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Research Article

Mismatch of research effort and threat in avian conservation biology

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Abstract

Avian declines and extinctions are a worldwide concern. Conservation priorities for birds should target threatened taxa (taxonomic targets) and regions with high levels of species richness and endemism (geographical targets). Does published research on bird conservation reflect the global taxonomic and geographic priorities? We surveyed six years (2000-2005) of six international conservation journals, and analyzed all articles on birds. Attention indexes were calculated for orders, threatened species, and biogeographic realms. We also examined how well research from tropical nations (with high levels of richness and endemism) are represented in the international literature. Results show that Struthioniformes is the order that has the highest attention (0.54), mostly because this order has relatively few species, and the lowest attention was recorded for Coliiformes (0.00). For some orders (Anseriformes, Apodiformes, Caprimulgiformes, Coraciiformes, Cuculiformes, Gaviiformes, Pelecaniformes, Phoenicopteriformes, Podicipediformes, Struthioniformes, Tinamiformes and Trogoniformes), most of the published research focuses on non-threatened species. The Nearctic and Palearctic are the biogeographic realms that receive most attention by avian conservationists. However, the Neotropical, Afrotropical, and Indomalayan are the regions with higher species diversity. Eighty-four countries contributed articles, but the majority of bird conservation research is conducted by North American and western European researchers. There is urgent need for capacity building in tropical developing nations. Birds are seriously threatened and are rapidly declining worldwide. However, bird conservation is still misplacing its focus in lower-biodiversity regions and for some orders focusing in non-threatened species. If such trends are not changed, the consequences for the persistence of birds worldwide may be dire.

Keywords: attention index, biogeographic realms, priorities

Resumo

Extinções de declínios populacionais em aves são uma preocupação mundial. Prioridades de conservação para aves devem focar em taxa ameaçados (prioridades taxonômicas) e regiões com altos níveis de riqueza e endemismo (prioridades geográficas). Será que as pesquisas publicadas sobre conservação de aves refletem tais prioridades? Nós analisamos todos os artigos sobre conservação de aves em seis periódicos internacionais de conservação entre 2000 e 2005. Índices de atenção foram calculados para ordens, espécies ameaçadas e regiões biogeográficas. Nós também representatividade de nações tropicais (com altos níveis de riqueza e endemismo) no cenário internacional de pesquisa em conservação de aves. Os resultados mostram que Struthioniformes é a ordem com o maior índice de atenção (0.54), principalmente por possuir poucas espécies, e o menor índice de atenção foi registrado para a ordem Coliiformes (0.00). Para algumas ordens (Anseriformes, Apodiformes, Caprimulgiformes, Coraciiformes, Cuculiformes, Gaviiformes, Pelecaniformes, Phoenicopteriformes, Podicipediformes, Struthioniformes, Tinamiformes and Trogoniformes), a maior parte dos trabalhos publicados foca em espécies não-ameaçadas. As regiões biogeográficas que recebem mais atenção são a Neártica e a Paleártica. Entretanto, as regiões com maior diversidade de aves são a Neotropical, a Afrotropical e a Indo-malaia. Autores de oitenta e quatro países publicaram artigos sobre o tema, mas a maioria das pesquisas é realizada por pesquisadores norte-americanos e europeus. Existe uma necessidade urgente de capacitação em países tropicais em desenvolvimento. As aves estão seriamente ameaçadas e rapidamente declinando em escala global. Entretanto pesquisas em conservação de aves ainda estão erroneamente colocando seu foco em regiões de baixa diversidade e no caso de algumas ordens, em espécies não-ameaçadas. Se tais tendências não mudarem, as consequências para a persistência de aves podem ser catastróficas

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Introduction

Global biodiversity loss is currently a major international concern [1], with some estimates suggesting that the current rate of extinction is between 1,000 and 10,000 times greater than the natural background rate [2-3]. An extinction rate of 1.0 species per 1,000 species per year has been estimated for birds [4]. However, if present habitat loss rates continue, extinction rates will reach 1.5 species per 1,000 species per year by the century's end [4].

This situation has prompted the nations of the world to pledge to reduce significantly the rate of biodiversity loss [5]. Certainly, substantial resources have been spent on conserving biodiversity in recent years, but the current amount of resources (human and economic) is still considerably less than would be ideal and needed to properly address such a paramount issue. The necessity to utilize limited economic resources for the protection of the most globally threatened species, habitats, and regions is a major issue in conservation biology [6-7]. Different criteria and scales have been proposed to identify priority areas for conservation [8-11] and procedures for maximizing the efficacy of regional protected area systems in protecting biodiversity have been proposed [12-14]. The criteria for listing species in the IUCN Red List have also been made more objective and rigorous [15].

The overall conservation status of birds has continued to deteriorate worldwide, and many bird populations are declining [16], including threatened species [3]. The major causes of threat for bird species are: habitat loss and degradation (including habitat fragmentation), harvesting, invasive species, pollution, accidental mortality, persecution, natural disasters, changes in native species dynamics, intrinsic factors, human disturbance, and disease [3]. Recently climate change has also appeared as a serious threat to birds [17]. More than 1,200 bird species are globally listed as threatened, 134 as Extinct and four as Extinct in the Wild [18]. Additionally, 18 Critically Endangered species are considered Possibly Extinct [19], and 66 species are too poorly known to be assessed (Data Deficient, DD) [18]. Many other bird species slipped closer to extinction, showing reduced populations or increasing rates of decline, but not at a rate sufficient to cross thresholds for higher categories on the IUCN Red List [20].

Birds are one of the best-known groups of living organisms, and endemic bird areas (EBAs) [21], important bird areas (IBAs) [22] and countries with the largest number of threatened species have already been identified [18,22]. The aim of this paper is to assess if the conservation community gives proper attention to birds, taking into account the most threatened bird orders, the most important areas for global avian diversity, and the importance of providing a picture of where in the world most bird conservation research is done.

Material and Methods

We surveyed six years (2000-2005) of avian conservation articles, published in six international conservation journals (*Animal Conservation*, *Biodiversity and Conservation*, *Biological Conservation*, *Bird Conservation International*, *Conservation Biology* and *Oryx*) and analyzed all contributed papers clearly dealing with birds. Articles were categorized by order whenever possible. We followed the taxonomy of BirdLife [23], due to its global coverage and periodic reviews and updates. Threatened species are those considered Critically Endangered (CR), Endangered (EN), and Vulnerable (VU) by the IUCN[18]. A taxonomic attention index (AI_{taxon}) was obtained for orders, dividing the number of papers for each order by the number of species of the same order. This provides a general picture of attention to orders, and a threat attention index (AI_{threat}) is obtained by dividing the number of articles dedicated to threatened species by the number of threatened species in each order. A non-threat attention index ($AI_{\text{non-threat}}$) is also obtained, dividing the number of articles dedicated to non-threatened species by the number of non-threatened species in each order. A biogeographic attention index (AI_{biogeog}) was also calculated for biogeographic realms, by dividing the number of papers for each biogeographic realm by the number of species found in that region. We also examine how well research from developing nations and their scientists was represented in the international bird conservation literature. The motivation for this stemmed from the hypothesis that widely available conservation literature is biased to regions of the world that are more affluent but of lower conservation concern, and that scientists conducting conservation research in lower-income countries are often from richer nations. To evaluate this, for each article we collected information on where the study was conducted (see AI_{biogeog} above) and the country of affiliation of those who carried out the research.

The availability, through peer-reviewed journals, of relevant information on taxonomy, biology, population status, threats, and protection measures proposed or achieved is an important component for the recovery strategy for a threatened species and for the very assessment of its threat status. An analysis of international conservation journals in the last years can offer an indirect index of attention for avian orders by conservation ornithologists. The journals considered admittedly represent only a fraction of the existing conservation literature on birds. Avian conservation articles are also published in other journals in related fields (ecology, genetics, and wildlife management) and in regional journals. However, the journals considered are truly international in scope and subjects, and they offer a considerable guarantee on the quality of the papers published. Therefore they are a good sample of the current research on bird conservation.

Results

A total of 824 articles focusing on avian conservation were found in the time period analyzed. However, a considerable portion of these articles focuses more on higher-level approaches (e.g., studying patterns of vertebrate diversity) than on addressing species-specific or order-specific issues for bird conservation (Appendix 1). The AI_{taxon} shows that Struthioniformes, Phoenicopteriformes, Sphenisciformes, and Gaviiformes are the orders that receive most attention by conservation ornithologists, whereas Coliiformes is the least studied one (Appendix 1). However, the results for Struthioniformes, Phoenicopteriformes, Sphenisciformes, and Gaviiformes may be biased due to the small number of species in these orders (Appendix 1), and even though they had a small number of published articles dedicated to them, this resulted in relatively high AI_{taxon} values. In general, values for AI_{taxon} were small, mainly due to the relatively small number of published articles compared to the total number of species in each order (Appendix 1).

A comparison between $AI_{\text{non-threat}}$ and AI_{threat} also shows that for some orders, most of the published research in birds focuses on non-threatened species ($AI_{\text{non-threat}} > AI_{\text{threat}}$) (Anseriformes, Apodiformes, Caprimulgiformes, Coraciiformes, Cuculiformes, Gaviiformes, Pelecaniformes, Phoenicopteriformes, Podicipediformes, Struthioniformes, Tinamiformes and Trogoniformes); for others the focus falls on threatened species ($AI_{\text{non-threat}} < AI_{\text{threat}}$) (Charadriiformes, Ciconiiformes, Columbiformes, Falconiformes, Galliformes, Gruiformes, Passeriformes, Piciformes, Procellariiformes, Psittaciformes, Sphenisciformes and Strigiformes) (Appendix 1); and for Coliiformes the attention between non-threatened and threatened species is the same ($AI_{\text{non-threat}} = AI_{\text{threat}}$) (Appendix 1). Phoenicopteriformes, Gaviiformes, and Struthioniformes are the avian order with the largest discrepancy between attention given to non-threatened and threatened species (Appendix 1). It is important to notice that 10 avian orders had not a single article dedicated to their threatened species, and eight had fewer than ten articles (Appendix 1)

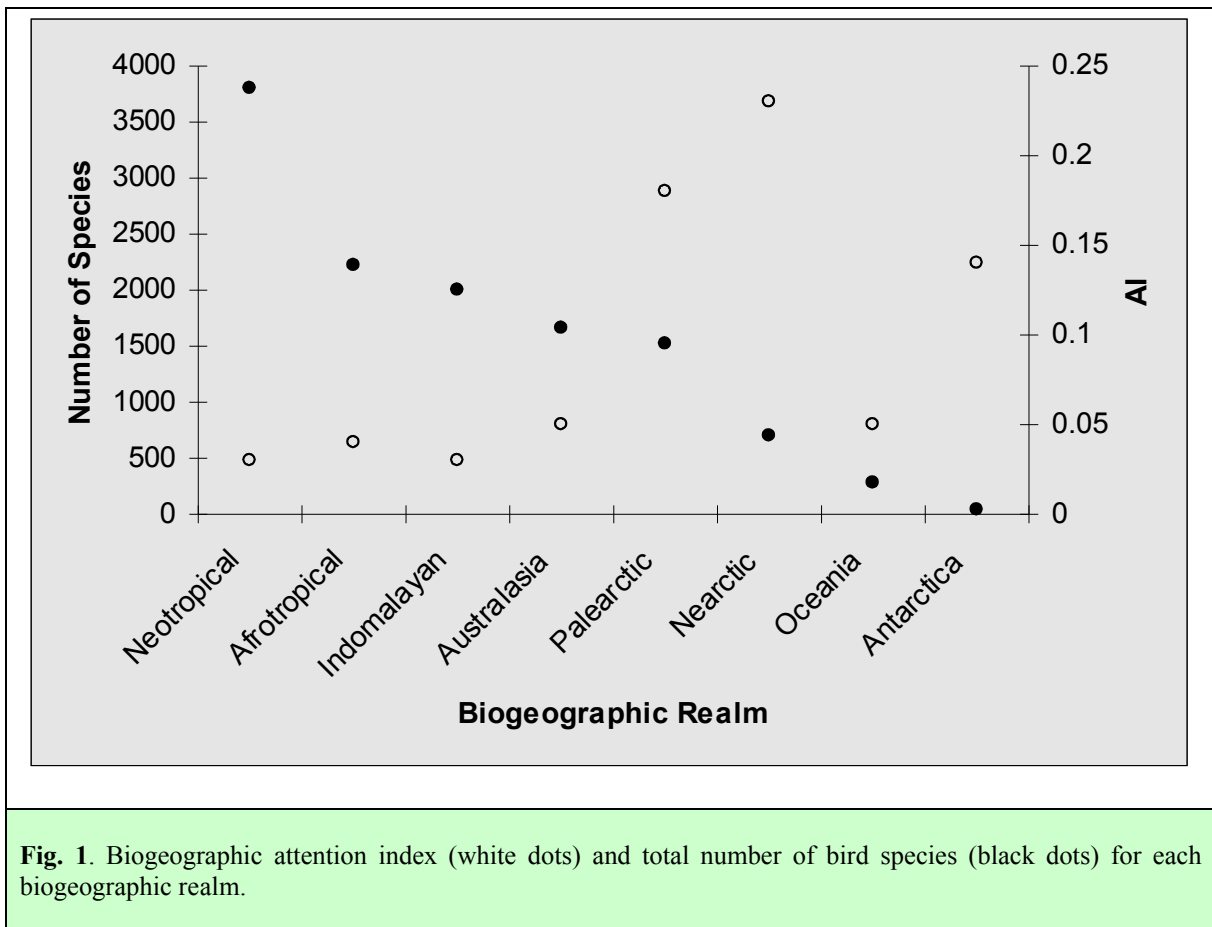


Fig. 1. Biogeographic attention index (white dots) and total number of bird species (black dots) for each biogeographic realm.

The AI_{biogeog} shows that the biogeographic realms that receive most attention by conservation ornithologists are the Nearctic and Palearctic regions (Fig. 1). The results for AI_{biogeog} clearly show a tendency for avian conservation studies to concentrate on the Nearctic and Palearctic realms, even though the Neotropical, Afrotropical, and Indomalayan realms have much higher species diversity (Fig. 1). It is clear that the most diverse biogeographic realms, which are also those that harbor the largest number of endemic and threatened species, are the least studied ones by bird conservation biology (Fig. 1).

The analysis of authors' country affiliation helps us understand the geographic bias in published studies. Authors from 84 countries contributed articles in the time period analyzed, but the great majority of avian conservation research nowadays is conducted by researchers based on North American (USA and Canada) and western European institutions (Fig. 2), which are regions/countries of relatively low bird diversity and endemism. Countries of higher bird diversity lagged behind in the number of published conservation articles dedicated to birds (Appendix 1). In Oceania, only French Polynesia contributed papers; in the Afrotropics, South Africa is the leading country in conservation-related avian research; in the Neotropics, Brazil is the country with the most contributions; and in the Indomalayan region, India is the country with the most contributions (Fig. 2). There is also a noticeable trend for high-income countries to publish more, relative to their species richness, than tropical developing countries do (ANOVA, $F = 7.4548$, $p = 0.00018$) (Fig. 3).

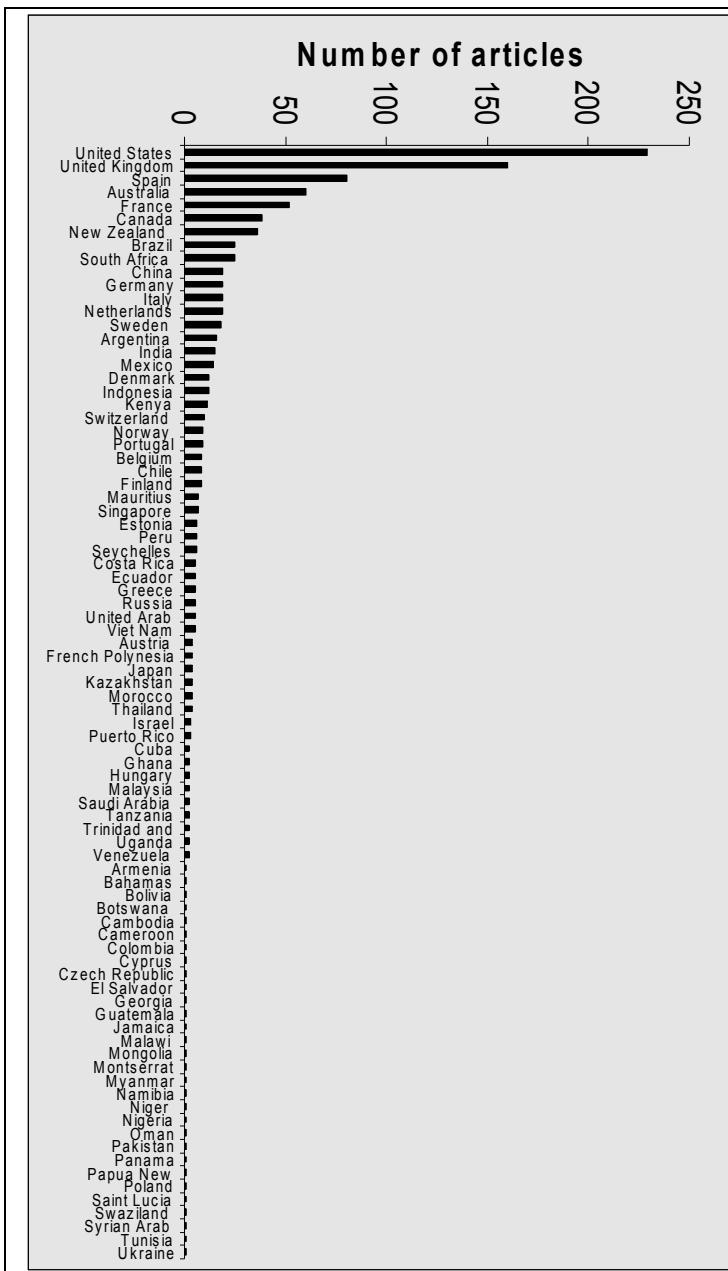


Fig. 2. Total number of articles on avian conservation published between 2000 and 2005 (n = 824), taking into account the country of author affiliation

Discussion

Even though a comparison of the published conservation scientific literature among amphibians, birds, and mammals clearly shows that birds (this article) receive more attention than mammals [24] and amphibians [25], several bird species are declining at an astounding rate [3,16], and recently, at least 16 bird species would probably have gone extinct in the absence of conservation intervention [20].

Our results focus at the order level, and may be complemented by the results of another study that made analyses at the species level [26], and found that non-threatened species are more likely to be the subject of general and comparative studies, and also that threatened species are more likely to be the subject of studies that concentrate on them as single species. About half of threatened species do not have a single publication dedicated to them [26]. Our results suggest this is also a worrisome trend at the order level, where several orders did not have a single article dedicated to threatened species (see Appendix 1).

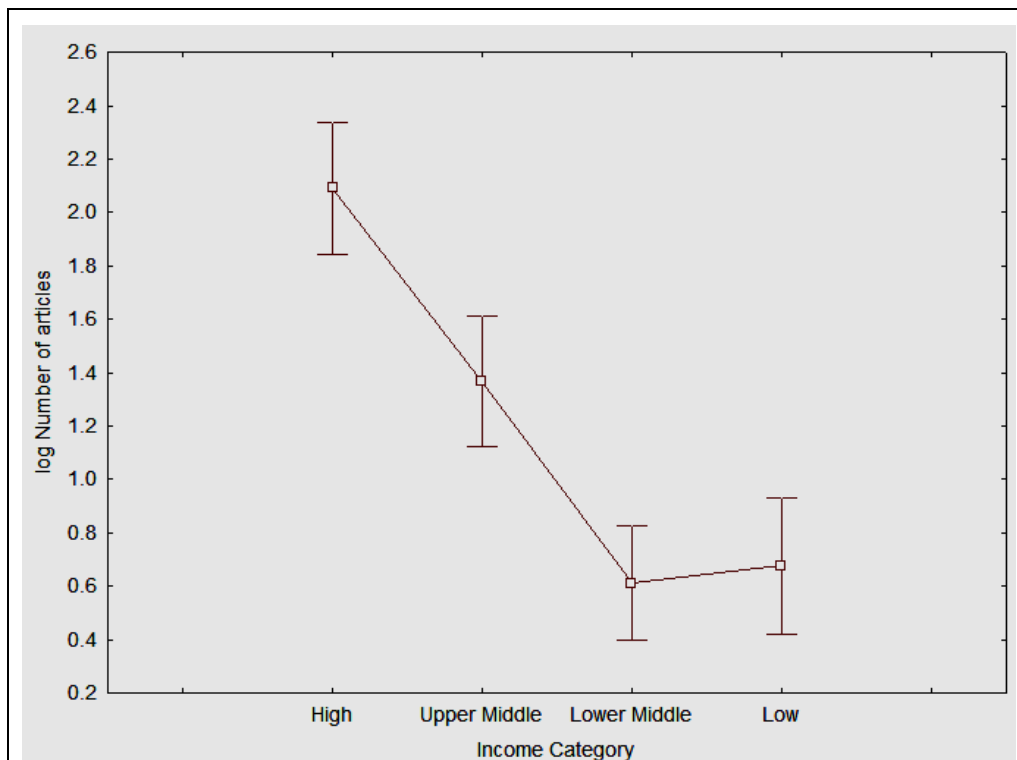


Fig. 3. The number of countries in each income category contributing articles on avian conservation between 2000 and 2005 and the number of articles published by countries in each income category.

Although there is evidence that bird populations are declining globally [3,16], contributions to the study of the problem come primarily from scientists based in the United States and western Europe (Fig. 2). A global analysis of the trends of birds, using the Red List Index, concluded that deteriorations have occurred worldwide, but with particularly steep declines for Indomalayan birds [16]. Even though the Indomalayan region has high levels of bird diversity and endemism [3] and high threat, presenting steep declines in birds [16], it is one of the least studied regions, with low AIs when compared to regions with lower diversity and endemism and less threat. The Neotropical region harbors the globe's most diverse avian fauna, representing nearly 38% of the world's total species [3], but our results show this is still the biogeographic realm with one of the

lowest attention indexes. Most bird conservation research is conducted in the Palearctic and Nearctic by authors based in these regions (Fig. 1 and 2). The global analysis of the trends of birds, using the Red List Index, also concluded that Procelariiformes were particularly threatened [16], and our results show that compared to other avian orders, it has a relatively high AI_{taxon} (see Appendix 1), and that within the order, more attention is given to threatened than non-threatened species (see Appendix 1), suggesting conservation ornithologists are giving attention in accordance with known priorities at least within this order.

Threatened bird species tend to have smaller geographical ranges than non-threatened species, and are disproportionately distributed in tropical countries and on islands with few resident ornithologists [26]. Avian conservation needs investments to build local capacity in developing countries in order to increase the number of professional and amateur ornithologists in tropical regions, where most bird diversity is located. It is important for bird conservationists in tropical countries to publish the results of their research. Nowadays, most of the research conducted in the tropical regions is not done by local scientists, but mainly by researchers from high-income countries [27], and our results show that this trend holds true for avian conservation studies. In middle- and low-income countries, there are local/regional journals, but they hold a substantial amount of information, and most of these are not published in English and are not readily available for an international audience [27]. Our results show that nowadays most bird conservation studies are done on high-income countries, and by researchers based in high income countries; a similar result was found by the Bird Conservation International study [26]. This seems to be in accordance with general conservation publication trends [27]. Many scientists from high-income countries feel a bit conflicted about where to conduct their research: if they work in developing countries, they are sometimes open to criticism as intellectual imperialists; if they work instead in their home countries, they are open to criticism as ignoring regions with more urgent conservation needs. The solution, presumably, is for researchers with more resources to collaborate with, and build capacity among, researchers from developing countries. Avian studies are skewed to: (1) community-level analyses, (2) non-threatened species (in the case of some orders, see Appendix 1), (3) the Nearctic and Palearctic realms, and (4) North American and Western European authors. Therefore there is an urgent need for studies focusing on: (1) population and metapopulation issues and species interactions, (2) threatened species for those orders where the focus so far has been on non-threatened species (Appendix 1), (3) tropical regions, and (4) more international authorship.

Implications for conservation

Most threatened bird species inhabit low-income countries, so the fact that only a small portion of published papers come from such countries reflects a continuing lack of conservation science resources and capacity in the places where threatened species are found [25]. Analyses of the trends in avian conservation studies [25, this study] suggest that avian conservation science is misplacing its focus in lower-biodiversity regions in general and in non-threatened species for some orders (see results), and if such trends are not changed the persistence of several bird species worldwide may be seriously compromised.

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Appendix 1: Threatened category summary for birds (IUCN 2008), number of articles by orders and attention index.

Order	Number of species	Number of threatened species	Number of articles	Number of articles on threatened species	AI _{taxon}	AI _{threat}	AI _{non-threat}
Anseriformes	167	28	25	4	0.150	0.143	0.151
Apodiformes	443	35	3	0	0.007	0.000	0.007
Caprimulgiformes	122	8	2	0	0.016	0.000	0.017
Charadriiformes	354	38	56	12	0.158	0.316	0.139
Ciconiiformes	121	21	16	5	0.132	0.238	0.11
Coliiformes	6	0	0	0	0.000	0.000	0.000
Columbiformes	336	59	8	4	0.024	0.068	0.014
Coraciiformes	221	25	5	0	0.023	0.000	0.025
Cuculiformes	167	11	2	0	0.012	0.000	0.013
Falconiformes	314	49	86	29	0.274	0.592	0.215
Galliformes	288	72	45	15	0.156	0.208	0.139
Gaviiformes	5	0	2	0	0.400	0.000	0.400
Gruiformes	229	55	48	31	0.210	0.564	0.098
Passeriformes	5889	573	165	62	0.028	0.108	0.019
Pelecaniformes	67	16	11	2	0.164	0.125	0.176
Phoenicopteriformes	6	1	3	0	0.500	0.000	0.600
Piciformes	409	17	11	1	0.027	0.059	0.025
Podicipediformes	22	5	1	0	0.045	0.000	0.059
Procellariiformes	130	58	30	21	0.231	0.362	0.125
Psittaciformes	374	96	23	13	0.062	0.135	0.036
Sphenisciformes	18	11	8	5	0.444	0.454	0.429
Strigiformes	202	33	12	2	0.059	0.061	0.059
Struthioniformes	13	5	7	2	0.538	0.400	0.625
Tinamiformes	47	5	1	0	0.021	0.000	0.024
Trogoniformes	40	1	2	0	0.050	0.000	0.051
General	-	-	290	-			
Total Aves	9990	1222	824	236	0.082	0.193	0.067