Distribution of birds in Colombia

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Abstract

Background

1. Colombia with 1941 known recorded bird species is one of the most species rich countries in the world. Efforts are necessary to conserve, study and promote sustainable use of this important taxonomic group throughout Colombia’s vast territory.

2. In an ideal world, informed decisions that are based on sound scientific information should be likelier to have successful outcomes. Nevertheless, there are barriers that make it difficult to access and use information in a timely fashion. Those same barriers impede the study, conservation and sustainable use of bird species in Colombia. On the other hand, given that there is good documentation about the ecology of a large number of species, information about the distribution of birds can be easily incorporated into decision-making processes, once this information becomes readily available in a consumable format using Geographic Information Sciences tools.

3. In this context, the main objective of this paper is to present the first compilation of the current distribution of 1889 (97%) species of birds in Colombia, using expert criteria. The
shapefiles were used to show the distribution and diversity of bird species in Colombia under both geopolitical and conservation geographic units.

4. The information provided in this paper can be used as a baseline for a huge number of initiatives that aim to strengthen conservation efforts and improve knowledge about one the most unique taxonomic groups in the country. These range from land use planning strategies at the municipal or department scale to sustainable use of bird species - such as those initiatives related to bird watching - in Colombia.

**New information**

This study has considered three key aspects: 1) the importance of birds for Colombia’s ecosystems, 2) the privileged place of Colombia in bird species richness and 3) the importance of data mobilisation in formats easily consumable by Geographic Information Systems (GIS) to facilitate the processes of informed decision-making. We present the first compilation - in shapefile format - for 1889 of the 1941 bird species recorded from Colombia. Using this novel collection, we showed the species richness of birds in Colombia’s 33 Departments plus its Capital District (DPs), 1122 Municipalities (MNs), 58 protected areas (PAs), 39 Regional Autonomous Corporations (the authorities responsible within their respective jurisdictions for regulating the environment and renewable natural resources in Colombia; CARs) and 916 Collectively Titled Territories (including both indigenous reservations and afro-descendant communities; CTTs). In addition, we provide a list of known bird species richness for the above geographic units found in the available literature. The information provided here can be used as a baseline for a huge number of initiatives concerning the study, conservation and sustainable use of bird species present in Colombia, providing access to key features of bird distribution that should facilitate decision-making.

**Keywords**

Aves, biodiversity, conservation, data mobilisation, decision-making, GIS, sustainable use

**Introduction**

Birds inhabit almost every ecosystem on earth and are amongst the most diverse, active and important ecosystem service providing groups (Sekercioglu 2006). Given the large body of knowledge about birds, they are frequently used in initiatives related to conservation and sustainable use of biodiversity around the world (Hausmann et al. 2019). Colombia, with 1941 known bird species (Ayerbe-Quinones 2019), is amongst the countries with the highest species richness of this biological group worldwide. Given the above, special effort is required to make information about Colombian birds freely available for research, conservation and sustainable use management and planning.
In an ideal world, decisions that are informed by sound data should have better odds of producing successful outcomes. Actions related to the study, protection and sustainable use of birds must be supported by information about the species and their relationships with both biotic and abiotic components of ecosystems. Activities that require data on bird distributions include: national planning and budgets for resource management in sectors such as agriculture, mining, infrastructure, protected areas, compliance with multilateral environmental agreements; development of environmental resource legislation; measurement and mitigation of human impact on the environment; mitigation of anthropogenic drivers and conflicts; and projects on sustainable use of biodiversity (Stephenson et al. 2017). Nevertheless, there are barriers that make it difficult for consumers to access and use information in a timely fashion.

Stephenson et al. (2017) pointed out several barriers that make it difficult to access and use information for biodiversity management. The four groups of barriers identified in the aforementioned paper are: 1) data availability, 2) data quality and usability, 3) willingness to collect and use data and 4) technical and financial capacity. However, with both constant technological advances and increasing necessity for information, an important ecosystem of tools, institutions and initiatives has grown with the aim of increasing technical capacity in biodiversity data mobilisation, use and reuse. Nevertheless, there are key issues remaining to be addressed that concern both data and domain integration of biodiversity information (König et al. 2019).

Data and information are valued in the degree in which they are findable, usable and in formats consumable by Geographic Information Sciences (GIScience), relevant to decision-making processes. Foody (2008) concluded that GIScience provides both data on environmental properties and techniques to explore, visualise, use and integrate geographic information with other data (e.g. biological data) for understanding biodiversity and conservation. For these reasons, we were inspired to create an invaluable information resource that would be useful as baseline to understand and conserve bird species based on their geographic distribution in Colombia.

**General description**

**Purpose:** Given the importance of data mobilisation for democratising information about birds in Colombia, the main objective of this paper is to present a shapefile with the current distribution of 1890 species of birds recorded from Colombia and use the obtained distribution to show some key features of bird species richness in Colombia in both geopolitical and conservation geographic units to facilitate decision-making processes, scientific research and sustainable use of biodiversity in Colombia.

**Sampling methods**

**Step description:** We used 1889 expert-based bird distribution maps obtained from the Guide to Birds of Colombia (Ayerbe-Quiñones 2018). The bird distribution maps in PNG
format were georeferenced and transformed into a raster format and posteriorly into a vector shapefile format using the Python Programming Language 2.7 and the software ArcGIS 10.7. Once we had the individual bird species maps in shapefile format, we used this information to obtain some key features and figures on bird species richness in Colombia. To perform this task, we evaluated distributions in three key management units in the country: geopolitical units, management and conservation units and collective territories.

To obtain the bird species number per geopolitical, natural, management and collectively titled territories, we made layer intersections between the shapefile of bird distribution and the layers for each one of the selected territories, using the EPSG 4686 system in the software ArcGIS v. 10.7 software. Layers used for intersection were: DPs and MNs (IGAC 2019), PAs (PNNC 2019), CARs (IDEAM 2018) and CTTs (Etnoterritorios 2020a, Etnoterritorios 2020b). Metadata for each one of the layers can be consulted in the respective data resource.

Finally, to make the compilation freely available, we uploaded it into the online data repository of the Instituto de Investigación de Recursos Biológicos Alexander von Humboldt (http://geonetwork.humboldt.org.co/geonetwork/srv/spa/catalog.search#/home/). In addition, the distribution map of each species was uploaded into the BioModelos platform where it can be consulted by species name (http://biomodelos.humboldt.org.co/).

**Geographic coverage**

**Description:** To establish the geographic coverage, we used the EPSG 4686 coordinates system. All the Colombian territory is included in this work.

**Coordinates:** -4.204 and 13.390 Latitude; -81.763 and -66.829 Longitude.

**Taxonomic coverage**

**Description:** In this paper, we follow the taxonomic system of Ayerbe-Quinones (2019).

**Taxa included:**

| Rank | Scientific Name | Common Name |
|------|-----------------|-------------|
| class | Aves            | Birds       |

**Usage licence**

**Usage licence:** Other

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Data resources

Data package title: Distribution of birds in Colombia. Year 2020

Resource link: http://geonetwork.humboldt.org.co/geonetwork/srv/spa/catalog.search#/metadata/5c2b19d2-6893-4955-aa65-509d1c3f2706

Number of data sets: 2

Data set name: BIRD_Colombia

Download URL: http://geonetwork.humboldt.org.co/geonetwork/srv/api/records/5c2b19d2-6893-4955-aa65-509d1c3f2706/attachments/BIRD_Colombia.rar

Data format: Shapefile

Description: The .Zip file contains a shapefile with the distribution of bird species in Colombia. The shapefile has three attributes.

| Column label | Column description                  |
|--------------|-------------------------------------|
| Order        | Scientific name of the Order in which the species is classified |
| Family       | Scientific name of the Family in which the species is classified |
| Species      | Bird species                        |

Data set name: Additional data

Download URL: http://geonetwork.humboldt.org.co/geonetwork/srv/api/records/5c2b19d2-6893-4955-aa65-509d1c3f2706/attachments/BIRD_Colombia.rar

Data format: EXCEL file

Data format version: .xlsx

Description: Within the same .Zip that contains the BIRD_Colombia shapefile, there is an Excel file with three sheets where the number of bird species per Municipalities, Indigenous Reservations and afro-descendant communities is shown. The Excel file has seven attributes.

| Column label | Column description                                                                 |
|--------------|------------------------------------------------------------------------------------|
| Code_Dane    | MN unique identifier assigned by the Colombian “Departamento Administrativo Nacional de Estadística” (DANE) |
| Department   | Name of the Department                                                             |
| Municipality | Name of the Municipality                                                           |
| Spp          | Number of species                                                                  |
As pointed out by Chapman (2005) - referring to primary species-occurrence data - biodiversity information has endless uses in almost every aspect of human endeavour worldwide. These include aspects that are not so obvious, such as food security, education and recreation. The same author called attention to the fact that it is necessary to make maximum use of these data to better understand biodiversity, to mitigate and monitor changes to our environment and to improve, conserve and sustainably use our biodiversity. In this context, the Shapefile compilation presented here has the potential to facilitate and improve research, conservation and sustainable use of biodiversity in Colombia, with a special focus on the country’s charismatic and ecologically-important birdlife.

Expert-based range maps for species distribution - like those presented here - are useful tools that help in research and conservation of biodiversity. With some limitations, these kinds of distributional models, based on group expert criteria, become valuable in cases in which there is a lack of reliable information on the distribution of biological species (e.g. Fourcade 2016, Mainali et al. 2020) and as a complement to both species distribution and ecological niche modelling techniques (e.g. Fourcade et al. 2013, Merow et al. 2017). Such maps can help to establish an information baseline to understand biodiversity patterns in poorly-known species. We consider that the lack of information for several species of birds in Colombia can be remedied in the meantime by the models presented here, which can be used as a starting point for many research, conservation and decision-making processes. A dynamic process for improving information on species distributions in one of the most biodiverse countries of the world will make it possible to generate a Living Atlas of Colombian Biodiversity that can be improved over time with the help of experts and the inclusion citizen science data.

Key figures on bird species richness in Colombia per different geographic units are presented in Tables 1, 2, 3, 4, 5. Information provided in these Tables can be used for a quick comparison between the number of species in different geographic units. Here, we present diverse examples of the information and comparisons that can be made in different territories. Additionally, we provide a comparison to available information - including both eBird (2020) database and literature - of the number of species recorded per DPs and PAs (Tables 1, 4). The differences amongst the number of species presented by sources are due to differences in the methods and sampling effort used to obtain the information. Expert maps use a coarser resolution than other methods; this can explain the tendency to obtain the highest number of species per geographic unit with this method. As noted
above, expert maps are used as a baseline and complement knowledge that can be used for education, decision-making processes and research.

| DP          | Number of bird species this work | Number of bird species eBird July 2020 | Number of bird species in other sources | References of other sources                          |
|-------------|----------------------------------|--------------------------------------|----------------------------------------|----------------------------------------------------|
| Cauca       | 1409                             | 1164                                 | 1102                                   | Ayerbe-Quinones et al. 2008                         |
| Nariño      | 1384                             | 964                                  | 1048                                   | Calderon-Leyton et al. 2011                         |
| Antioquia   | 1125                             | 1047                                 |                                        |                                                    |
| Boyacá      | 1107                             | 913                                  |                                        |                                                    |
| Meta        | 1063                             | 1048                                 |                                        |                                                    |
| Cundinamarca| 1062                             | 919                                  | 941                                    | Chaparro-Herrera et al. 2018                        |
| Chocó       | 1059                             | 941                                  |                                        |                                                    |
| Putumayo    | 1050                             | 1000                                 |                                        |                                                    |
| Caquetá     | 1046                             | 850                                  |                                        |                                                    |
| Valle del cauca | 982 | 1024 | 989 | Cárdenas et al. 2020 |
| Norte de Santander | 940 | 654 |     |                                                    |
| Córdoba     | 929                              | 632                                  | 504                                    | Ballesteros et al. 2015                            |
| Cesar       | 882                              | 613                                  |                                        |                                                    |
| Santander   | 874                              | 844                                  |                                        |                                                    |
| Caldas      | 861                              | 883                                  | 923                                    | Corporación Autónoma Regional de Caldas and Asociación Calidris 2010 |
| Casanare    | 858                              | 688                                  | 507                                    | Zamudio et al. 2011                                |
| Tolima      | 822                              | 794                                  |                                        |                                                    |
| Arauca      | 798                              | 554                                  | 512                                    | Izquierdo et al. 2019                              |
| La guajira  | 770                              | 581                                  |                                        |                                                    |
| Huila       | 748                              | 765                                  |                                        |                                                    |
| Bolívar     | 728                              | 598                                  |                                        |                                                    |
| Risaralda   | 719                              | 894                                  |                                        |                                                    |
| Magdalena   | 697                              | 647                                  |                                        |                                                    |
| DP       | Number of bird species this work | Number of bird species eBird July 2020 | Number of bird species in other sources | References of other sources |
|----------|----------------------------------|----------------------------------------|-----------------------------------------|-----------------------------|
| Amazonas | 690                              | 639                                    |                                         |                             |
| Guaviare | 678                              | 579                                    |                                         |                             |
| Vichada  | 639                              | 559                                    |                                         |                             |
| Quindío  | 633                              | 687                                    |                                         |                             |
| Guainía  | 614                              | 546                                    |                                         |                             |
| Sucre    | 584                              | 405                                    |                                         |                             |
| Vaupés   | 572                              | 610                                    | 558                                     | Carrillo et al. 2018        |
| Atlántico| 510                              | 403                                    | 363                                     | Castro-Vásquez 2016         |
| Bogotá, D.C. | 489 | 535 | | |
| Archipiélago de san Andrés, Providencia y Santa Catalina | 198 | 180 | | |

Table 2.
Ten Colombian MNs with highest number of bird species recorded in this paper.

| DP       | MN                  | Number of bird species |
|----------|---------------------|------------------------|
| Cauca    | Santa Rosa          | 1033                   |
| Putumayo | Mocoa               | 1002                   |
| Nariño   | Ipiales             | 1000                   |
| Nariño   | Córdoba             | 993                    |
| Nariño   | Puerres             | 992                    |
| Nariño   | Potosí              | 991                    |
| Putumayo | San francisco       | 983                    |
| Caquetá  | San Vicente del Caguán | 949               |
| Caquetá  | Florencia           | 928                    |
| Caquetá  | El paujil           | 911                    |
Table 3.
Number of bird species per CAR in Colombia obtained in this paper.

| CAR                                                        | Number of bird species this work |
|------------------------------------------------------------|----------------------------------|
| Corporación Autónoma Regional del Cauca                    | 1409                             |
| Corporación Autónoma Regional de Nariño                     | 1384                             |
| Corporación para el Desarrollo Sostenible del Sur de la Amazonia | 1199                             |
| Corporación Autónoma Regional de la Orinoquia               | 1106                             |
| Corporación para el Desarrollo Sostenible del Área de Manejo Especial La Macarena | 1065                             |
| Corporación Autónoma Regional para el Desarrollo Sostenible del Chocó | 1059                             |
| Corporación para el Desarrollo Sostenible de Urabá          | 1041                             |
| Corporación Autónoma Regional del Valle del Cauca           | 983                              |
| Corporación Autónoma Regional del Centro de Antioquia       | 963                              |
| Corporación Autónoma Regional de la Frontera Nororiental    | 940                              |
| Corporación Autónoma Regional de los Valles del Sinú y San Jorge | 928                              |
| Corporación Autónoma Regional del Guavio                    | 924                              |
| Corporación Autónoma Regional de Chivor                     | 896                              |
| Corporación Autónoma Regional de Boyacá                     | 893                              |
| Corporación Autónoma Regional del Cesar                     | 882                              |
| Corporación Autónoma Regional de las cuencas de los ríos Rionegro y Nare | 862                              |
| Corporación Autónoma Regional de Caldas                     | 861                              |
| Corporación Autónoma Regional de Santander                  | 861                              |
| Corporación Autónoma Regional de Cundinamarca               | 835                              |
| Corporación Autónoma Regional para la Defensa de la Meseta de Bucaramanga | 824                              |
| Corporación Autónoma Regional del Tolima                    | 821                              |
| Corporación Autónoma Regional de la Guajira                 | 770                              |
| Corporación Autónoma Regional del Alto Magdalena            | 748                              |
| Corporación para el Desarrollo Sostenible del Norte y Oriente de la Amazonia | 725                              |
| Corporación Autónoma Regional de Risaralda                  | 719                              |
| Corporación Autónoma Regional del Magdalena                 | 697                              |
| Corporación Autónoma Regional del Sur de Bolívar             | 636                              |
| CAR                                                                 | Number of bird species this work |
|-------------------------------------------------------------------|----------------------------------|
| Corporación Autónoma Regional del Quindío                         | 633                              |
| Área Metropolitana del Valle de Aburrá                            | 510                              |
| Corporación Autónoma Regional del Atlántico                       | 510                              |
| Corporación Autónoma Regional del Canal del Dique                 | 506                              |
| Corporación Autónoma Regional de Sucre                            | 500                              |
| Departamento Administrativo Distrital del Medio Ambiente de Santa Marta | 488                              |
| Establecimiento Público Ambiental                                 | 486                              |
| Departamento Técnico Administrativo del Medio Ambiente Barranquilla | 482                              |
| Corporación para el Desarrollo Sostenible de la Mojana y del San Jorge | 479                              |
| Secretaría Distrital de Ambiente de Bogotá D.C.                   | 378                              |
| Departamento Administrativo de Gestión del Medio Ambiente de Santiago de Cali. | 308                              |
| Corporación para el Desarrollo Sostenible del Archipiélago de San Andrés Providencia y Santa Catalina | 198                              |

Table 4.
Bird species per PAs in Colombia. Classification of PAs used here is: Parque Nacional Natural (PNN), Santuario de Flora (SF), Santuario de Fauna (SFA), Reserva Nacional Natural (RNN), Vía Parque (VP), Santuario de Flora y Fauna (SFF) and Área Natural Única (ANU).

| Category | PA                        | Number of bird species this work | Number of bird species in other sources | References of other sources |
|----------|---------------------------|---------------------------------|----------------------------------------|-----------------------------|
| PNN      | Sumapaz                   | 919                             |                                        |                             |
| PNN      | Chingaza                  | 911                             | 531                                    | Linares-Romero et al. 2020  |
| PNN      | Serranía de los Churumbelos | 909                             | 421                                    | Salaman et al. 1999         |
| PNN      | Alto Fragua Indiwasi      | 893                             |                                        |                             |
| PNN      | Cordillera de los Picachos | 877                             |                                        |                             |
| SF       | Plantas Medicinales Orito Ingi Ande | 860                             |                                        |                             |
| PNN      | Paramillo                 | 846                             |                                        |                             |
| PNN      | Los Farallones de Cali    | 840                             |                                        |                             |
| PNN      | El Cocuy                  | 787                             |                                        |                             |
| Category | PA | Number of bird species this work | Number of bird species in other sources | References of other sources |
|----------|----|---------------------------------|----------------------------------------|----------------------------|
| PNN      | Serranía de los Yariguíes | 775                       | 583                                   | Donegan et al. 2010        |
| PNN      | Tama          | 737                       |                                        |                            |
| PNN      | Las orquídeas | 729                       |                                        |                            |
| PNN      | Munchique     | 711                       |                                        |                            |
| PNN      | Sierra de la Macarena | 697                     | 183                                   | Rangel-Ch. et al. 1995a    |
| PNN      | Serranía de Chiribiquete | 465                  | 355                                   | Álvarez et al. 2003        |
| PNN      | Tinigua       | 628                       | 441                                   | Cadena et al. 2000         |
| PNN      | Sierra Nevada de Santa Marta | 616                 |                                        |                            |
| PNN      | Amacayacu     | 615                       | 355                                   | Rangel-Ch. 1995            |
| PNN      | Los Katíos    | 609                       |                                        |                            |
| PNN      | La Paya       | 596                       |                                        |                            |
| PNN      | Cahuaralí     | 592                       |                                        |                            |
| PNN      | Complejo volcánico Dona Juan Cascabel | 586     |                                        |                            |
| PNN      | Rio Pure      | 570                       |                                        |                            |
| PNN      | Yaigojé Apaporis | 562              |                                        |                            |
| SFA      | Acandí Playón | 541                       |                                        |                            |
| RN       | Nukak         | 539                       |                                        |                            |
| RN       | Puinawai      | 516                       |                                        |                            |
| PNN      | Utría         | 504                       |                                        |                            |
| VP       | Isla de Salamanca | 498                |                                        |                            |
| PNN      | Nevado del Huila | 493               |                                        |                            |
| PNN      | Los Nevados   | 489                       | 162                                   | Rangel-Ch. and Garzón-C. 1995 |
| PNN      | Tayrona       | 485                       | 200                                   | Rangel-Ch. and Lowy-C. 1995 |
| SFF      | El Corchal “El Mono Hernández” | 484       |                                        |                            |
| PNN      | El Tuparro    | 482                       | 320                                   | Rangel-Ch. et al. 1995b    |
| PNN      | Puracé        | 477                       |                                        |                            |
| Category | PA | Number of bird species this work | Number of bird species in other sources | References of other sources |
|----------|----|----------------------------------|----------------------------------------|-----------------------------|
| PNN      | Sanquiang | 477                              |                                        |                             |
| PNN      | Tatamá   | 467                              |                                        |                             |
| SFF      | Los Flamencos | 465                            |                                        |                             |
| PNN      | Catatumbo Bari | 457                         |                                        |                             |
| PNN      | Los Corales del Rosario y San Bernardo | 457 | 141 | Duque-García and Franke-Ante 2011 |
| PNN      | Uramba Bahía Málaga | 456                           |                                        |                             |
| SFF      | Ciénaga Grande de Santa Marta | 453                       |                                        |                             |
| PNN      | Las Hermosas | 440                          |                                        |                             |
| PNN      | Pisba     | 429                              |                                        |                             |
| SFF      | Los Colorados | 420                         |                                        |                             |
| PNN      | Selva de Florencia | 419                  | 357 | Gómez et al. 2020          |
| SFF      | Isla de la Corota | 304                     |                                        |                             |
| PNN      | Cueva de los Guacharos | 393                    |                                        |                             |
| SFF      | Galeras   | 349                              |                                        |                             |
| ANU      | Los Estoraques | 342                        |                                        |                             |
| SFF      | Otún Quimbaya | 340                     |                                        |                             |
| SFF      | Guanentá Alto Rio Fonce | 330                |                                        |                             |
| SFF      | Iguaque   | 322                              |                                        |                             |
| PNN      | Bahía Portete-Kaurrele | 277              |                                        |                             |
| PNN      | Macuira   | 250                              |                                        |                             |
| PNN      | Old Providence Mc Bean Lagoon | 194                |                                        |                             |
| PNN      | Gorgona   | 84                               |                                        |                             |
| PNN      | Corales de Profundidad | 39               |                                        |                             |
Table 5.
Ten Colombian CTTs with highest number of bird species recorded in this paper. Territories included here are indigenous reservations and afro-descendant communities.

| Category                        | Collective Titling Territory                | Ethnic group or community     | Number of bird species |
|---------------------------------|--------------------------------------------|-------------------------------|------------------------|
| Indigenous reservation          | Kamëntšá Biýá de Sibundoy                  | Kamëntšá                      | 993                    |
| Afro-descendant communities     | La Nueva Esperanza                         | La Nueva Esperanza            | 961                    |
| Indigenous reservation          | Nasa Uh                                    | Nasa                          | 946                    |
| Indigenous reservation          | Yunguillo                                  | Inga                          | 876                    |
| Indigenous reservation          | Simorna                                    | Emberá Chamí                  | 875                    |
| Indigenous reservation          | La Florida                                 | Paéz                          | 869                    |
| Indigenous reservation          | Alto Orito                                 | Emberá Chamí                  | 865                    |
| Indigenous reservation          | Inga de Condagua                           | Inga                          | 862                    |
| Indigenous reservation          | San José                                   | Inga                          | 861                    |
| Indigenous reservation          | Rumiyaco                                   | Pasto                         | 856                    |

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Author contributions

DV conceived the idea, work coordination and wrote the manuscript; ET, JT and BR developed the shapefile compilation, GIS processing and wrote the manuscript; CC-M wrote the manuscript; JR eBird consultation and wrote the manuscript; FA-Q provided original species distribution models in digital format, taxonomic review and provided critical elements to develop the manuscript and shapefile compilation; JMO-Q provided critical elements to develop the manuscript and shapefile compilation and he critically reviewed the final manuscript.
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