Research Article

Feathered Icons: Drivers of Global Attention on Bird Species

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Global biodiversity faces profound threats. Efforts to slow biodiversity loss remain inadequate without greater public engagement. With challenges in the biases of species knowledge across taxa and regions, many endemic or threatened species receive insufficient attention. Birds, with their ecological importance and cultural visibility, present an ideal object for exploring biases in species knowledge. To understand factors driving scientific and public interest in birds, we compiled a comprehensive dataset to investigate how phenotypic, ecological, and cultural factors influence attention toward global bird species. Our analysis reveals that factors related to public familiarity and species charisma significantly shape public and scientific priorities. In contrast species that are threatened or have limited ranges often receive little public attention. IUCN status alone fails to sustain public interest in these species. To address this imbalance, we propose comprehensive strategies such as media campaigns and conservation education to better engage the public and scientific communities. These efforts are crucial for ensuring conservation efforts could encompass a sufficient range of species.

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Introduction

In the Anthropocene, the threats to global biodiversity are well-documented, yet slowing the current rates of biodiversity loss remains a significant challenge[1][2][3]. Numerous conservation policies have been developed to protect the global biodiversity, but these policies often rely primarily on biological criteria, such as species richness or threat levels based on the IUCN Red List, without fully integrating social and cultural factors[3][4]. This oversight may exacerbate existing inequalities in conservation efforts by channeling funding and resources to a narrow subset of species, ignoring those that are less familiar to the public but vital for ecosystem or local cultural practices[5][6].

Human values and the actions increasingly affect many species[7]. To advance more balanced conservation efforts, it is necessary to increase the public understanding of species[8]. As outlined in the Kunming-Montreal Global Biodiversity Framework (GBF), the awareness-raising campaign of public awareness includes a visual identity, and public-facing messages for the goals and targets[9]. This campaign aims to engage all of society to halt and reverse biodiversity loss. Specifically, GBF Target 21 calls for accessible "best available data, information and knowledge" for decision makers, practitioners and the public to guide biodiversity management. Therefore, improving public awareness of species is crucial for the success of conservation interventions, as it can encourage more favorable attitudes towards biodiversity conservation and then promote behavioral change that enhances conservation efforts[10].

Scientific knowledges about species and relevant ecosystems are important to conservation efforts as well[11]. The success of conservation efforts hinges on the availability of a robust body of evidence-based research about the species or habitats in question[12]. While science can influence public attention through effective communication and media coverage, societal priorities, shaped by policy and funding, can in turn guide the direction of scientific research[5].

Despite the importance of public and scientific engagement, knowledge about species is often unevenly distributed both taxonomically and geographically[13][14]. Charismatic animals, such as tigers (*Panthera tigris*), lions (*P. leo*), and great apes, gain significant attentions from both the public and researchers[15][16], whereas other groups, such as insects, receive far less concern and conservation support, despite their essential role in ecosystems[17][18]. This bias poses serious risks for species that need conservation but fail to attract sufficient attention and conservation resources.

The biases in species knowledge are influenced by various factors. Phenotypic traits, such as body size and coloration, directly influence species charisma and feasibility for research[19][20][21]. Large mammals[15][19] or colorful birds[22][23], butterflies[24] and plants[21] are more likely to be appreciated by their charisma, while smaller or cryptic species, like many insects[17][18], are frequently overlooked. Ecological factors, such as abundance and range size, also play key roles. Species with larger populations and broader distribution ranges are more likely to be studied and recognized by the public[25][26]. Conversely, geographically restricted species, often found in regions with low human development indices, are more vulnerable to extinction but receive less attention than common species[27]. Moreover, cultural labels of species can further skew the distribution of attention and conservation resources. For example, birds like the bald eagle (*Haliaeetus leucocephalus*), used as team mascots, are tied to cultural and patriotic identities. The cultural significance of these species as mascots increases public attention and conservation efforts[28].

Specifically, the effect of conservation status, as assessed by the IUCN Red List, varies widely across taxonomic groups and geographic regions. Threatened species may attract attention through conservation efforts and media publicity[25][29]. For example, reptiles listed by the IUCN as threatened with extinction attract more interest[30]. However, many species, such as plants and insects, remain overlooked due to a lack of familiarity or appeal[11][16][18][21][31], raising questions about the sufficiency of the IUCN status in sustaining interest from both the public and scientific communities.

Birds hold a unique position within both ecological systems and human culture, making them an ideal group for studying biases in species knowledge. Birds play critical roles as pollinators, seed dispersers, and pest controllers, contributing significantly to ecosystem health[32]. Additionally, birds have long been admired for their beauty, songs, and flight, becoming enduring symbols in art, literature, and mythology[33][34]. Birds also provide substantial economic and recreational benefits. For example, birdwatching and avitourism generate significant revenue, foster a greater appreciation for nature, and benefit local economies[35][36]. However, there remains a significant gap in understanding the factors that shape both public and scientific interest in bird species. Existing studies often focus on a narrow set of factors[25] or limited regions[37][38][39], lacking a comprehensive global analysis that considers a broader range of influences.

To address this gap, we undertake a comprehensive assessment of global bird species based on extensive datasets (Figure 1). First, we aim to identify the factors that affect scientific and public interest in bird species, focusing on phenotypic traits, ecological factors and cultural factors. Second, we investigate whether threatened or endemic species attract more or less attention compared to other species. Third, we explore opportunities to enhance public knowledge of bird species to achieve a more balanced understanding of global bird biodiversity. By answering these questions, we hope to develop strategies that can elevate attention towards overlooked species and contribute to more effective global conservation efforts.

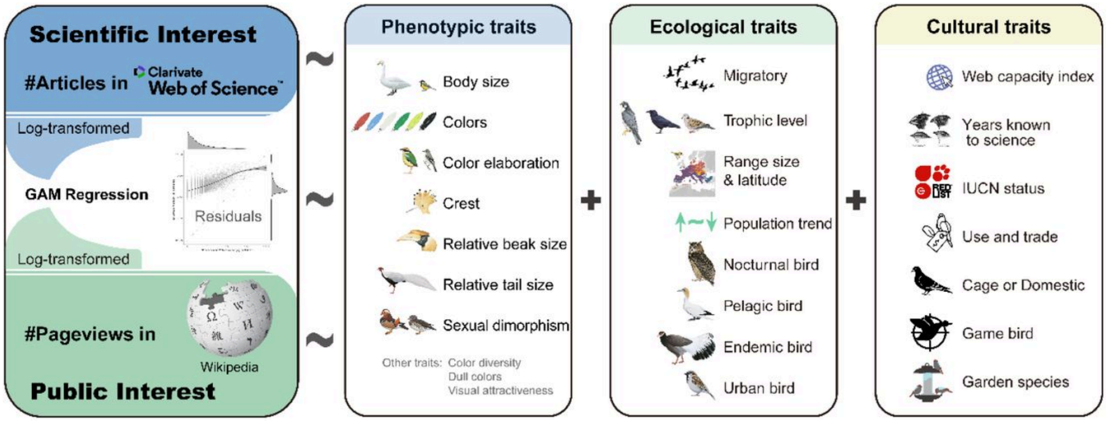

Figure 1. Regression workflow and most important variables in regression models. The response variables (left) included scientific and public interest and their residuals after generalized additive regression (GAM). The scientific interest was indicated by the number of articles indexed in the Web of Science that refer to a given species. The public interest was indicated by the total number of pageviews across the languages on the species page on Wikipedia. The relative interest of scientists and the general public was measure by the GAM regression residuals. The predictor variables include phenotypic traits (e.g., body size, colors, color elaboration, crest, relative beak and tail size and sexual dimorphism), ecological factors (e.g., migratory ecology, trophic level, range size, latitude, population trend, whether the bird is nocturnal, pelagic, endemic or urban) and cultural traits (e.g., web capacity index, years known to science, IUCN status, use and trade, cage or domestic, game bird and garden species). We the modelled the response variable and predictor variables to quantify the effect of these factors on the scientific and public interest of bird species. The bird illustrations refer to the illustrations In Birds of the World (S. M. Billerman, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA.

Results

Distribution of scientific and public interest

The number of scientific papers focusing on bird species varied by four orders of magnitude and exhibited a highly skewed distribution (median ± SE = 2 ± 2.37, range = 0 - 9606) (Figure 2). Notably, 29.14% of bird species lacked scientific papers associated with their scientific name in the Web of Science. A small number of species attracted substantial scientific attention, for instance, *Gallus gallus*, appearing in 9606 scientific papers. In contrast, Wikipedia pageviews showed a less skewed distribution but a greater disparity across species (median ± SE = 55410 ± 9990.68; range = 6,066-19,459,648) (Figure 2).

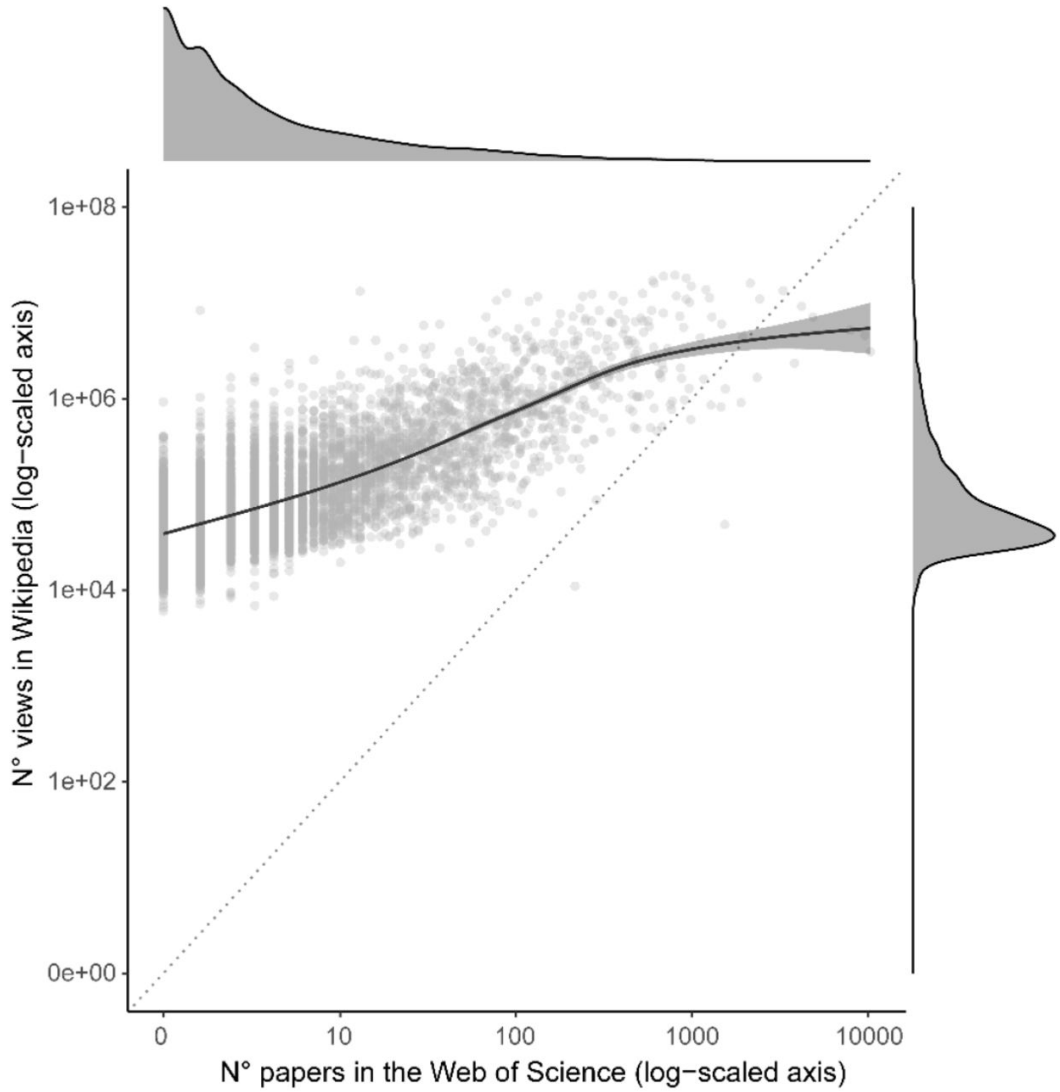

Figure 2. Relationship between public and scientific interest across the bird species. Relationship between number of views in Wikipedia (public interest) and number of papers in the Web of Science (scientific interest) for each species. Both axes are log-scaled to ease visualization. Density functions are provided for both scientific (above scatter plot) and public interests (right of scatter plot) to illustrate the distribution of values. The regression line is obtained by fitting a Gaussian generalized additive model through the data ($F_{8,647}$ = 2,056,624; p < 0.001). The farther away a dot is from the fitted line, the more the attention is unbalanced toward either scientific (negative residuals) or public interest (positive residuals).

doi.org/10.32388/OW9FIJ

Drivers of scientific and public interest

We modeled scientific and public interest in relation to phenotypic traits, ecological traits, and cultural factors (Figure 3). This analysis revealed a set of drivers associated with high scientific and public interest, with a considerable overlap in scientific and public priorities. Phenotypic traits were more important in the public interest model (14% of explained variance) than in the scientific interest model (9%), where species with larger body mass were more attractive to both scientists and the general public. In contrast, ecological factors played a more important role in explaining scientific interest (10%) than public interest (2%). Species with larger range sizes, higher latitudes, and increasing populations received greater scientific and public attention, and so as migratory and urban birds. Carnivorous species, however, attracted less scientific and public interest. While cultural factors explained less variance in scientific interest (4%) and public interest (3%), phenotypic and cultural factors together explained 19% of explained variance in scientific interest and 12% in public interest. Cage or domestic, game birds, and garden species received more scientific and public interest. Birds with higher web capacity indices and longer histories known to science received more scientific and public interest.

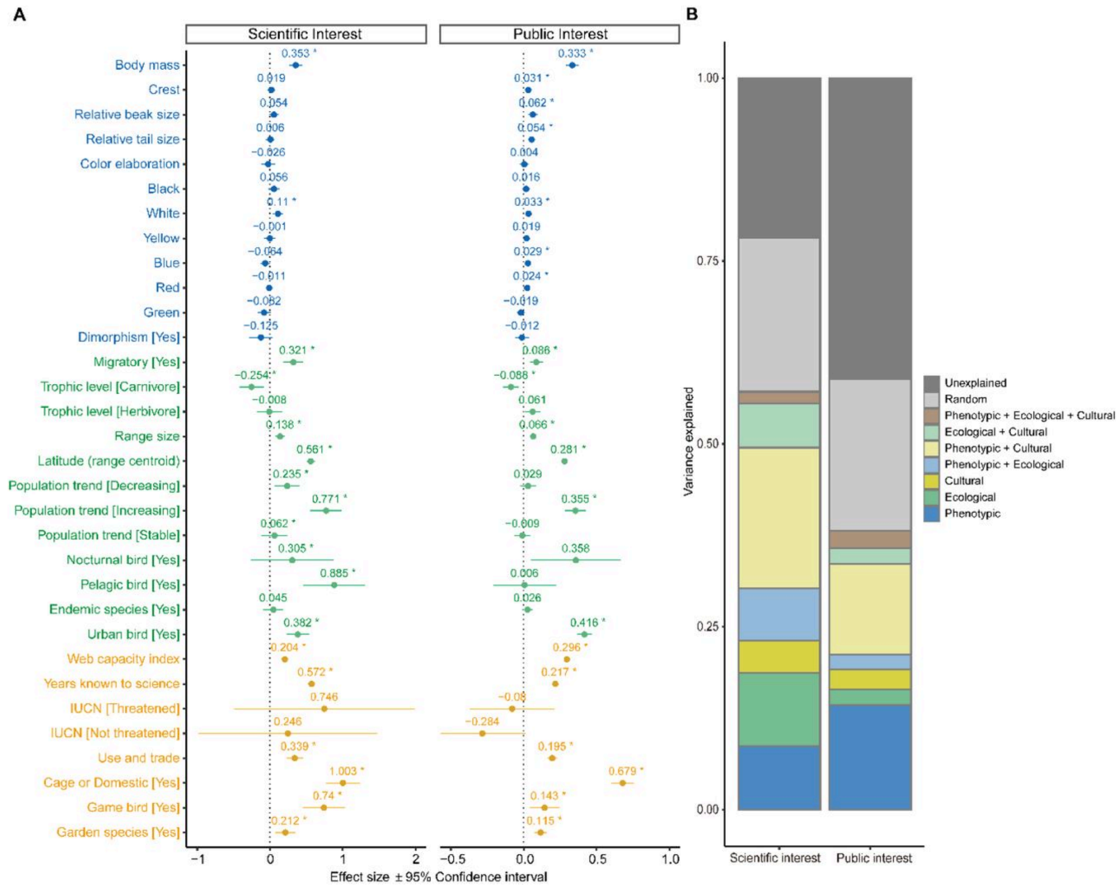

Figure 3. Drivers of scientific and public interest across bird species. (A) Forest plots summarize the estimated parameters (effect size mean ± 95% CI, N = 8646) based on (truncated for scientific interest model) negative binomial generalized linear mixed models (Eq. 1). Baseline levels for multilevel factor variables are: Trophic level (Omnivore), Population trend (Unknown) and IUCN (Unknown). The left one modelled scientific interest (marginal R2 = 0.683), and the right one modelled public interest (marginal R2 = 0.555). Asterisks (*) mark significant effects ($\alpha = 0.01$). Estimated regression parameters and p-values are in Table S2. (B) Outcomes of the variance partitioning analysis, whereby we partitioned out the relative contribution of phenotypic traits (dark blue), ecological (dark green) factors, cultural factors (dark yellow) and their joint contribution. Unexplained variance is the amount of unexplained variance after considering the contribution of random factors related to species' taxonomy (as obtained via conditional R2).

Some factors were specifically associated with scientific or public interest (Figure 3). A large beak, tail, crest and more blue, red, and white coloring helped birds receive more public interest. The color diversity of bird species, however, negatively affected the scientific interest in them (Figure S2).

Pelagic birds attracted more scientific attention. Specifically, while both researchers and the public showed more interest in threatened species compared to non-threatened species, the IUCN status attracted little attention from the public compared to scientists.

Bias between scientific and public Interest

In most orders of bird species, the scientific interest was consistent with public interest (Figure S1). We modeled the bias between scientific and public interest (indicated by the residuals in Figure 2) in relation to phenotypic traits, ecological traits, and cultural factors. Various factors drive the bias between scientific and public attention among bird species. Species with higher visual attractiveness score, representing more red and blue colors, larger crests, longer tails, and larger body mass tend to attract more public interest than scientific interest (Figure 4, S7). Urban birds attracted more public attention, whereas pelagic birds attracted more scientific attention. Furthermore, birds involved in use and trade, or classified as cage or domestic and game species, with higher web capacity indices and longer history known to science, attracted more public interest. Game birds and those listed on the IUCN Red List, however, attracted more scientific interest (Figure 4).

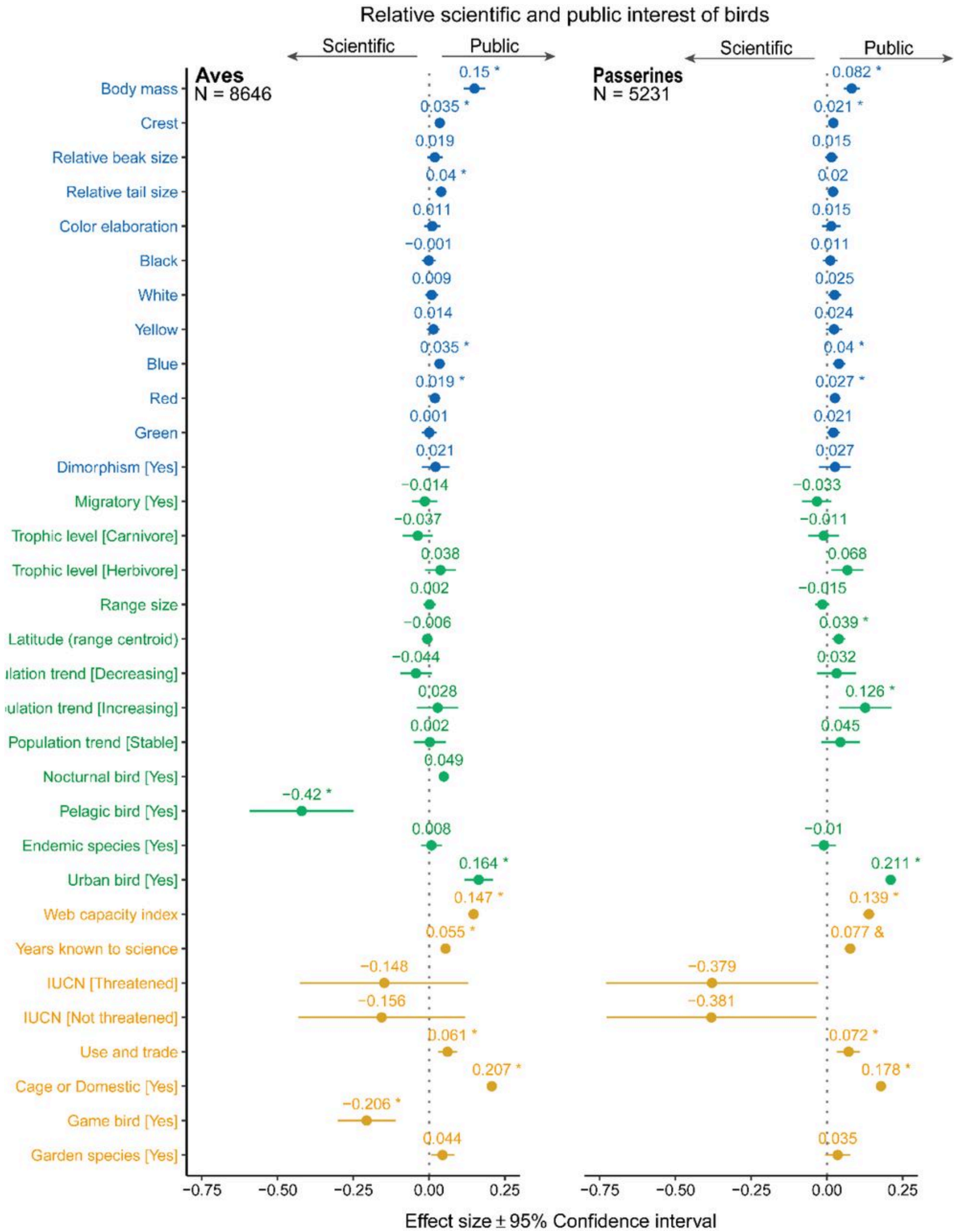

Figure 4. Drivers of relative scientific and public interest across bird species. Forest plots summarize the estimated parameters (effect size mean ± 95% CI) based on Gaussian linear mixed models testing the relationship between residuals from the regression line in Figure 2A and possible drivers, include phenotypic traits (blue), ecological (green) and cultural factors (yellow). Positive residuals indicate species with a greater popular than scientific interest, and negative values indicate the opposite way (Figure S1). Factor baselines: Trophic level (Omnivore), Population trend (Unknown) and IUCN

(Unknown). The left one was model on all the bird species (marginal R2 = 0.178, N = 8646), and the right one focused on passerines (marginal R2 = 0.202, N = 5231). Asterisks (*) mark significant effects (α = 0.01). Estimated regression parameters and p-values are in Table S1.

We further explored this disparity by rerunning the analysis using a subsample, Passeriformes, which constitute more than half the bird species (Figure 4). While most results were consistent with the main model, an increasing population (Main: 0.0283 ± 0.0350; Passeriformes: 0.1262 ± 0.0444) and a higher latitude (Main: -0.0058 ± 0.0093; Passeriformes: 0.0392 ± 0.0107) were more important, and a larger body mass was less important (Main: 0.1498 ± 0.0181; Passeriformes: 0.0818 ± 0.0139) for a passerine to attract more public than scientific attention.

Discussion

Through a comprehensive assessment, our study provides valuable new insights into the drivers of public and scientific interest in bird species. The findings indicate that cultural factors, such as birds used and traded in aviculture, as pets, or hunted as game, were among the strongest drivers of both public and scientific attention. Additionally, species in regions with greater internet access and those that were scientifically recognized earlier tended to attract more interest. Notably, the IUCN conservation status garnered little public attention compared to scientific interest. Ecological factors also played a crucial role. Species with larger ranges, higher latitudinal distribution, migratory behaviors, urban adaptability, and expanding populations were more likely to capture both public and scientific interest. In terms of phenotypic traits, larger birds received more scientific and public interest. Birds with more blue or red plumage, larger beaks, and longer tails, received more attention from the public. These results underscore the ongoing bias in how birds are perceived and studied, with many lesser-known species remaining overlooked despite their conservation needs. The following discussion explores these drivers in more detail, focusing on the role of use and trade of birds, public familiarity, species charisma, and the limited impact of IUCN status on sustaining public interest. Finally, we propose strategies to bridge the gap between public awareness and conservation priorities.

The role of bird use and trade in shaping species awareness

Our results revealed that birds involved in trade and human use, especially those having a history kept by humans, attracted more scientific and public attention. This finding aligns with previous research on the internet salience of birds[25], where domesticated birds and game species showed high visibility online. The long-standing traditions of aviculture and bird keeping[40] have increased their familiarity with humans. Besides, these birds provide controlled environments for studying behavior, physiology, and genetics, such as chicken (*Gallus gallus domesticus*)[41], facilitating research that would be challenging to conduct with wild populations.

However, the strong public interest in bird keeping also raises significant conservation concerns. The high demand for exotic birds has led to unsustainable harvesting from wild populations, putting additional pressure on species already vulnerable due to habitat loss and environmental degradation[42][43]. Without stronger regulations, the wild bird trade risks exacerbating the decline of many species, particularly those highly valued for their appearance or rarity.

The scientific and public interest towards game species is well pronounced as well. With a widespread cultural legacy, hunting is frequently connected with self-esteem, history and cultural identity of both modern and ancient societies, bringing public attention to those game species[25]. Meanwhile, the underlying scientific value of game birds remains substantial. Studying game birds is crucial today as their management practices can significantly impact biodiversity, benefiting some non-game species while harming others[44]. Understanding these trade-offs helps develop strategies to enhance conservation efforts, attracting significant research attention.

Species charisma drives public attention

The direct aesthetic appeal of phenotypic traits is a strong predictor of public interest. Birds with more visually striking appearances tend to garner more public attention, aligning with previous studies on the appeal of charismatic species[15][16]. Specifically, we observed a strong public preference for birds with blue and red plumage, while species with brown and grey coloration were less favored. This preference has been evidenced to be strongly associated with aesthetic preference[22][23][39][45]. Although color diversity and elaboration are positively linked to visual attractiveness[23][46], they did not significantly influence public attention in our findings. Interestingly, we found that species with higher color diversity attracted less scientific interest. This may be due to the association between bird

doi.org/10.32388/OW9FIJ

color diversity and human disturbance, as species with fewer colors are more common in human-modified environments, leading to greater exposure and public familiarity[47][48].

While some studies suggest that small birds have higher visual attractiveness[29][39] and online popularity[24][49], our global-scale analysis incorporating various comprehensive variables revealed that body size is one of the strongest predictors of both scientific and public interest. Larger species consistently attract more attention than smaller ones. This pattern is consistent across a wide range of taxa, including vertebrate species[19] and species across the tree of life[29]. Larger birds, such as raptors, tend to be more noticeable and iconic, while smaller species, like songbirds, may receive less attention due to their ubiquity and difficulty in identification[50]. However, some variability exists within groups; for instance, the relationship between body size and interest is less pronounced among Passerines, where other factors such as behavior or song may play a stronger role[50].

Charismatic species, often those with striking phenotypic traits or significant cultural associations, tend to attract more attention and funding[16]. While this can be beneficial for the conservation of these species, it poses challenges for less charismatic species that are equally or more threatened[16][39]. The focus on charismatic species can divert resources away from less appealing but ecologically important species, leading to gaps in conservation efforts.

Addressing these biases is essential for ensuring that non-charismatic species, which may play critical roles in their ecosystems, receive adequate attention and resources. Achieving a balance between charismatic and non-charismatic species is critical for the holistic conservation of biodiversity.

Familiarity as a driver of both scientific and public interest

Our analyses indicate that species with larger range sizes and those distributed at higher latitudes attract more scientific and public interest. Similarly, migratory, urban, or expanding populations receive more attention from scientists and the public. These characteristics are likely associated with high levels of public familiarity, particularly due to the widespread distribution of many urban-associated bird species[51]. Additionally, urban populations generally have better internet access and are more likely to contribute a larger share of web content[25]. Previous studies have shown that species familiarity strongly correlates with visual appeal[23], internet interest[25][28][52], and scientific interest[21], suggesting that familiarity is appealing. The greater number of internet users in temperate and higher latitudes may also explain why birds at higher latitudes attract more attention.

In contrast, pelagic birds, while less commonly encountered, attract strong scientific interest due to their unique adaptations and behaviors. Their extensive geographic ranges and pelagic habits expose them to diverse culture[25]. As highly mobile species, pelagic birds provide fascinating opportunities for research into migration, foraging, and ecological interactions, such as their use of olfactory maps for oceanic navigation[53].

As expected, the web capacity index and the number of years since a species was first scientifically named are positively associated with both scientific and public interest. When the public is familiar with the species, the species tend to be more prominent in regions with greater internet usage, where public familiarity and internet salience reinforce one another[25][54]. Furthermore, with historical biases in geographic distribution and traits, along with the time-lag between scientific recognition and cultural significance, species named earlier tend to receive more attention[55][56].

Familiarity plays an important role in shaping public awareness of species. Species that are more visible and commonly encountered tend to receive more attention from the public, contributing to heightened awareness of their ecological roles and conservation needs[38]. This increased public awareness can drive support for conservation efforts, particularly when species are culturally significant or symbolically important[57]. However, familiarity can also lead to misconceptions about the conservation status of the species. Familiar species are often perceived as abundant, well-protected, or extensively studied, which may not always be the case[58]. This misperception can reduce public support and funding for their conservation. It is therefore critical to increase awareness not only of the conservation needs of familiar species but also of lesser-known ones, in order to garner broader support for conservation initiatives.

Limitations of IUCN status in sustaining public interest

The spatial and phylogenetical bias in scientific and public attention given to bird species, while less pronounced than in other taxa[29], still reflects a significant imbalance. Specifically, species with a smaller range size and lower latitude received less attention from both scientists and the public. As bird species richness peaks around the equator[51], this concentration of interest on a few, often more familiar, species leaves many others under-studied and under-protected. This imbalance hinders comprehensive biodiversity conservation efforts. To effectively preserve biodiversity and foster cultural awareness for long-term sustainability[20][52], it is crucial to address this bias and develop conservation strategies that encompass a broader range of species.

Notably, conservation rarity, as indicated by IUCN status, is a significant driver of scientific interest. Contrary to the previous study on European birds[37], our findings show that threatened species attract more attention from both researchers and the public compared to unthreatened species. Many threatened species, such as reptiles listed by the IUCN as threatened, attract attention through conservation efforts and media publicity[25][29][30]. However, compared to Chordata and species across the tree of life[29], birds still receive little public attention through the lens of IUCN assessments. This pattern is consistent in many taxa, such as plants and insects, which remain overlooked, even when listed as threatened[11][16][18][21][31]. One reason for this discrepancy could be the public's familiarity with bird species. Because birds are generally well-documented and familiar to many people, there may be a perception that they are less in need of attention compared to other less familiar taxa. This familiarity can lead to a bias where the public assumes that bird species are already well-protected and extensively studied, thereby diverting interest and resources to other groups[59].

Furthermore, threatened bird species are often less common and less visible in everyday environments, making the urgency of their conservation status less apparent to the general public[18]. The plight of small threatened birds, may be overshadowed by the charismatic appeal of other large animals, such as large mammals[15], further contributing to the disparity in attention and conservation efforts. This highlights the limitations of relying solely on IUCN status to generate sustained public interest.

While the IUCN status highlights species at risk, our findings suggest that it is not sufficient on its own to sustain long-term interest and promote effective conservation. To address this gap, it is essential to re-evaluate the role of IUCN status in driving public and scientific interest, and to develop more comprehensive strategies for engaging the public and scientific community. These could include targeted outreach programs, better integration of conservation messaging into media, and leveraging technology, such as citizen science platforms, to make the public more aware of less visible species[60]. Additionally, incorporating ecological significance and the role of species within their ecosystems into public narratives may help generate broader support for conservation efforts beyond just relying on the IUCN Red List[61].

Opportunities to align public awareness with conservation priorities

The bias in public and scientific attention revealed by our study, driven by various factors associated with species charisma, familiarity, and their conservation status, highlight significant challenges for biodiversity conservation. Charismatic species or those commonly involved in use and trade receive a disproportionate amount of attention, while many ecologically important but less visible species are often ignored. These biases hinder the effectiveness of conservation efforts, as many species remain overlooked by both the public and scientific communities.

One promising approach to bridging the gap in public awareness is through targeted media campaigns. These tools have proven effective in creating emotional connections between the public and wildlife, often leading to greater engagement with conservation efforts. For instance, natural history films such as "Planet Earth 2" has been instrumental in raising public awareness of species, prompting audience engagement with conservation-related content at levels similar to those achieved by dedicated conservation campaigns[62]. Media platforms provide an ideal opportunity to expand public attention beyond charismatic megafauna, highlighting the unique ecological roles of lesser-known species. For example, a study found that 43.8% of species saw a rise in information-seeking behavior during their dedicated awareness days, underscoring the potential of promoting lesser-known species through targeted events[10]. By shifting focus to underrepresented species, media campaigns can reshape public interest and encouraging broader support for biodiversity conservation.

In addition to media campaigns, integrating conservation topics into educational curricula offers a long-term solution for aligning public awareness with conservation priorities. Research has shown that classroom discussions around conservation can significantly improve student engagement with biodiversity issues. For example, studies on high school students found that decision-making discussions during science lessons enhanced personal reasoning and fostered greater student participation in conservation efforts[63]. Interactive assignments like the Biodiversity Challenge have also been shown to increase student engagement, particularly by raising awareness of lesser-known species and promoting a deeper understanding of biodiversity conservation[64]. Educational approaches like these are crucial for fostering early engagement with biodiversity, helping to build a generation of conservation advocates who are knowledgeable about the importance of protecting all species, regardless of their visibility or appeal[65]. This long-term strategy ensures that conservation awareness is cultivated early, making students more likely to support comprehensive conservation efforts in the future.

Conclusion

Through a comprehensive assessment of global bird species, we revealed that the bias in public and scientific interest are primarily driven by factors associated with species charisma, familiarity, as well as their conservation status. However, the IUCN status showed limited effect on sustaining public interest public attention. Moreover, many ecologically important but less visible and charismatic species are often overlooked. To foster more effective and balanced conservation efforts, strategies must better engage both the public and scientific communities. For example, leveraging media campaigns can promote lesser-known species to a boarder audience, while integrating conservation education into school curricula can foster long-term public awareness. Although our research incorporated a wide range of comprehensive factors to assess global scientific and public interest in birds, internet-based methods may not fully capture the complexities of public interest, especially in regions with limited internet access. By addressing the underlying drivers of scientific and public interest, conservation efforts can be better aligned to protect a diverse range of species, ensuring their survival and the preservation of biodiversity.

Methods

To investigate the factors driving scientific and public interest in global bird species, we selected a set of candidate factors associated with phenotypic, ecological, and cultural traits, along with two indicators assessing the scientific and public interest. Scientific interest was measured by the number of articles indexed in the Web of Science, while public interest was assessed using Wikipedia pageviews across all available languages. After data preparation and exploration, we applied Gaussian linear mixed models to quantify the impact of these factors on both scientific and public interest, as well as the bias between them.

Selection of candidate factors

From a comprehensive dataset of nearly all extant bird species[23], we collected various phenotypic traits, including coloration (e.g., the amount of red, blue, and green), color elaboration (i.e., the extent to which the overall plumage deviates from a dull brown-grey coloration), color diversity (the number of occupied color loci), body mass, the length of crest, tail, and beak, and visual aesthetic attractiveness scores at both the species and sex levels.

Based on a dataset[25], the ecological variables included nocturnal birds (species primarily or entirely nocturnal in their activity patterns), pelagic birds (seabirds with extensive geographic ranges that spend a significant portion of their life cycle in the pelagic environment), endemic species (species with distributions restricted to a single country), and urban birds (species recorded as inhabiting anthropogenic environments). Population trend data were obtained from the IUCN Red List of Threatened Species 2024(1)[66] by querying the IUCN Red List API v4 using the Python package '*requests*' version 2.32.3[67].

Range size, latitude of the species range, trophic level, and migration ecology were obtained from AVONET[68] and processed according to the procedures suggested by Santangeli et al.[23]. For each species, range size was defined as the size of the resident or breeding range. To account for potential latitudinal patterns, we determined the latitude of the centroid of each species' range. Species-specific trophic levels were categorized into three groups: carnivores (including all predators, scavengers, and invertivores), omnivores, and herbivores. Similarly, migratory status was classified into two categories: migratory species (either partial or full migrants) and non-migratory species (residents).

Baes on the dataset of Ladle et al.[25], cultural factors included cage or domestic species (species historically kept by humans for pleasure or food), game species (species actively hunted for recreation), garden birds (species commonly found in rural gardens), Web Capacity Index (percentage of global internet users in countries where the species is present), and years known to science (the number of years since the species was scientifically classified). Additionally, conservation rarity, measured by the IUCN Red List status, was identified as a significant driver of scientific and public interest. We extracted threat status from the IUCN Red

List of Threatened Species 2024(1) and reclassified this variable into three categories to balance factor levels: threatened (including 'Vulnerable', 'Endangered', and 'Critically Endangered' species), non-threatened (including 'Least Concern' and 'Near Threatened' species), and unknown status (including 'Data Deficient' and 'Not Evaluated' species). We also collected the 'Use and Trade' status from the IUCN Red List of Threatened Species 2024(1), which recorded whether whole individuals or parts/products from individuals are harvested from the wild for use.

Furthermore, species with a common name tended to attract more scientific and public interest[29][69]. For each bird species in the dataset, we queried the GBIF API using the Python package ‘*requests*’ to collect vernacular names in various languages[70]. However, since the majority of birds have a common name, particularly in English, this variable was deemed redundant and statistically insignificant for our analysis. Consequently, it was excluded from further consideration.

Measures of scientific and public interest

We gathered data on two indicators reflecting human attention towards bird species, related to scientific and public interests.

We measured scientific interest as the number of articles indexed in the Web of Science that refer to a given species. This is a standard quantitative estimate of research effort toward individual species[21][29][71]. We collected the data using the Python package ‘*clarivate wos starter python client*’[72]. Specifically, following the procedure previous study suggested, we queried the Web of Science’s Core Collection database using topic searches (‘TS’) and the species scientific name as the search term, and recorded the total number of references published between 1945 and 2024, i.e., PY= (1945-2024).

We measured public interest for each species as the total number of pageviews across the languages where the species is represented on Wikipedia. As one of the top 10 most visited websites in the world (https://www.similarweb.com/top-websites, accessed on Sep 1, 2024), Wikipedia provides a vast source of information for bird enthusiasts, with the majority of bird species containing a page in this digital encyclopedia. Wikipedia data has also been widely used to explore patterns of public interest in biodiversity, where total pageviews was often selected as a particularly useful metric[29][69]. To extract the number of pageviews for each species, we first obtained the identification number of each species from the Wikidata knowledge base using the Python package ‘*qwikidata*’ version 0.4.2[73]. We then used each species’ identifier to query Wikidata API to get the title of each species’ page in the available languages. Finally, we queried Wikimedia REST API with the title and the language of each page to collect the monthly user pageviews (i.e., excluding views by bots) for the period between January 1, 2008, and December 31, 2023.

Data analysis

We ran all analysis in R version 4.3.2[74], using the *tidyverse*[75] suite for data handling and visualizations. We followed the general protocol for conducting and presenting results of regression-type analyses[76]. We used the package '*glmmTMB*' version 1.1.9[77] for modeling and '*ggplot2*' version 3.5.1[78] for visualizations. For model validation, we used the suite of functions of the package '*performance*' version 0.12.2[79] to visually inspect model residuals and evaluate overdispersion, zero-inflation, and multicollinearity. Given the large sample size of our dataset, we used a conservative approach in the identification of significance, setting an alpha level for significance at 0.01 instead of the usually accepted 0.05[80]. In interpreting results, we used an evidence-based language, whereby we focused on effect sizes and direction of effects rather than significance (i.e., p-values)[81]. We listed exact p-values in Supplementary tables.

Data preparation

Given that many bird species exhibit sexual dimorphism, with distinct phenotypic traits for males and females, and that the metrics chosen to reflect scientific and public interest were only available at the species level, data aggregation was necessary prior to analysis. To address this, we aggregated gender-specific traits to the species level. As previous studies have suggested, birds with more elaborate colors and multi-colored plumages are more visually attractive. For dimorphic species, we selected the gender with higher color elaboration and diversity to represent the species. If both genders exhibited the same values for color elaboration and diversity, we averaged the non-color traits (body mass, crest length, tail length, beak length, and visual aesthetic attractiveness). Additionally, we included a binary variable to indicate whether the species exhibits sexual dimorphism. This approach ensured that the most visually representative traits were used in our analysis, maintaining consistency and relevance in our evaluation of scientific and public interest.

To evaluate the effect of different aggregation methods, we employed an alternative approach. For dimorphic species, we retained the color traits of the gender with higher color elaboration and diversity, while averaging the non-color traits. The same data analysis procedures were applied to these aggregated datasets to assess the impact of different aggregation methods on our results, ensuring the robustness and reliability of our findings.

Data exploration

Data exploration was conducted following the protocol described by Zuur, Ieno, and Elphick[82]. Prior to model construction, we visually inspected variable distributions, the presence of outliers, multicollinearity among predictors, and the balance of factor levels. The color variables were processed in a manner analogous to that employed by Santangeli et al.[23], as the data structure was comparable.

We log-transformed body mass and range size to homogenize their distributions and minimize the effect of outliers. All continuous variables were scaled (to a mean of zero and a standard deviation of one) to obtain comparable effect sizes and facilitate the convergence of regression models. Following multicollinearity testing with Pearson's r correlations, we dropped the variable color diversity as it correlated ($|r| > 0.6$) with several other color variables, and tested its effect in a separate model. Most color variables were also correlated, so we retained six uncorrelated colors (black, white, yellow, blue, red, and green) in the model, capturing most of the chromatic variability across birds. Notably, the excluded colors (purple, brown, grey, and rufous) represent colors closer to the global color average across all species, meaning that these are well captured as a group by the lowest values of the color elaboration variable. We tested the effect of these excluded dull colors in a separate model. Pearson's r correlations among the final set of predictors were all below ± 0.5. In the main text, we present results using the sum of the light and dark versions of each color.

Upon inspecting the distribution of the number of articles in the Web of Science (scientific interest) and the number of views on Wikipedia (public interest), we identified several outliers. We excluded the Greater Honeyguide (*Indicator indicator*), Melodious Blackbird (*Dives dives*), and Whooper Swan (*Cygnus cygnus*) due to the generation of numerous unrelated results from topic searches of their scientific names. For species with no pageviews on Wikipedia, we manually collected their Wikidata identifiers and reran the script to gather the pageviews. Ultimately, we removed species with no Wikipedia pageviews to facilitate the convergence of regression models. After the removal of missing values, 8,646 bird species were retained for the regression analysis.

Regression analysis

In the initial set of models, we investigated the role of phenotypic, ecological, and cultural traits in explaining scientific and public interest (dependent variables). We fitted Gaussian linear mixed models assuming a Poisson error structure (suitable for count data) and a log-link function (ensuring positive fitted data). The models followed the formula (in R notation): where y represents either the number of articles in the Web of Science (scientific interest) or the number of views on Wikipedia (public interest). We included Order (factor with 41 levels), Family (247 levels), and Genus (2248 levels) as random intercept factors to account for taxonomic non-independence of samples.

The scientific interest model exhibited overdispersion (dispersion ratio = 26.364, Pearson's Chi-Squared = 227019.580, p-value < 0.001). We refitted the model assuming a negative binomial distribution. Although no overdispersion was detected, the new scientific interest model overfitted zeros (Observed zeros: 2557, Predicted zeros: 2902, Ratio: 1.13). Consequently, we refitted the model as a truncated negative binomial model using the default truncated_nbinom2 parameterization. The public interest model encountered convergence issues, which were resolved by refitting the model assuming a negative binomial distribution. After model validation, no overdispersion, zero inflation, or multicollinearity were found in the final models.

We employed variance partitioning analysis to estimate the relative contributions of phenotypic traits, ecological traits, and cultural factors in determining the observed patterns of scientific and public interest. We used variance explained (marginal (R^2)) to evaluate the contribution of each variable and combination of variables to the scientific and public interest that each species receives, partitioning their explanatory power with the R package '*modEvA*' version 3.17[83].

To ensure the consistency of our results, we ran additional sets of models. First, we ran three models using three subsamples of data based solely on observations of males (N = 2410), females (N = 942), or undefined sex (N = 5675; including largely sexually monomorphic species). These three models followed the same structure as in Eq. 1, but excluded the term dimorphism. The public interest models on the subsample of females showed overdispersion, likely due to the relatively small sample size. After cleaning the outliers using the 'simulateResiduals' function in the R package '*DHARMa*' version 0.4.6[84], the model's performance improved. Additionally, we tested whether the effect of traits would change in Passerines by running the models within the subset of data corresponding to Passeriformes. The model structure was essentially the same as for all bird species, but excluded Order from the random factors, and the game bird, nocturnal bird, and pelagic bird variables, as these variables have consistent values across all Passeriformes.

Given that the number of loci (a measure of color diversity), dull colors (grey, brown, and rufous), and purple were found to be highly correlated (r > 0.6) with other color variables, a basic model as in Eq. 1 was tested in which the number of loci, the dull colors, and purple were included separately as independent variables, with the color variables replaced by either the number of loci or by the dull colors and purple.

We also conducted an analysis to understand how these traits drive the relative interest of scientists and the general public in bird species. First, we used a generalized additive model (GAM) to investigate

doi.org/10.32388/OW9FIJ

the relationship between public interest and scientific interest. For each species, we extracted the residuals from this regression curve, where positive residuals indicate species with greater popular than scientific interest, residuals close to zero indicate species with balanced popular and scientific interest, and negative residuals indicate species with greater scientific than public interest. Next, we used a Gaussian linear mixed model to model the relationship between the residuals and species-level traits. This model followed the same general formula as Eq. 1, but with the response variable replaced by the regression residuals. We reported the significant variables as well as residuals at the family level.

Passeriformes is the largest order of birds and among the most diverse clades of terrestrial vertebrates, representing more than half the bird species in the world[85]. We reran the model within the subset of Passeriformes, with the model structure being essentially the same as for all bird species, but excluding Order, game bird, nocturnal bird, and pelagic bird variables. Furthermore, we ran another model to evaluate how visual attractiveness affects the relative interest of scientists and the general public in bird species. This model followed the same general formula as the former one, but replaced all phenotypic traits (body mass, crest, beak, tail, and color variables) with the visual attractiveness score.

To verify the robustness of our results, different quality checks were performed, namely (i) rerunning the analysis on datasets with a different data aggregation method (Figure S3); (ii) rerunning the analysis using three subsamples of males (N = 2472 species), females (N = 985 species), or undefined sex (N = 5968 species; largely sexually monomorphic species) (Figure S4, S5); and (iii) rerunning the analysis using a subsample of Passeriformes (N = 5231 species) (Figure 3). We note, however, that patterns of trait relationships to scientific and public interest are more evident for males than for females, possibly due to lower sample sizes and less variability in traits in females.

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Supplementary data: available at https://doi.org/10.32388/OW9FIJ

Declarations

Funding: No specific funding was received for this work.

Potential competing interests: No potential competing interests to declare.