complete participant–species observations. Statistical analyses were conducted in R (version 4.3.1; R Core Team, 2023). Cumulative link mixed models were fitted using the ordinal package, while threshold-specific binomial generalised linear mixed models were fitted using lme4 (Bates et al. 2015). Species-specific slopes, confidence intervals and pairwise comparisons were estimated using emmeans. Model diagnostics were undertaken using functions from performance and DHARMA. Population-averaged predicted probabilities were calculated using Gauss–Hermite quadrature implemented through statmod. Data preparation and visualisation were undertaken using readxl, dplyr, tidyr, purrr, tibble, ggplot2, forcats and scales.

Descriptive distributions of awareness, feeling and visitation likelihood scores were examined separately for each species. Response frequencies and percentages were used to characterise variation across species and rating categories.

A series of regression models was fitted to investigate the relationships between species awareness, feelings towards species and stated likelihood of visiting them in a zoo. Multiple models were used to address distinct research questions, with the response variable and explanatory variables varying according to the specific relationship being investigated. This approach enabled the individual and combined associations of awareness and feeling with visitation likelihood to be examined, alongside potential differences in these relationships among species.

The principal analyses used cumulative link mixed models (CLMMs), fitted using the ordinal package in R with a cumulative logit link. Stated visitation likelihood was treated as a five-category ordinal response variable. Species was included as a categorical fixed effect, while awareness and feeling were entered as numerical predictors representing their respective five-point rating scales. Participant identity was included as a random intercept to account for non-independence arising from repeated ratings of different species by the same individual. Thus, the models estimated associations between explanatory variables

and the cumulative odds of reporting a higher visitation-likelihood category, while allowing baseline response tendencies to vary among participants.

Three initial models were fitted to investigate the independent and combined associations of awareness and feeling with visitation likelihood: an awareness-only model, a feeling-only model and a model containing both predictors. All models additionally included species and the participant-level random intercept. Model fit was compared using Akaike's information criterion (AIC), and nested models were compared using likelihood-ratio tests. Regression coefficients were expressed on the cumulative log-odds scale, with odds ratios calculated by exponentiation.

Subsequent models investigated whether the relationships between the explanatory variables and visitation likelihood varied across species or depended on one another. A species $\times$ feeling interaction was introduced to test whether the strength of the feeling-likelihood association differed among the ten species, with awareness retained as a covariate. Awareness and feeling were mean-centred for the interaction analyses to facilitate interpretation of model coefficients. The interaction model was compared with the corresponding additive model using a likelihood-ratio test. Species-specific feeling slopes were subsequently estimated, and pairwise comparisons were adjusted using the Holm method to account for multiple testing.

A further model included an awareness $\times$ feeling interaction in addition to the species $\times$ feeling interaction. This tested whether the association between feeling and visitation likelihood varied

according to awareness after accounting for species-specific differences. The additional interaction was evaluated through comparison with the simpler species-interaction model.

Collectively, this modelling strategy distinguished between the individual associations of awareness and feeling with visitation likelihood, their independent associations when considered together, variation among species, and the robustness of the results to alternative representations of the ordinal response variable. All findings were interpreted as associations rather than causal effects. Further proportional odds diagnostics and sensitivity analyses were undertaken and are reported in the Supplementary material (S2 and S3). Model validation analyses were also run and can be viewed in full in Supplementary material S4.

Results

Associations between affective evaluation (feeling), species awareness and visitation likelihood

The analytical dataset comprised 973 complete observations from 98 participants, each of whom was asked to evaluate ten reptile and amphibian species in terms of their feelings towards them, their species awareness and their visitation likelihood (Figure 1).

Cumulative link mixed models indicated that both awareness and feeling were associated with stated visitation likelihood when examined separately, although the association with feeling was substantially stronger. In the model containing awareness and

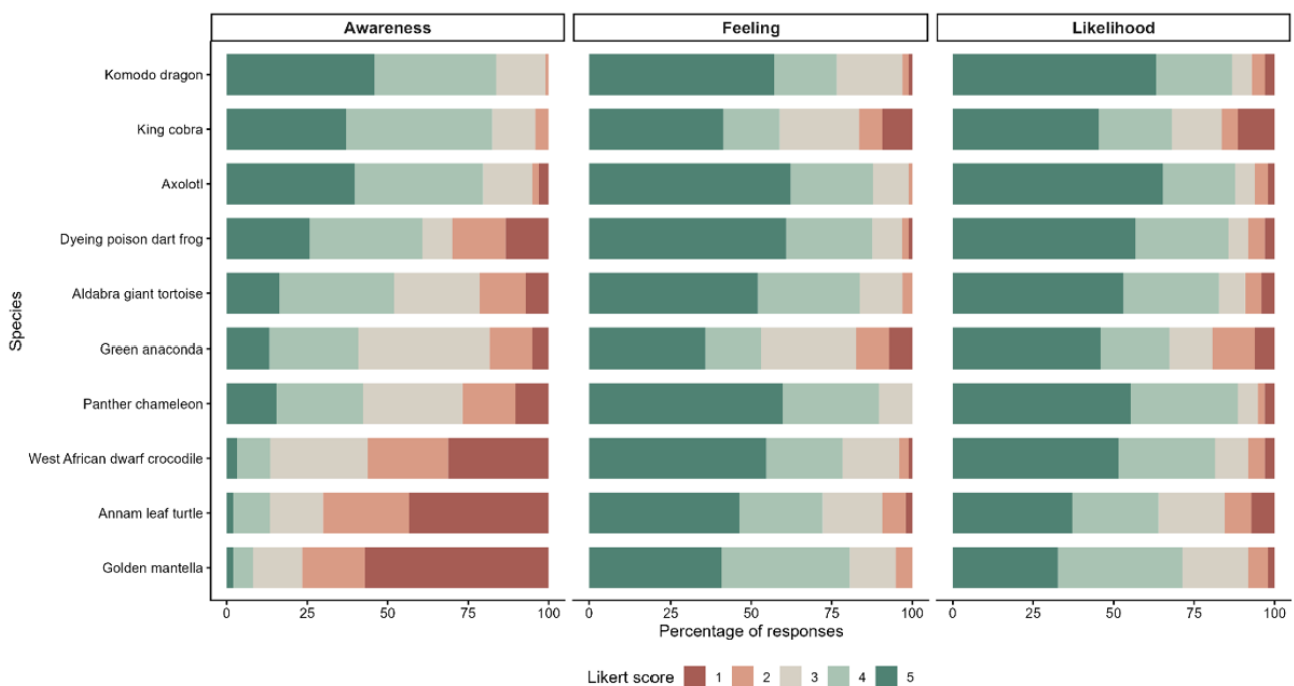


Figure 1. Distribution of awareness, feeling and stated visitation likelihood ratings across ten reptile and amphibian species. Horizontal stacked bars represent the percentage of responses in each category of the five-point Likert scales. Scores range from 1 (lowest rating) to 5 (highest rating). Species are ordered according to their overall awareness ratings. Percentages were calculated separately for each species and measure.

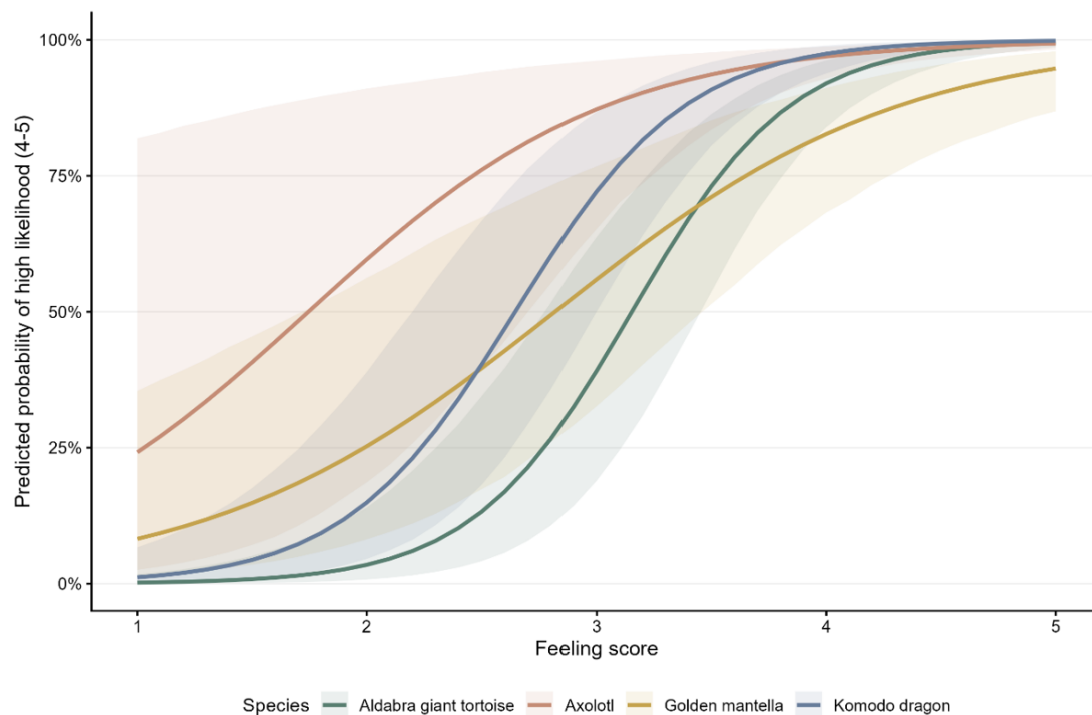


Figure 2. Predicted probability of high stated visitation likelihood as a function of feeling score for four selected species. Lines represent model-based predicted probabilities of reporting a visitation-likelihood score of 4 or 5, estimated from the cumulative link mixed model containing species, feeling, their interaction and awareness, with participant identity included as a random intercept. Shaded regions represent 95% confidence intervals. Predictions were calculated at mean awareness and with the participant-level random intercept set to zero. The four species illustrate variation in the estimated feeling–likelihood association. Predictions are conditional on the proportional odds assumption of the fitted model.

species, greater awareness was associated with increased odds of reporting a higher visitation-likelihood category ($\beta=0.198$, $SE=0.084$, $OR=1.22$, 95% CI for OR [1.03, 1.44], $P=0.019$). In the corresponding model containing feeling and species, higher feeling scores were strongly associated with increased visitation likelihood ($\beta=2.294$, $SE=0.134$, $OR=9.92$, $P<0.001$). Four species were selected to illustrate variation in the estimated association between feeling and visitation likelihood: Aldabra giant tortoise (reference species and strongest estimated association), Komodo dragon (relatively strong association), Axolotl (relatively weak

association) and Golden mantella (weakest estimated association). (Figure 2).

When awareness and feeling were included simultaneously, feeling remained strongly associated with visitation likelihood ($\beta=2.298$, $SE=0.135$, $OR=9.96$, $P<0.001$), whereas awareness was no longer significantly associated with the outcome ($\beta=-0.022$, $SE=0.094$, $OR=0.98$, $P=0.811$). Adding feeling to the awareness-only model substantially improved model fit (likelihood-ratio $\chi^2_{(1)}=423.21$, $P<0.001$). Conversely, adding awareness to the feeling-only model did not improve fit ($\chi^2_{(1)}=0.058$, $P=0.811$).

Table 1. Comparison of cumulative link mixed models

Model	Fixed effects	AIC	ΔAIC
M1	Species + Awareness	1988.810	430.450
M2	Species + Feeling	1565.656	7.296
M3	Species + Awareness + Feeling	1567.598	9.238
M4	Species $\times$ Feeling + Awareness	1558.360	0.000
M5	Species $\times$ Feeling + Awareness $\times$ Feeling	1558.931	0.571

Note. AIC=Akaike Information Criterion; ΔAIC =difference from the lowest-AIC model (M4). All models included participant identity as a random intercept and used a cumulative logit link with 10 adaptive Gauss–Hermite quadrature points. Lower AIC values indicate better relative model fit. M4 had the lowest AIC; M5 had a similar AIC ($\Delta AIC=0.571$).

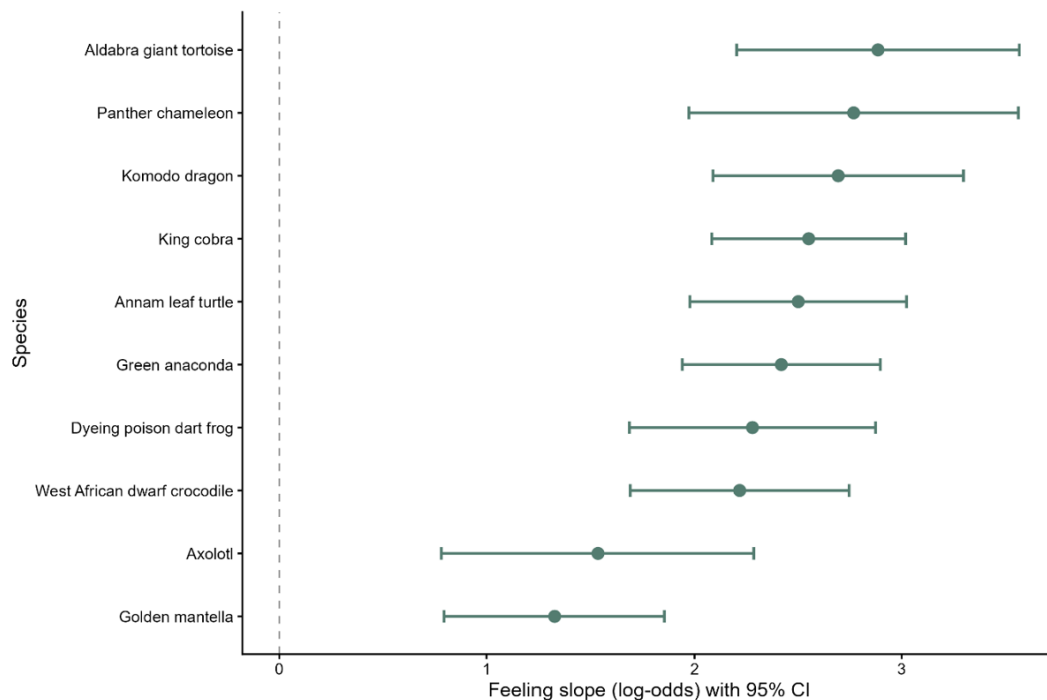


Figure 3. Species-specific associations between feeling and stated visitation likelihood. Points represent estimated species-specific feeling coefficients (cumulative log-odds slopes), with horizontal bars indicating 95% confidence intervals, obtained from the cumulative link mixed model including a species $\times$ feeling interaction, awareness and a participant-level random intercept. Positive coefficients indicate that higher feeling scores were associated with increased odds of reporting a higher visitation-likelihood category. All species-specific slopes were positive and statistically significant. Following Holm adjustment for multiple comparisons, the feeling slope for Golden mantella was significantly lower than those for Aldabra giant tortoise, Annam leaf turtle *Mauremys annamensis*, Green anaconda *Eunectes murinus*, king cobra and Komodo dragon.

The model containing feeling alone also had a substantially lower AIC (1565.66) than the awareness-only model (1988.81). Including awareness alongside feeling did not improve model fit (AIC=1567.60) (Table 1). Together, these findings indicate that feeling was strongly associated with stated visitation likelihood, whereas awareness provided little additional explanatory information after accounting for feeling and species.

Species-specific associations between feeling and visitation likelihood

The association between feeling and stated visitation likelihood differed significantly among species. Introducing a species $\times$ feeling interaction improved model fit relative to the corresponding main-effects model (likelihood-ratio $\chi^2_{(9)}=27.24$, $P=0.0013$; Table 1). Species-specific feeling coefficients were positive for all ten species, indicating that more favourable feeling scores were associated with increased odds of reporting higher visitation likelihood across all species examined. The estimated coefficients ranged from 1.32 for Golden mantella to 2.89 for Aldabra giant tortoise *Aldabrachelys gigantea*. Other relatively large coefficients were observed for panther chameleon *Furcifer pardalis* ($\beta=2.77$), Komodo dragon ($\beta=2.69$) and king cobra ($\beta=2.55$). The estimated coefficient for axolotl *Ambystoma mexicanum* was 1.53 (Figure 3). All species-specific feeling coefficients were significantly greater than zero (all $P<0.001$). Following Holm adjustment for 45 pairwise comparisons, five significant differences in feeling slopes were identified. The feeling–likelihood association was significantly weaker for Golden mantella than for Aldabra giant tortoise (adjusted $P=0.0077$), Annam leaf turtle ($P=0.0363$), Green anaconda ($P=0.0464$), King cobra ($P=0.0112$) and Komodo dragon

($P=0.0168$). No other pairwise comparisons remained statistically significant following adjustment.

These findings suggest that the strength of the association between feeling and visitation likelihood varies among species, with Golden mantella exhibiting a shallower association than several other species. However, differences in slope magnitude should not be interpreted as differences in absolute species popularity or overall visitation likelihood. Awareness was not significantly associated with visitation likelihood in the species–interaction model after accounting for feeling and species ($\beta=-0.030$, $SE=0.096$, $P=0.755$).

Further interaction models were investigated but did not significantly improve model fit (See Supplementary material S2). Proportional odds diagnostics and sensitivity analyses were undertaken indicating that across all ten species, feeling was positively associated with visitation likelihood at each of these three thresholds. Species-specific coefficients ranged from 1.83 to 3.31 for likelihood ≥ 3 , from 1.49 to 3.24 for likelihood ≥ 4 , and from 1.20 to 3.40 for likelihood=5. All species-specific feeling associations were statistically significant at each threshold (all $P<0.05$) (see supplementary material S3).

Discussion

Our findings suggest that charismatic potential exists within taxa that are traditionally underrepresented in flagship conservation. Across a diverse set of reptile and amphibian species, positive affect evaluation (feeling) consistently predicted willingness to engage with conservation-relevant contexts, regardless of taxonomic group, body size, or baseline familiarity. This suggests

that conservation communication strategies may systematically underestimate the appeal of non-mammalian taxa by relying on overly narrow conceptions of charisma.

The strong association between affective evaluation and hypothetical engagement aligns with existing work demonstrating that emotional responses play a central role in shaping conservation support (Colleony et al. 2017; Albert et al. 2018). Importantly, our results indicate that such affective responses can be elicited by species that lack traits traditionally associated with “charismatic megafauna”. Small-bodied, brightly coloured amphibians and reptiles, such as axolotls, dyeing poison dart frogs *Dendrobates tinctorius* and chameleons, received some of the highest affective scores, suggesting that aesthetic features like colouration and neotenus appearance may compensate for the absence of large size. This supports previous findings that body size alone is an incomplete proxy for charisma (Berti et al. 2020) and highlights opportunities to diversify flagship species selection. Species commonly associated with fear or danger, including snakes, were evaluated less positively on average, consistent with studies documenting phobia responses to reptiles (Prokop et al. 2024). Notably, awareness was a weaker and less consistent predictor of engagement than affective evaluation. This finding challenges the assumption that familiarity alone drives conservation interest and suggests that increasing public knowledge without addressing affective framing may have limited impact. Conservation campaigns that prioritise emotional resonance through visual appeal, narrative framing, or perceived vulnerability, may therefore be more effective than those that rely solely on information provision.

These results have implications for efforts to address taxonomic bias in conservation funding and messaging. Flagship species are frequently selected based on perceived public appeal, yet this appeal is often inferred rather than empirically tested. By demonstrating that reptiles and amphibians can elicit affective responses associated with engagement, this study supports calls to broaden informed species selection and highlight the charismatic potential of reptiles and amphibians in practice (Smith et al. 2012; Ducarme et al. 2013).

Several limitations should be considered when interpreting these findings. First, the cross-sectional observational design prevents causal conclusions regarding the relationships between awareness, feelings and stated visitation likelihood. The absence of an independent awareness association after adjustment for feeling does not establish that awareness has no influence on visitation decisions, nor does it demonstrate that its association is mediated by feeling. Additionally, zoo contexts may themselves influence perceptions of species rarity, vulnerability, and conservation relevance, which could in turn affect perceived charisma and willingness to engage (Rizzardi Orlandi et al. 2026).

Second, the feeling measure incorporated both likeability and interest, potentially introducing conceptual overlap with stated visitation intention. Consequently, the strong association between feeling and likelihood may partly reflect related evaluative constructs rather than entirely distinct psychological processes. Future research should disentangle these dimensions and test whether affect-driven engagement translates to concrete conservation behaviours, such as donations or policy support. Nonetheless, the consistency of patterns across taxa suggests that the core findings are robust enough to inform hypothesis generation and strategic experimentation in conservation communication.

Finally, the outcome represented self-reported hypothetical likelihood of visiting rather than observed visitor behaviour. The

extent to which these stated intentions predict actual visitation or engagement with particular species remains to be established.

Overall, our findings indicate that charismatic potential is not confined to mammalian flagship species and that conservation strategies grounded in mammal-centric assumptions may be unnecessarily limiting. Broadening the range of species considered capable of eliciting public engagement could help mitigate taxonomic bias and better align conservation priorities with global patterns of biodiversity threat.

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