BIO DIVERSITY 2016

Status and Trends of Colombian Continental Biodiversity

Instituto Humboldt Colombia

BIODIVERSITY 2016

Status and Trends of Colombian
Continental Biodiversity

BIODIVERSITY **2016.** Status and Trends of Colombian Continental Biodiversity.

Instituto de Investigación de Recursos Biológicos Alexander von Humboldt (Research Institute of Biological Resources Alexander von Humboldt).

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INSTITUTO HUMBOLDT COLOMBIA

MINAMBIENTE

TODOS POR UN NUEVO PAÍS
PAZ EQUIDAD EDUCACIÓN

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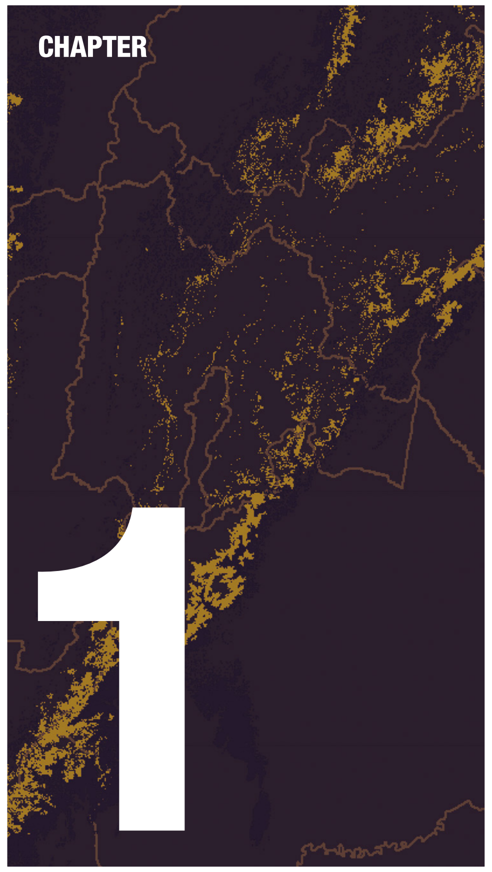
Status and Trends of Colombian Continental Biodiversity

INSTITUTO HUMBOLDT COLOMBIA

Contents

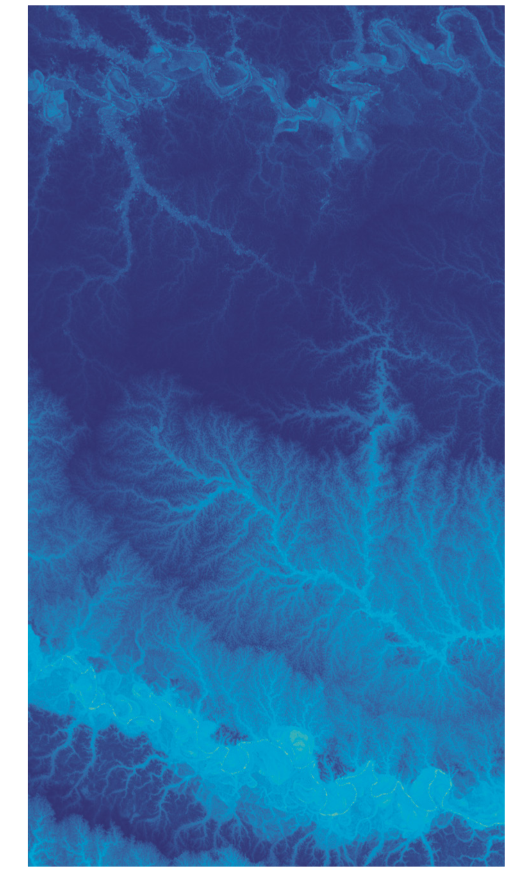


KNOWLEDGE ABOUT BIODIVERSITY

FACTORS OF BIODIVERSITY TRANSFORMATION AND LOSS

RESPONSE OF SOCIETY TO THE LOSS OF BIODIVERSITY

OPPORTUNITIES FOR TERRITORIAL MANAGEMENT OF BIODIVERSITY



APPENDIX

Prologue

Biodiversity in the Era of the Post-conflict

Juan Carlos Bello
Panama City, July 25th, 2017
Science Division Coordinator for Latin America and the Caribbean
Unated Nations Program for the Environment-UN Environment

"HAVING ROBUST, UPDATED, AND OPEN ACCESS INFORMATION ABOUT THE STATUS AND TRENDS OF BIODIVERSITY IS INDISPUTABLY ESSENTIAL. FROM A LOCAL TO A NATIONAL SCALE, IT IS FUNDAMENTAL TO KNOW WHERE THE GREATEST TRANSFORMATIONS OF BIODIVERSITY ARE OCCURRING, WHAT ARE THE FORESEEABLE CONSEQUENCES OF SUCH CHANGES, WHAT IS BEING DONE, OR WHAT COULD BE DONE. THIS IS INFORMATION THAT ENABLES FINDING AN ONGOING SOLUTION TO THE QUESTION OF HOW TO INCORPORATE BIODIVERSITY IN THE DEVELOPMENT OF THE COUNTRY."

2016, the year that this Report covers, is a milestone in Colombia's recent history. Despite the enormous political polarization within Colombian society that also reflects polarizations taking place in other parts of the Western world, there is no doubt that the signing of the Habana Agreement between the Colombian government and the revolutionary group FARC-EP (The Revolutionary Armed Forces of Colombia-People's Army) marks a turning point in the development of the country nationally, regionally, and locally. This peace process will imply, in one way or another, the transformation of Colombia's rural areas, and this simple fact will make biodiversity regain a central role in discussions. Such role may be played as a victim of previous and new environmental degradations that result from the conflict, as a frontier for territorial exploitation or transformation, as a way of life for rural communities, or simply as a source of prosperity and well-being. Debates about development in Colombia's post-conflict era will thus unavoidably include the question of what to do with and how to relate to the immense biological richness of the country. The creation of *Programas de Desarrollo con Enfoque Territorial* (Development Programs with a Territorial Approach-PDET for its initials in Spanish) in 170 municipalities prioritized for the post-conflict is a clear example of the novel dynamics in the country. PDET represent an opportunity for local communities to propose, deliberate, and manage their visions of development for the next 15 years based on the recognition and vital connection to their territories. It is the chance for communities to express the vision they have regarding their relations to nature and use existing connections to construct their own environmental, social, and economic sustainability. On the other hand, it is also the opportunity to reconcile multiple plans of territorial and sectoral planning that exist in Colombia, solve historical inequities, and start engaging the rural and urban parts of the country and decreasing the gaps between them.

In this scenario, having robust, updated, and open access information about the status and trends of biodiversity is indisputably essential. From a local to a national scale, it is fundamental to know where the greatest transformations of biodiversity are occurring, what are the foreseeable consequences of such changes, what is being done, or what could be. This is information that enables finding an ongoing solution to the question of how to incorporate biodiversity in the development of the country.
From this perspective, the Report on the Status and Trends of Colombian Continental Biodiversity is a tool designed to include biodiversity in the process of a transition towards sustainable development. It enables monitoring changes, informing the rest of the country about these changes, alerting and identifying opportunities, and placing findings in the service of dialogues for the achievement of peace and sustainability. In other words, the report is a tool to create and develop the interface between science, politics, and society, which is imperative in times of the post-conflict. Although the 2016 volume of the Report does not necessarily answer such questionings, it gives a panorama about the type of topics and approaches that are being treated in the knowledge and management of biodiversity. For this, the Report uses a fresh and accessible language that reaches a variety of audiences. Consequently, the Report accomplishes its purpose of inviting readers to reflect about different ways of giving biodiversity a central role in the search for solutions to current challenges in society. I congratulate all authors and institutions that made this report possible, and I invite all readers to bring to life the contents of this publication.

EN
Antillean Manatee
Trichechus manatus

Introduction

Biodiversity 2016

Brigitte L. G. Baptiste
General Director of Humboldt Institute
Member of the the Intergovernmental Science-Policy Platform on
Biodiversity and Ecosystem Services-IPBES

"THE CHALLENGE OF COMMUNICATION CONTINUES TO BE A MAJOR PART OF THE INSTITUTIONAL PROJECT, AND THE NEW LANGUAGES WITH WHICH WE ARE LEARNING TO COMMUNICATE WITH SOCIETY AND OTHER INSTITUTIONS ARE AN EXPERIMENT THAT WE EXPECT TO BE INCREASINGLY GRATIFYING."

Comparettia macroplectron
Endemic to Colombia

This third volume of the annual report on biodiversity in Colombia continues the editorial line that begun in 2014. Using novel analytical and graphic proposals, these reports have the goal of communicating the contents to a broad public, making it available for discussion without sacrificing the quality of information. The challenge of communication continues to be a major part of the institutional project, and the new languages with which we are learning to communicate with society and other institutions are an experiment that we expect to be increasingly gratifying. The report for 2017 is already under construction and it counts on new digital technologies so the power of a Colombian vital connection may be entirely expressed.

The included content evidences that we are still far away from having a systematic follow-up about most of the topics related to the management of biodiversity and ecosystem services, which is the only way to evaluate the effectiveness of policies and investments made by society. In fact, a limitation that is recognized is that of identifying positive or negative changes that affect different levels of organization of life on this planet; therefore, our global navigation route of the Aichi targets is still to be verified.

An additional purpose of this process includes the invitation of all Colombians to contribute in constructing and maintaining basic monitoring indicators for management since it is impossible to identify long-term trends of flora and fauna in the country without the support of institutions, researchers, and citizens. This challenge is immense in a megadiverse country such as Colombia. For this reason, the report will continue to open its pages to experts, and even indigenous peoples or local communities, for them to present their perspectives about environmental change and its effects on biodiversity in a systematic and documented manner. This has the objective of stimulating the commitment of everyone in the management of biodiversity and ecosystem services. The only way of overcoming the risk of extinction is through the active process of social learning in which all sectors assume a part of the complex responsibility in protecting the forms of life of the country, a roughly counted tenth of all creatures on Earth.

I thank all the people that contributed in this Report, those who have supported us in the phases of production, and all readers and users, who are the ultimate judges of its utility.

Introduction

Contents and Trends of BIO 2014-2016

Germán Andrade and Luz Adriana Moreno
Editors

VU
Spectacled Bear
Tremarctos ornatus

The Report on the Status and Trends of Colombian Continental Biodiversity in its volume of 2016 recognizes the consolidation of the report as a series, with a novel format that gives information on the status and trends of biodiversity through a communication emphasis that considers graphics, a synthetic message, and communication of information by using different media. The reports of the years 2015 and 2016 additionally count with an interactive virtual platform in Spanish and English (**reporte.humboldt.org.co**) where various contents regarding Colombian biodiversity are included.

Although the report is edited by the Humboldt Institute and is partly constructed by contributions from all of its areas, it also includes contributions from other institutes associated to the *Sistema Nacional Ambiental* (National Environmental System-Sina for its initials in Spanish), academia, NGOs, research groups, etc. Each year the participation of external authors is greater, and in this volume there are contributions of more than 40 institutions.

This year, the section of Biodiversity in Numbers has the purpose of quantitatively showing the advances, challenges, and opportunities of the topics developed inside the book.

The SiB Colombia starts being used as a strategy to integrate knowledge so in the future it may be consolidated into this section with the purpose of giving information about the trends and status of some taxonomic groups.

Biodiversity 2016 in numbers

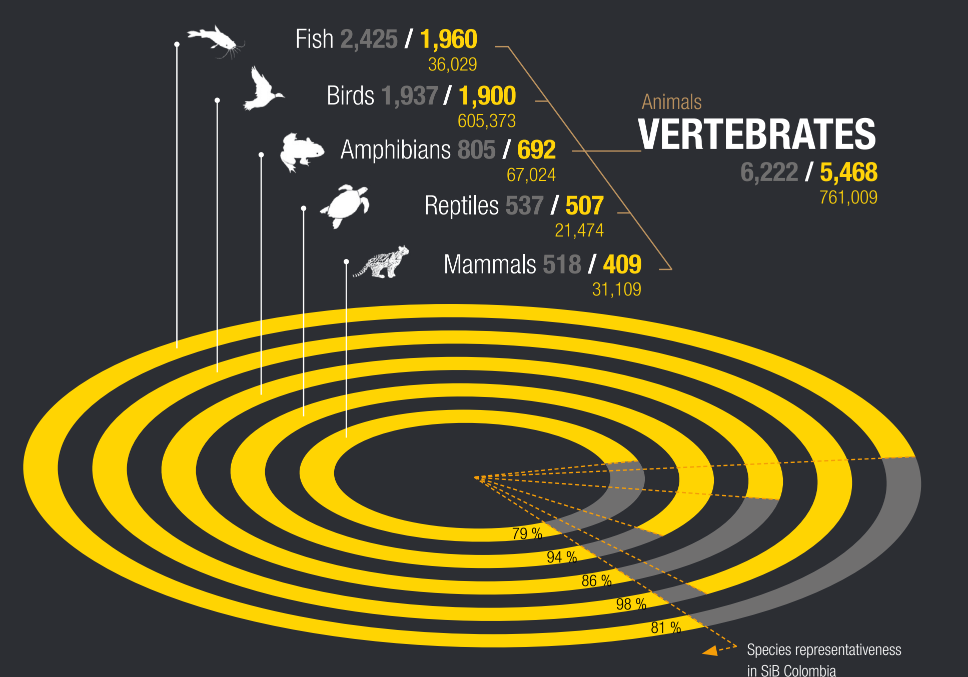
A perspective from SiB Colombia about our species

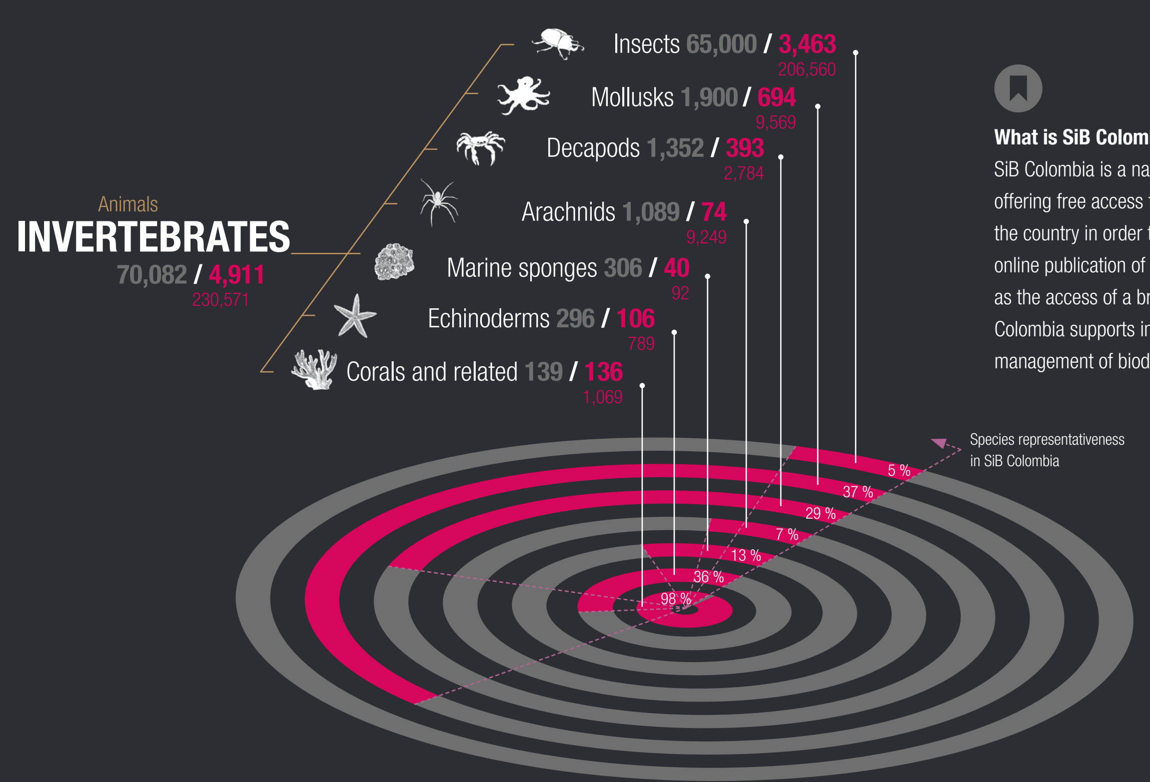
Dairo Escobar[a], Javier Gamboa[a], and Leonardo Buitrago[a]

This numerical analysis creates a perspective about the management of knowledge regarding our biodiversity at a species level. Such panorama allows for the identification of what should be the approaches of future research efforts in order to have the most complete national biodiversity inventory that is possible.

Reading guide

BIOLOGICAL GROUP
Group — Number of species reported in literature / **Number of species with at least one record in SiB Colombia**
Number of records in SiB Colombia



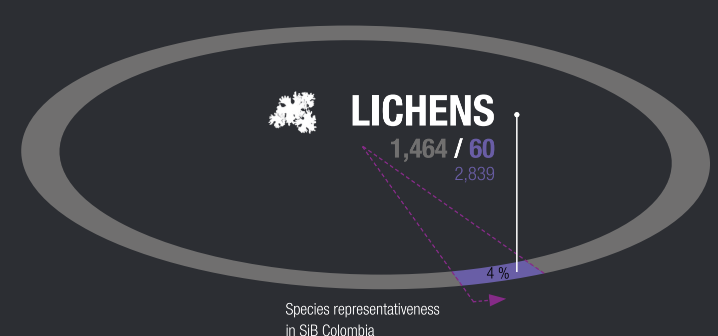


What is SiB Colombia?

SiB Colombia is a nation wide initiative that has the purpose of offering free access to information on the biological diversity of the country in order to create a sustainable society. It facilitates online publication of biodiversity data and information, as well as the access of a broad variety of publics. In this way, SiB Colombia supports in a timely and efficient manner the integrated management of biodiversity.

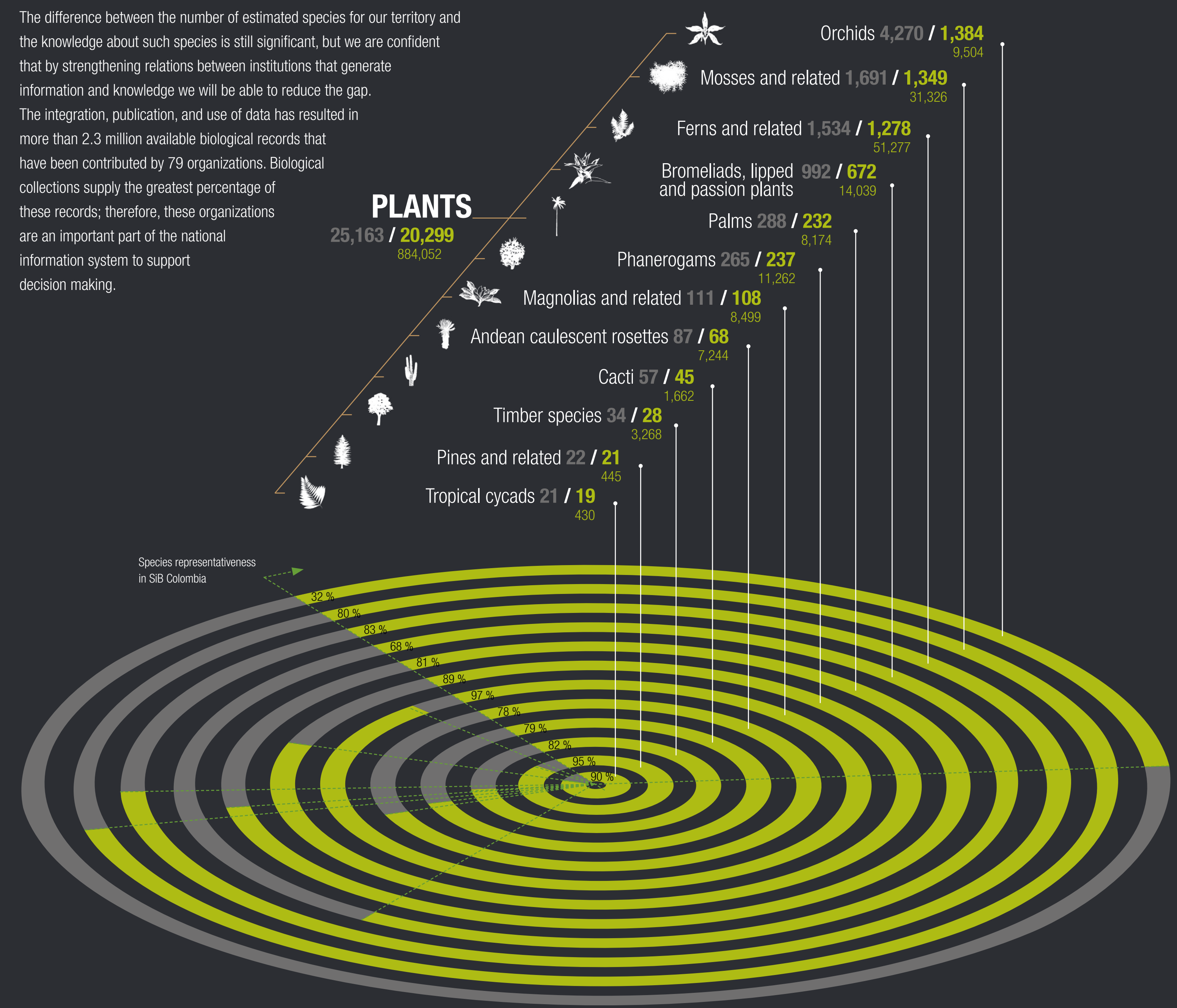
Why is the publication of data through SiB Colombia important?

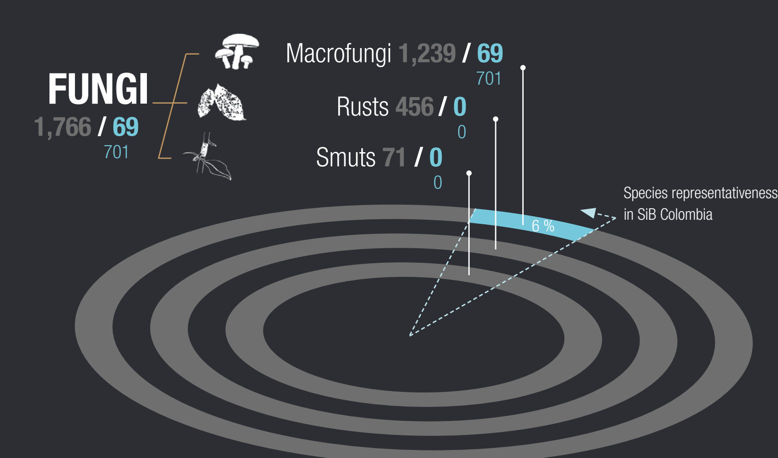
More and better available data connected and consolidated in SiB Colombia catalyze the generation of knowledge that is needed for a good integrated management of our biodiversity, which in turn has a direct and positive effect on the quality of life of society. The publication of data increases visibility and the public acknowledgement of those who share their data, thus facilitating the creation of an online national biodiversity inventory for the country that has access to multimedia content of specimens and observations. Such content supports responses to national and regional necessities, and it complements existing initiatives and efforts to create a better country.



SiB Colombia in 2016

The difference between the number of estimated species for our territory and the knowledge about such species is still significant, but we are confident that by strengthening relations between institutions that generate information and knowledge we will be able to reduce the gap. The integration, publication, and use of data has resulted in more than 2.3 million available biological records that have been contributed by 79 organizations. Biological collections supply the greatest percentage of these records; therefore, these organizations are an important part of the national information system to support decision making.





SiB Colombia participation channels

SiB Colombia Portal
Be part of the SiB Colombia community by staying informed about our activities and publishing data with the help of guides and manuals.
« www.sibcolombia.net »

Data portal
Explore, use, and contribute to data quality for more than 54,000 species that belong to the country's biodiversity.
« datos.biodiversidad.co »

Biodiversity Catalogue
Discover detailed information about species in Colombia in more than 4,000 species information files.
« catalogo.biodiversidad.co »

Naturalista
Share your passion for nature. Find tools to contribute to the knowledge of biodiversity in the country.
« naturalista.biodiversidad.co »

Institution: a. *Sistema de Información sobre Biodiversidad de Colombia-Instituto de Investigación de Recursos Biológicos Alexander von Humboldt.*

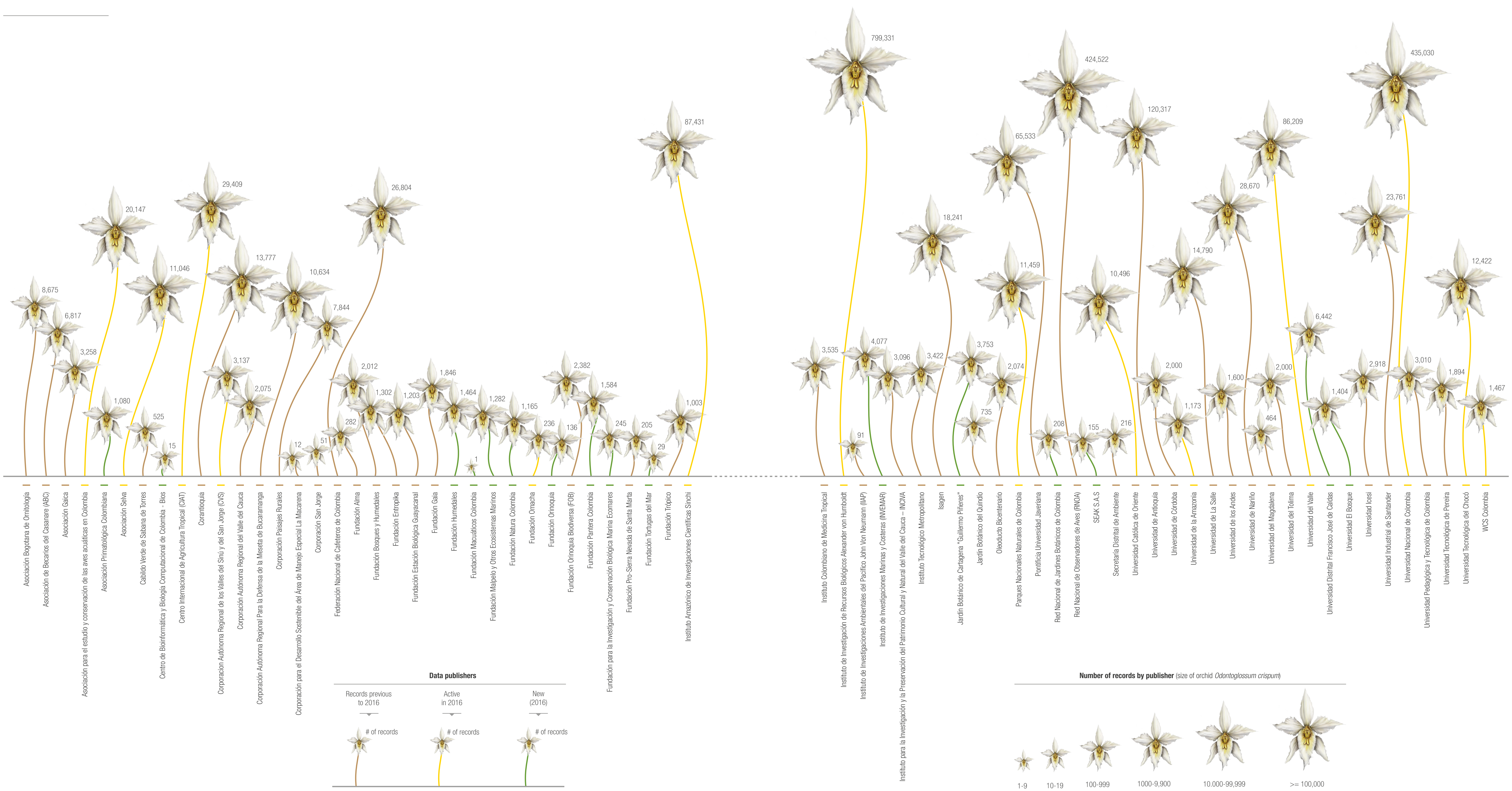
Biodiversity 2016 in numbers

Number of records by publishing entity in SiB Colombia

Our allies

SiB Colombia identifies itself as a collaborative community in which organizations contribute by sharing their data, experiences, abilities, and technology to facilitate the publication and use of data about biodiversity for the benefit of all.
The management of networks and inter-institutional cooperation developed by the Coordinating Team of SiB Colombia enabled the growth of the community to 79 participating organizations possible.
Of these, 17 are new publishing associates that share open data through SiB Colombia.

SiB Colombia exists thanks to the participation of many organizations and people that share data and information under the principles of open access, cooperation, transparency, recognitions, and shared responsibility. More and better available, connected, and consolidated information transforms into knowledge that is useful to conserve, use, and connect to biodiversity.



Reading Guide

THE TEXT IN EACH INFORMATION FILE OF BIODIVERSITY 2016 IS STRUCTURED WITH THE GOAL OF INTRODUCING, CONTEXTUALIZING, OR EXPLAINING A TOPIC IN A SUCCINCT MANNER. IN MANY CASES QUESTIONS OR IDEAS ABOUT A PARTICULAR SUBJECT ARE PROPOSED FROM THE PERSPECTIVE OF AN INTEGRATED MANAGEMENT OF BIODIVERSITY AND IN THE CONTEXT OF THE COUNTRY, ESPECIALLY IN TERMS OF THEIR IMPLICATIONS, RISKS, OPPORTUNITIES OR SUCCESSFUL EXAMPLES.

The content presented in this report is informative and does not seek to exhaustively cover the topics included.

Numerical identification of information file. First number represents the chapter; following two numbers represent its placement inside the chapter.

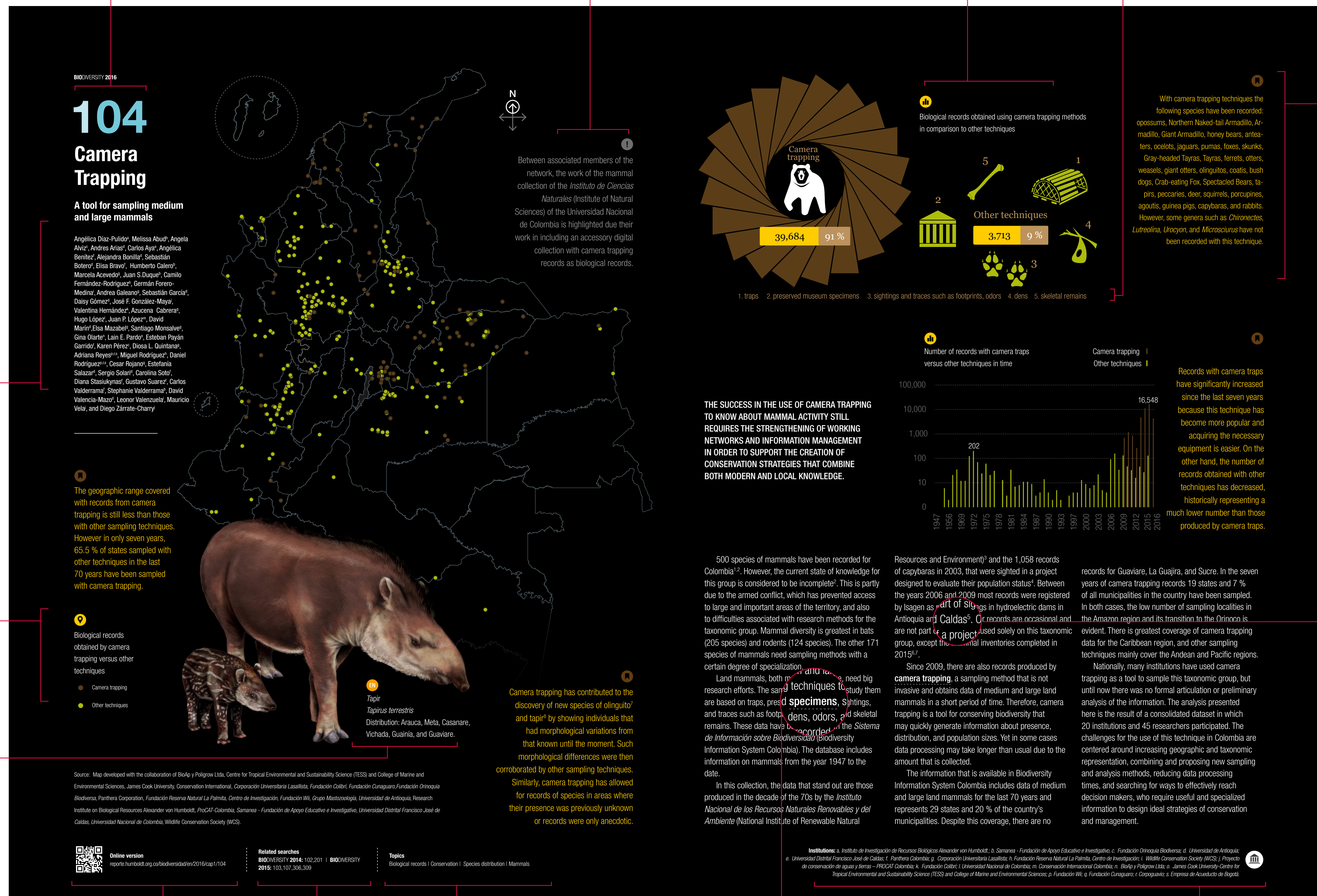
Additional or clarifying information that is key when interpreting maps or graphics.

Title, description, and source for each graph or timeline.

Conventions of maps or graphs, such as color scales and other categories that are necessary for reading.

IUCN Threat Categories

Least Concern		Threat			Extinction	
LC	NT	VU	EN	CR	EW	EX
Least Concern	Near threatened	Vulnerable	Endangered	Critically Endangered	Extinct in the Wild	Extinct



Authors of the information file. Respective institutional affiliations may be found in the lower right corner and an index of all authors may be consulted in the Appendix chapter.

Title, description, and source of each map. None of the maps in this book was conceived as an exact geographical representation, so the scale and location of some territories may vary.

Data about the illustrated species such as common name, latin name, threat status in Colombia according to the IUCN, average weight, etc.

The report has a virtual version that holds complementary content that includes methodological information and supporting material such as figures, graphs, recordings, additional analysis, and, in some cases, direct links to sources of information that may give the user access to more details on the subject. Additionally, the content of each information file is available for download in PDF format, as well as suggested citation, author profiles, topics index, and the complete bibliography of the report (reporte.humboldt.org.co).

Highlighted information boxes that develop additional or complementary content.

This icon indicates the existence of additional virtual content, as well as the source of information when it is available online.

Suggested citation

Díaz-Pulido, A., Abud, M., Alviz, A., Arias-Alzate, A., Aya, C., Benitez, A.,… Zárrate-Charry, D. (2017). Camera Trapping. In Moreno, L. A., Andrade, G. I., and Ruiz-Contreras, L. F. (Eds.), Biodiversity 2016. Status and Trends of Colombian Continental Biodiversity. Bogotá D.C., Colombia: Instituto de Investigación de Recursos Biológicos Alexander von Humboldt.

Bibliographical references in the Cited Literature section of the Appendix chapter.

Each information file has a virtual version that may be accessed through the quick response code (QR) or given URL. In the web the cited literature, details of methodologic processes, and additional information may be consulted.

Information files published in Biodiversity 2014 and 2015 that contain similar information.

Topics developed that are also treated in other parts of the book.

Highlighted key concepts with definition or more details in the Glossary section of the Appendix chapter.

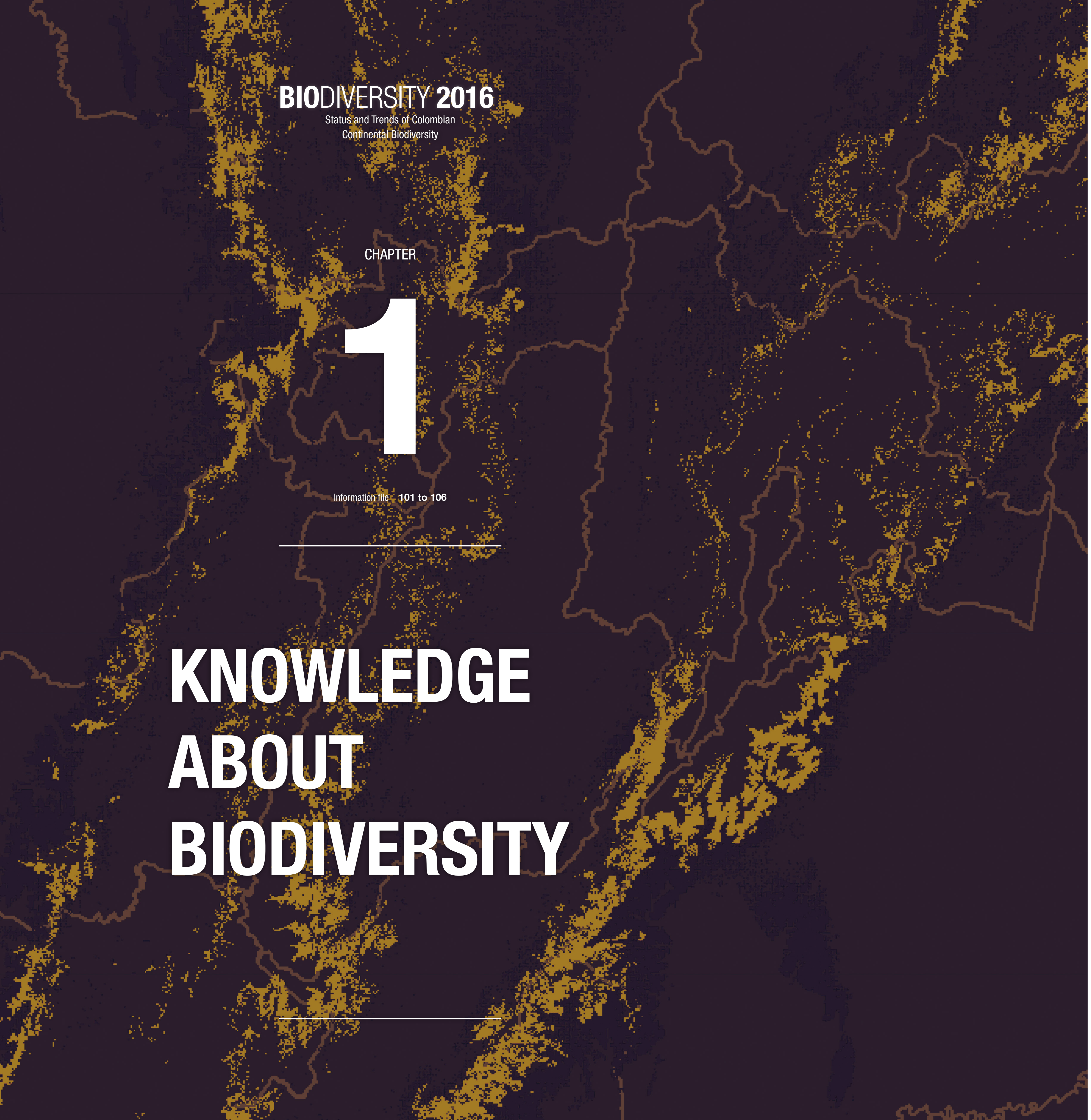
Institutional affiliations of authors.

Measuring Units

mm	Millimeter
m³	Cubic meter
m	Meter
km²	Square kilometer
km³	Cubic kilometer
ha	Hectare
m.a.s.l.	Meters above sea level
%	Percentage
kg	Kilogram
USD	United Stated dollar

Abbreviations

sp.	Species
p.e.	For example



BIODIVERSITY **2016**

Status and Trends of Colombian Continental Biodiversity

CHAPTER

1

Information file **101 to 106**

KNOWLEDGE ABOUT BIODIVERSITY

This first chapter, as in previous versions, has the purpose of showing and collecting information with temporal and spatial dimensions that evidences the conservation status of some groups and, when possible, may present for example trends of publications of taxonomic and geographic data in the *Sistema de Información sobre Biodiversidad de Colombia* (Information System of Colombian Biodiversity-SiB Colombia). The topics included in the books of BIO 2014, 2015, and 2016 reveal that many studies covering different organization levels of biodiversity, as well as a variety of taxonomic groups, have been developed in the country. Yet studies must coincide in the use of variables of time and space that meet a national scale. This necessity has been and will continue to be the aim of the Report. This first chapter chiefly covers the subject of management of information and data about biodiversity.

The topics addressed in the different versions of the report include the historic perspective of the role of collections in the knowledge about biodiversity in the last century (BIO 2014), the contributions of the Humboldt Institute to biological collections during four decades (BIO 2015), and the patrimonial value of biological collections (BIO 2015). Also, there was a presentation of the SiB Colombia as a repository of data (BIO 2014) and a compilation of published data and the role of the Institute in such databases (BIO 2016), in addition to derived topics such as online biological records (BIO 2014) and open data (BIO 2015).

Information and knowledge are approached from determined biological groups such as diversity of birds and turtles (BIO 2014), conservation status of amphibians and crocodilians (BIO 2015), and freshwater rays (BIO 2016), as well as from a perspective of genetic diversity as a tool for knowledge (BIO 2015) and biological groups for their importance in use, as is the case with medicinal plants (BIO 2014) and crocodilians (BIO 2015). Information regarding ecosystems has been chiefly addressed from those that are considered strategic ecosystems. For forests, a synthesis about the status of knowledge and associated research lines was presented (BIO 2015). Regarding tropical dry forests, different information files that respond to an internal research agenda are included that cover the following questions: what records of amphibians, dung beetles, and plants exist for the dry forest? what and where is the conservation status of dry forest fragments? how has the management of dry forests advanced? (BIO 2015). Additionally, oak forests (BIO 2016) are treated from a viewpoint of phytosociology and management recommendations. In relation to paramo ecosystems, the topics of forest upper boundaries and biological diversity are addressed (BIO 2015).

Emerging topics in the basic knowledge of biodiversity comprise the presentation of new techniques such as camera traps, which change the previous approaches about the status of fauna (BIO 2016), and a first introduction to functional diversity of forests (BIO 2016).

In the future, the information regarding those particular groups already included should be updated, and new biological groups must be incorporated. Similarly, at the ecosystem level, there should be annual monitoring processes according to type, location, and functional attributes. The management of information and its presentation will be synthetic and present compiled data that will get closer to the use of indicators for the status of knowledge about biodiversity.

101

Freshwater Rays

State of knowledge

Carlos A. Lasso[a], and Mónica A. Morales-Betancourt[a]

List of Rays in Colombia and 13 related species

Threat category
VU Vulnerable

Characteristics
Maximum size
Maximum weight

Use
Food
Medicinal
Ornamental

Distribution
AM Amazon
CA Caribbean
OR Orinoco
MC Magdalena-Cauca

Gomes's Round Ray
Heliotrygon gomesi
AM
60 cm · 6 kg

VU
Discus ray
Paratrygon aiereba
AM
85 cm · 42 kg

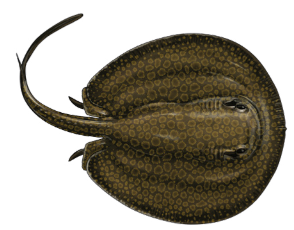
Manta Ray
Paratrygon sp 1
OR
80 cm · 28 kg

Manzana Ray
Paratrygon sp 2
OR
47 cm · 5 kg

Long-tailed River Stingray
Plesiotrygon iwamae
AM
52 cm · 20 kg

Dwarf Antennae Ray
Plesiotrygon nana
AM
52 cm · 12 kg

Thorny River Stingray
Potamotrygon constellata
AM
55 cm · 17 kg



Magdalena River Stingray
Potamotrygon magdalenae
MC CA
48 cm · 6 kg

VU
Ocellate River Stingray
Potamotrygon motoro
AM OR
62 cm · 11 kg

Smooth-back River Stingray
Potamotrygon orbignyi
AM OR
64 cm · 12 kg

VU
Rosette River Stingray
Potamotrygon schroederi
OR
58 cm · 10 kg

Raspy River Stingray
Potamotrygon scobina
AM OR
49 cm · 6 kg

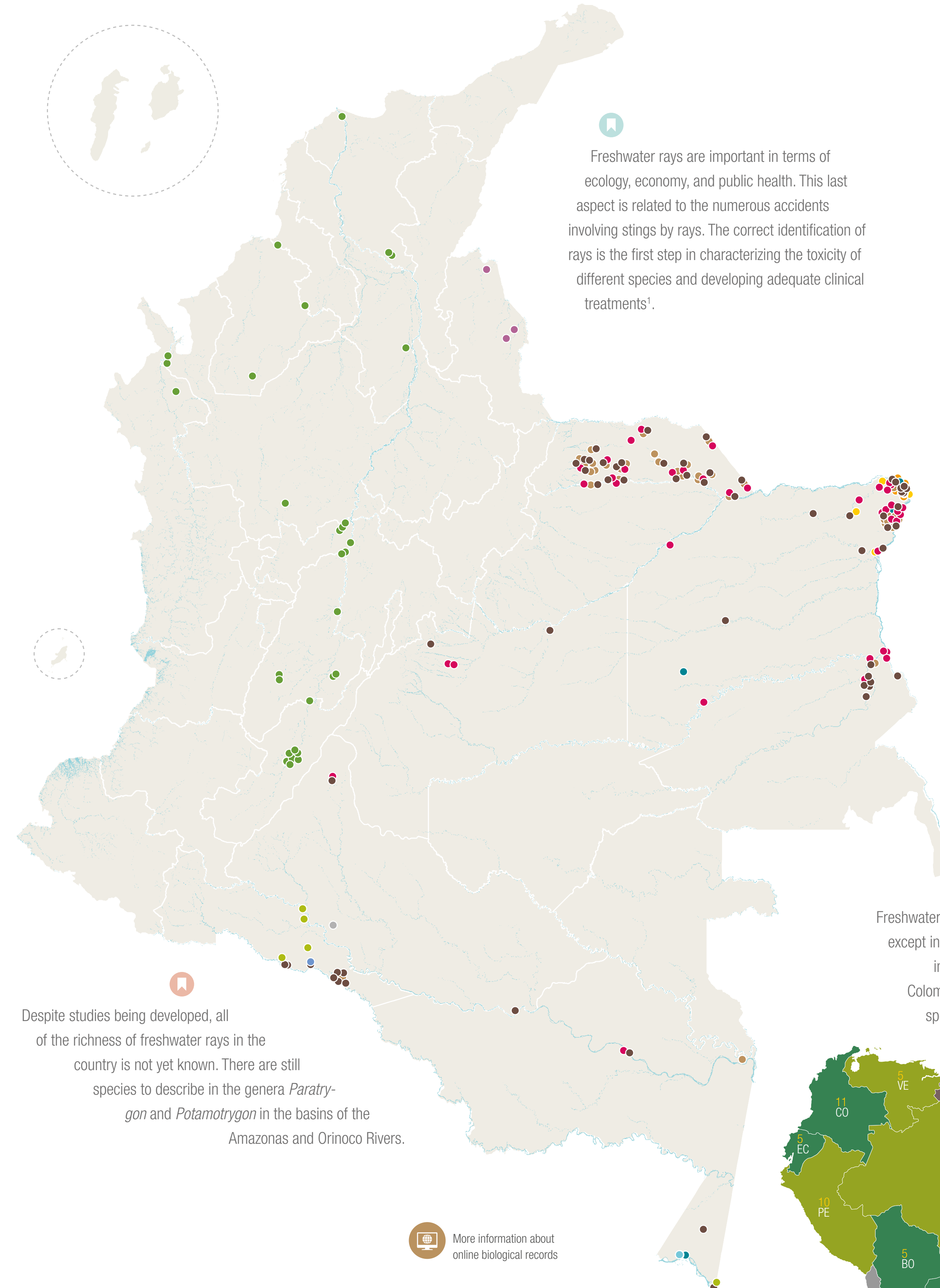
VU
Maracaibo River Stingray
Potamotrygon yepezi
CA
56 cm · 5 kg

DESPITE THEIR IMPORTANCE IN SCIENTIFIC, ECONOMIC, AND PUBLIC HEALTH MATTERS, FRESHWATER RAYS HAVE HAVE NOT BEEN STUDIED IN DETAIL. TAXONOMIC, BIOLOGICAL, ECOLOGICAL, FISHING, COMMERCIAL, NORMATIVE, AND SANITARY ASPECTS ARE YET TO BE INVESTIGATED.

Freshwater rays are cartilaginous fishes that are restricted to continental water bodies in South America. They are viviparous, have low fertility rates, slow growth and late maturation. These characteristics make them very vulnerable to anthropic pressures such as bycatch and fishing for commercial consumption, and, most importantly, ornamental use.
Freshwater rays are of great national and international interest due to their demand in the aquariums market. Colombia is one of the major exporters of rays, making this market an important source of income at the local level for indigenous and rural communities in areas of low economic development. However, the exploitation of this market has developed without appropriate technical criteria to guarantee its sustainability. In addition, information about the biology, fishing, and population dynamics of species of freshwater rays is lacking. Therefore the Humboldt Institute has been working on increasing the amount of knowledge and making population estimates for this group of animals.

In South America there are 34 different species of rays. After Brazil, Colombia is the second country with greatest species richness of rays, having 11 registered species up to date; still new species are being discovered with the advent of research. In Colombia, freshwater rays are distributed in all of the basins and slopes of the Caribbean, but are not present in the rivers of the slopes of the Pacific. There is one endemic species, the Magdalena River Stingray, which is distributed in the Magdalena-Cauca basin and the Caribbean rivers (Atrato, Sinú, Canalete and San Jorge). The basins with the largest number of rays are those of the Amazon and Orinoco Rivers[1,2]. Four out of the eleven species of rays in Colombia are found in the threat category of Vulnerable, being uncontrolled ornamental fishing their major threat[3]. Currently, a species list and distribution data of freshwater rays exist in Colombia. Also, there is information on the biology, ecology, and fishing of some of the species and there have been advances in the methodology for developing population estimates[4]. Yet it is clear that more research is needed to identify and describe all species and also explore many areas.

Distribution map of species of rays in Colombia



Freshwater rays are important in terms of ecology, economy, and public health. This last aspect is related to the numerous accidents involving stings by rays. The correct identification of rays is the first step in characterizing the toxicity of different species and developing adequate clinical treatments[1].

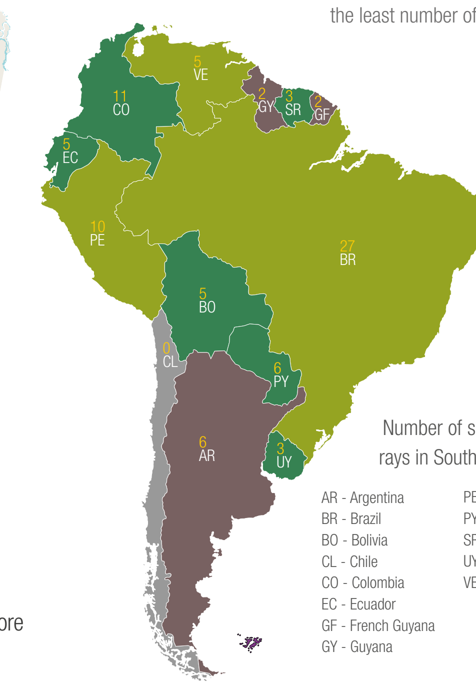
In Colombia, rays are distributed in all basins except those in the rivers of the Pacific slopes. The basins with greatest number of species are those of the Amazonas and Orinoco Rivers.

Despite studies being developed, all of the richness of freshwater rays in the country is not yet known. There are still species to describe in the genera *Paratrygon* and *Potamotrygon* in the basins of the Amazonas and Orinoco Rivers.

Freshwater rays are distributed in South America[2], except in Chile, the only country in the continent in which they are not present. Brazil and Colombia are the two countries with greatest species richness, while the Guyanas have the least number of species.

More information about online biological records

Number of species of rays in South America



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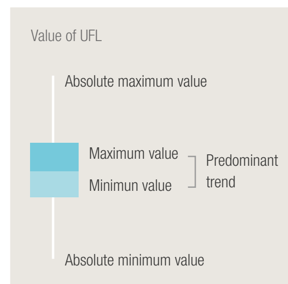
The Upper Forest Limit in the High Mountains of Colombia

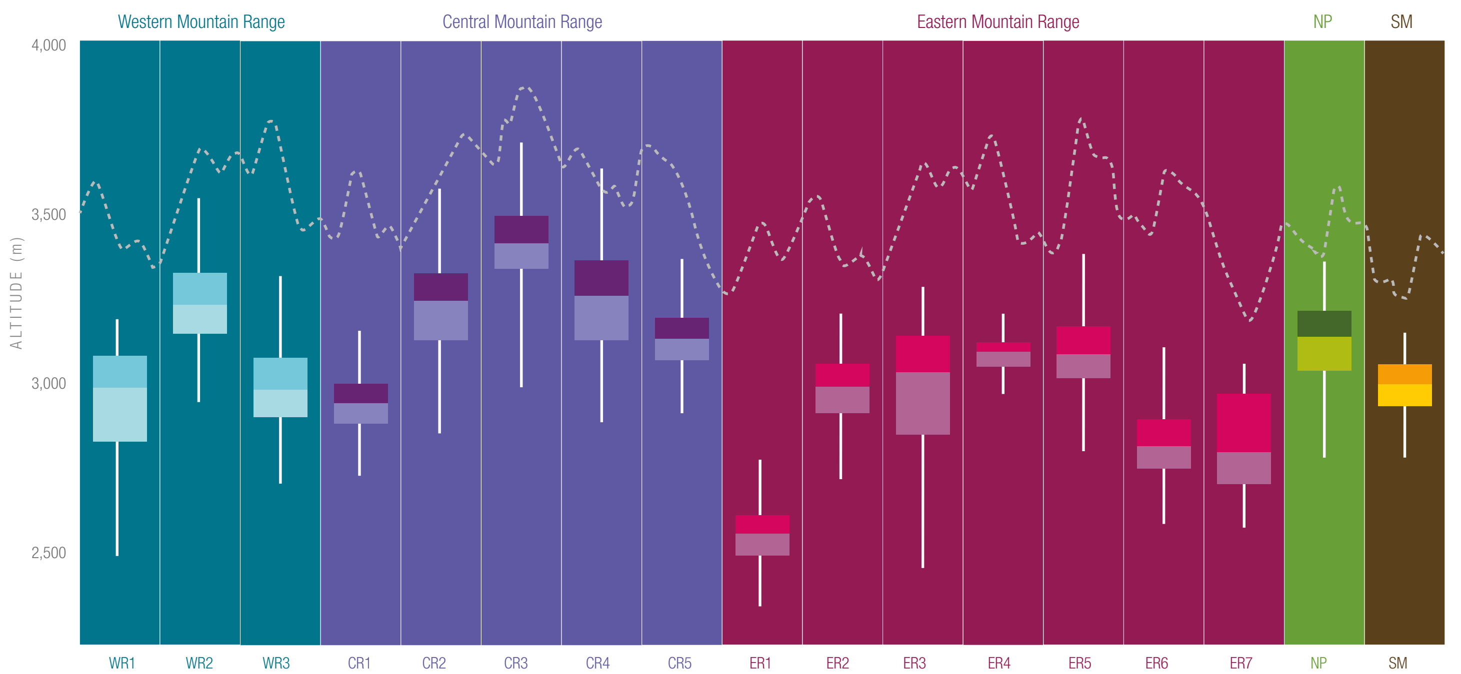
Carlos Sarmiento[a], Catherine Agudelo[a], and Olga León[a]

Altitude of UFL in the paramo districts of Colombia

WR1: Paramillo
WR2: Frontino-Tatamá
WR3: Duende Cerro Plateado
CR1: Belmira
CR2: Sonsón
CR3: Viejo Caldas- Tolima districs
CR4: Valle Tolima
CR5: Macizo Colombiano
ER1: Perijá
E2: Santanderes
ER3: Boyaca
ER4: Altiplano Cundiboyacense
ER5: Cundinamarca
CE6: Los Picachos
CE7: Miraflores
NP: Nariño-Putumayo
SM: Sierra Nevada de Santa Marta



Proyecto Páramos y Humedales (Paramos and Wetlands Project), financed by the Fondo Adaptación, completed the vegetation characterization in the high mountain altitudinal gradient in 500 sampling stations distributed in 85 localities in most mountain systems of the country. The geographical position of the UFL in Colombia was identified based on satellite images, new climatic data, and diverse modelling techniques.



The variation of the UFL occurs in a bell shaped pattern in the North-South direction, showing that central parts of each mountain range have the highest altitudes.

Each mountain range also presents differences: in the Central range the UFL reaches the highest altitudes (3,700 m.a.s.l.) in the paramo complex Los Nevados (Viejo Calda-Tolima districts). This is related to the size of the mountain and the presence of volcanic materials in the soil.

In the Western Mountain Range, the UFL reaches 3,450 m.a.s.l. in the paramo complex Frontino. In this area, humidity favors a higher altitude since humid air of the Pacific Ocean ascends over the western slope and deposits water in the higher parts of the range.

In the Eastern Mountain Range, UFL reaches 3,345 m.a.s.l. in the paramo complex Cruz Verde-Sumapaz. The regions of Nariño-Putumayo and Sierra Nevada de Santa Marta present altitudes of 3,355 and 3,200 m.a.s.l., respectively.

THE UPPER FOREST LIMIT (UFL) IN COLOMBIA VARIES IN RELATION TO THE DIVERSITY OF TOPO-CLIMATIC AND GEOLOGICAL CONDITIONS AND ITS CURRENT DEGREE OF TRANSFORMATION.

The upper forest limit is a global ecological condition determined by changes in environmental factors as altitude increases. Such changes limit the development of trees[1] and enable the existence of other life forms with adaptations that are suited for survival in those areas. The tropical Andes are recognized as a transition zone between the high Andean forest and sub-paramo.

Although Colombia has a broad collection of information regarding paramo ecosystems, there is less knowledge about the UFL as a transition area, and data about species composition, changes in structure according to climatic and topographic conditions, ecological functioning, and related ecosystem services is scarce. These transition zones are acknowledged as systems with essential roles in the flux of organisms, materials, and energy between ecosystems[2]. In comparison to those adjacent ecosystems, the UFL differs in species composition, ecosystem functions, and temporal dynamics[3].

The altitudinal location of the UFL is dynamic in terms of space and time and is chiefly explained by variations in temperature[4]. Nevertheless, other factors and processes also determine the location of the limit at the regional and local levels: 1. Abiotic factors such as increasing radiation, low water availability, topography, and soil properties; 2. Human activities that cause changes in disturbance; 3. Biotic interactions such as competition or facilitation, limited dispersal[3], and the presence of invasive species such as grass for cattle.

Spatial variations may include, for example, higher elevations of the UFL when mountain massifs are larger or higher. Similarly, in isolated areas or mountains of lower peaks, the limit may be located at lower altitudes (top, telescope of Massenerhebung effect)[5]. Lower UFL are also found in drier slopes that present greater variations in water regimes, or in areas that are under anthropic pressures.

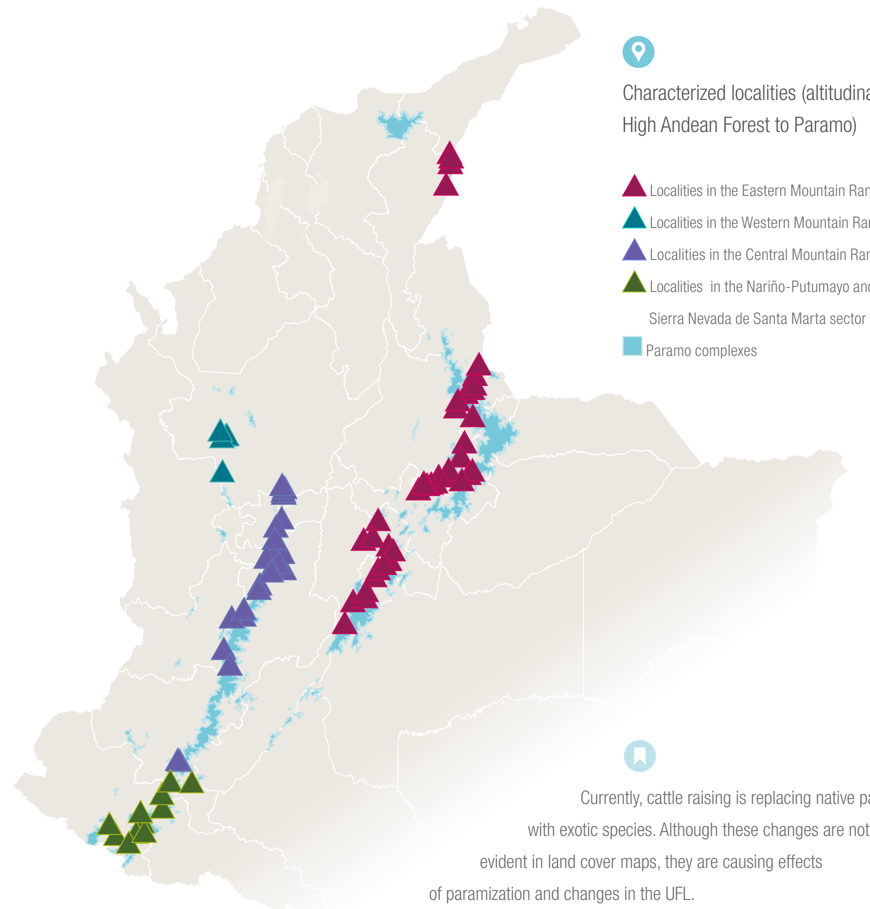
In relation to temporal variations, pronounced rises and drops in the location of the UFL occurred during glacial and interglacial cycles of the Pleistocene, and more recently in the Holocene. During glacial maximums, the boundaries descended to between 800 and 1,000 m beneath current altitudes[6].

Due to its close relation with temperature, the UFL is a potential indicator of the effects caused by global warming if ecosystemic distribution and structure is monitored. In conserved areas, global warming could result in an ascending limit whereas in transformed areas paramo pioneer species would descend, thus avoiding the regeneration of the forest.

Thanks to the project *Páramos y Humedales* (Paramos and Wetlands), financed by *Fondo Adaptación*, it was confirmed that the UFL responds to topo-climatic and geological variables of the mountain ranges of the country; therefore, existing differences between regions and localities were evidenced. This finding allows for a differentiated management that considers specific characteristics of each region and locality.

Knowing the exact location and variations of the UFL is important in scenarios of climate change, decision making, and land use planning. It is necessary to develop more research to identify and quantify the anthropic pressures that mostly affect these areas since such pressures modify the location and cause the ascent of the UFL.

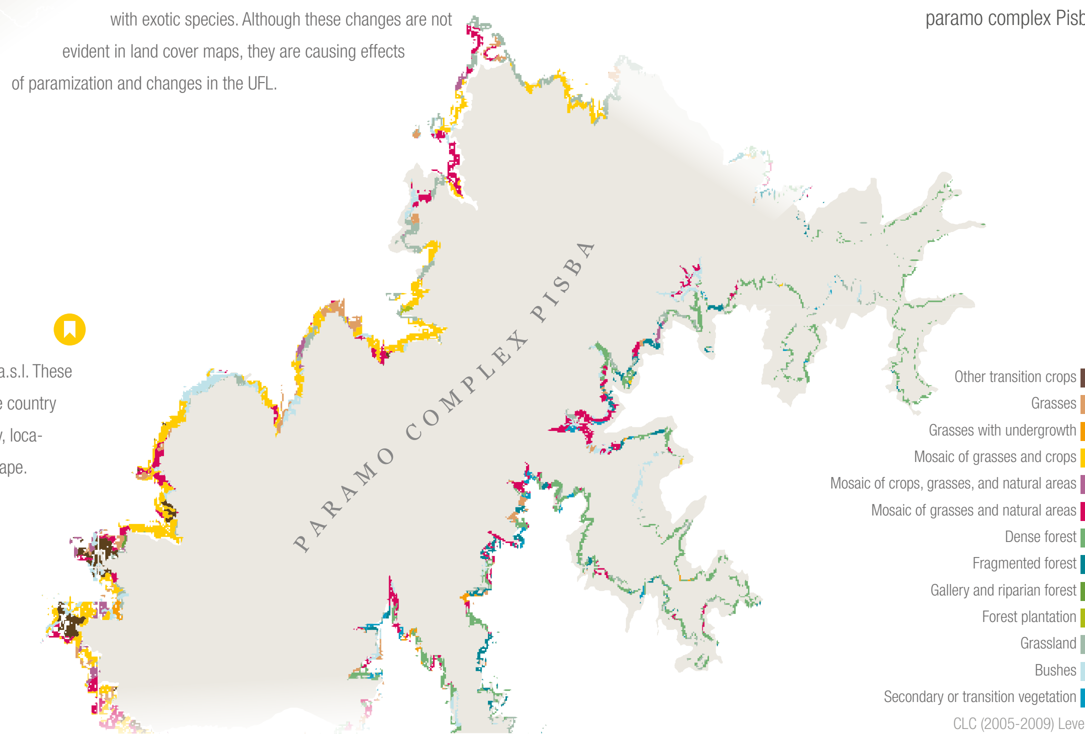
Characterized localities (altitudinal gradient High Andean Forest to Paramo)



According to the Ideam 2005-2009 land covers, a change in the use of the soil is evidenced. From 573,763 ha, 415,918 remain (72.5 %). The sector with greatest levels of transformation is the Eastern Mountain Range, where 66,766 ha have been transformed. In this sector, the area of the Distrito de Páramos de Boyacá has 38.7% of potential UFL under other uses, chiefly mosaics of grasses and crops (10,324 ha) and grasses (6,524 ha). The sector of the Central Mountain Range has 22,642 transformed ha, where the Distrito Viejo Caldas Tolima presents the largest area dedicated to other uses with 15,898 ha (36.5 %). In the Western Mountain Range Sector, 10.8 % (2,159 ha) of potential UFL is under other uses and the area with greatest transformation is Duende Cerro Plateado with 21.48 %. The sectors Nariño-Putumayo and Sierra Nevada de Santa Marta have 44,088 ha (26 %) and 524 ha (3 %) transformed, respectively.

Currently, cattle raising is replacing native pastures with exotic species. Although these changes are not evident in land cover maps, they are causing effects of paramization and changes in the UFL.

Map of the land covers for the UFL in Boyacá, paramo complex Pisba



The FUB is distributed between 2,450 and 3,700 m.a.s.l. These ranges change in different mountain sectors around the country depending on aspects of climate, topography, soils, geology, location, and human transformations on the landscape.

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Colombian Biodiversity Data Contributions by the *Instituto Humboldt*

Carolina Castro[a], Juan Rey[a], and Edwin Tamayo[a]

THE *INFRAESTRUCTURA INSTITUCIONAL DE DATOS* (INSTITUTIONAL INFRASTRUCTURE OF DATA) HOLDS AND PRESENTS TO THE PUBLIC INFORMATION THAT IS PRODUCED BY THE ALEXANDER VON HUMBOLDT INSTITUTE. IN THIS WAY, IT INFRASTRUCTURE ALLOWS FOR THE INSTITUTE TO BE THE GREATEST BIOLOGICAL DATA PUBLISHER FOR COLOMBIA IN THE *SISTEMA DE INFORMACIÓN SOBRE BIODIVERSIDAD* (BIODIVERSITY INFORMATION SYSTEM COLOMBIA).

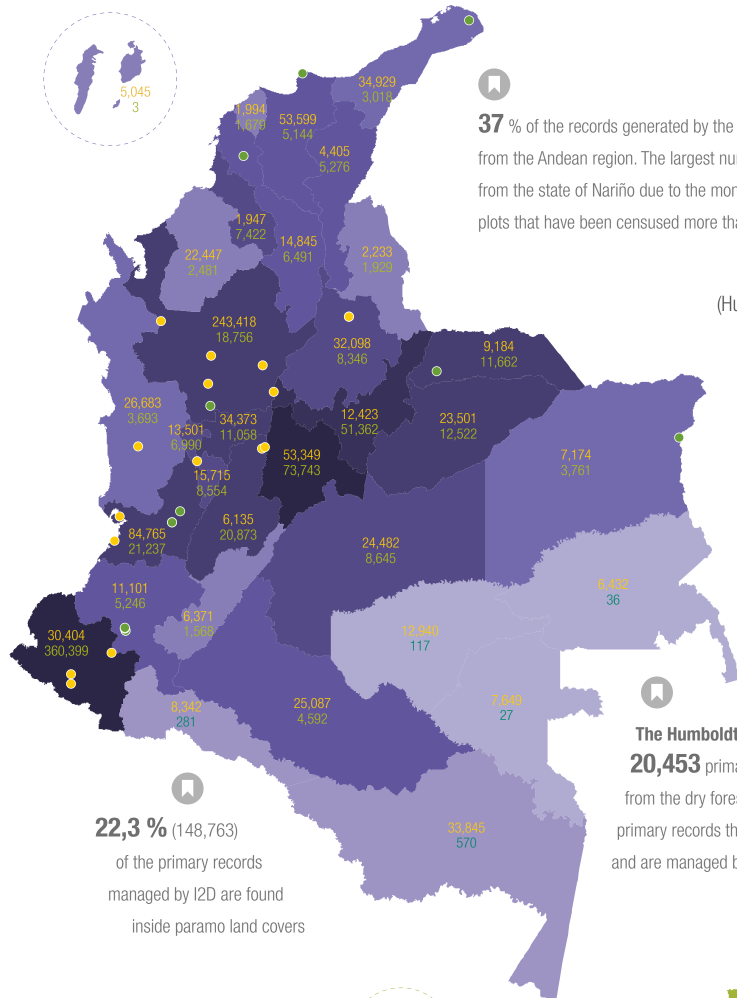
The availability of data and information that have a temporal dimension is essential to guarantee reliability, promote collaboration, and increase efficiency when investing resources[1]. Over twenty years of research, the Humboldt Institute has generated a significant amount of data that is currently shared in national platforms such as the Biodiversity Information System of Colombia and global platforms such as the Global Biodiversity Information Facility (GBIF). These efforts were made in response to the necessities of the country and international commitments such as those established in the Convention on Biological Diversity (CBD), which highlights the importance of strengthening the free and open access to data.

The data generated by the Humboldt Institute is kept by the Institutional Infrastructure of Data, which was consolidated in 2013 with the goal of facilitating the accomplishment of the Institute's mission goals, thus ensuring the integration, security, and access to research data in which both national and international associates have collaborated.

Since the establishment of that infrastructure, international standards and quality protocols have been implemented in the data generated by institutional research, represented chiefly by biological (607 **species files**, 927,949 **biological records**, 113 **species lists**, 108,579 **camera trapping images**, 1 **sound landscape** and 2 **phylogenies**) and geographical (satellite images, geographical layers, geographic databases, maps, and web services) data. This collection of data seeks to contribute to the national knowledge in terms of biodiversity.

Consequently, the data generated by the Institute is centralized and structured. It is used as a tool in decision making pertaining threatened, exotic and invasive species and strategic ecosystems (such as tropical dry forests, wetlands, and paramos), among other aspects.

Besides showing the contribution the Institute has made at different scales, this type of analysis also identifies information gaps for taxonomic groups and areas that should be prioritized due their lack of data. In this way, a contribution to the planning of future projects is made.



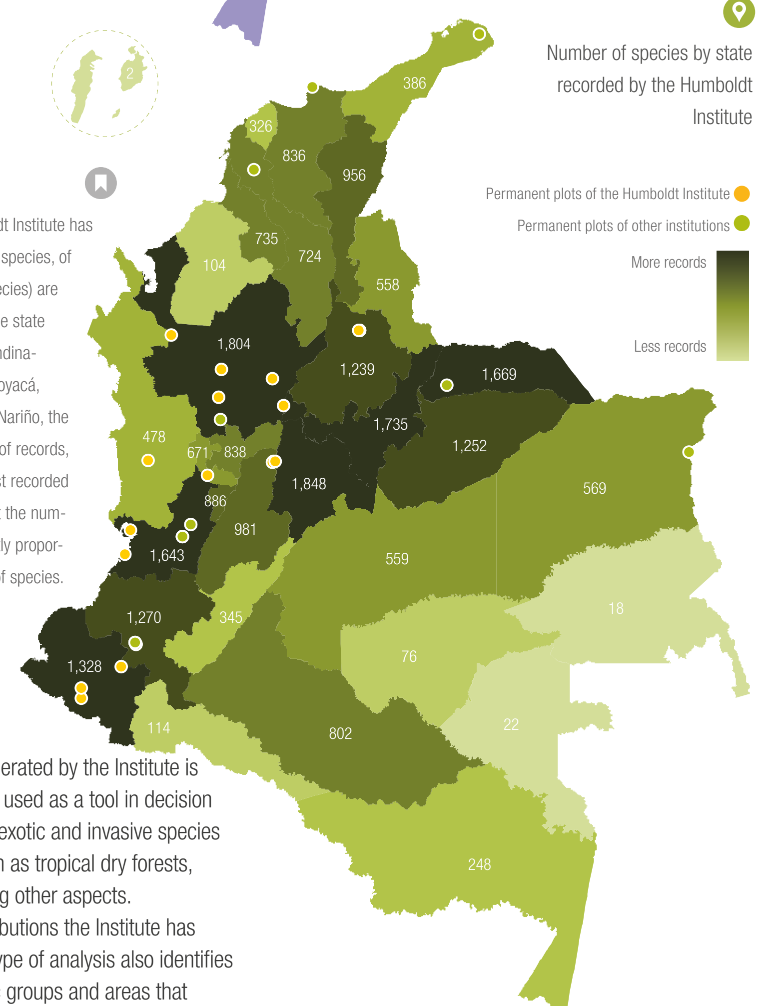
37 % of the records generated by the Humboldt Institute are from the Andean region. The largest number of records come from the state of Nariño due to the monitoring of permanent plots that have been censused more than once.

Number of biological records by state (Humboldt Institute in comparison to other institutions)

Records by other institutions
Records by the Humboldt Institute
Permanent plots of the Humboldt Institute
Permanent plots of other institutions
More records
Less records

22,3 % (148,763) of the primary records managed by I2D are found inside paramo land covers

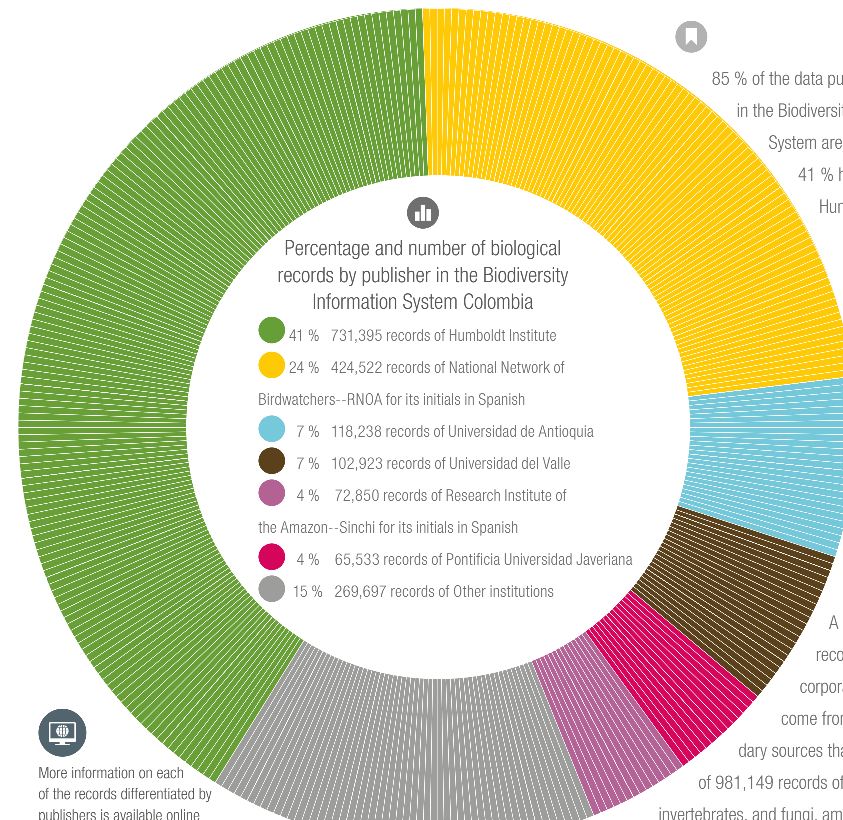
The Humboldt Institute has obtained **20,453** primary biological records from the dry forest (3,1% of the total of primary records that have coordinates and are managed by I2D).



Number of species by state recorded by the Humboldt Institute

Permanent plots of the Humboldt Institute
Permanent plots of other institutions
More records
Less records

The research of the Humboldt Institute has contributed a total of **25,022** species, of which **50,2 %** (12,545 especies) are concentrated in eight states. The state with most recorded species is Cundinamarca, followed by Antioquia, Boyacá, Arauca, and Valle del Cauca. Nariño, the state with the greatest amount of records, is the sixth state with most recorded species, making evident that the number of records is not directly proportional to the number of species.



Percentage and number of biological records by publisher in the Biodiversity Information System Colombia

- 41 % 731,395 records of Humboldt Institute
- 24 % 424,522 records of National Network of Birdwatchers--RNOA for its initials in Spanish
- 7 % 118,238 records of Universidad de Antioquia
- 7 % 102,923 records of Universidad del Valle
- 4 % 72,850 records of Research Institute of the Amazon--Sinchi for its initials in Spanish
- 4 % 65,533 records of Pontificia Universidad Javeriana
- 15 % 269,697 records of Other institutions

85 % of the data published in the Biodiversity Information System are from six institutions. 41 % have been published by the Humboldt Institute.

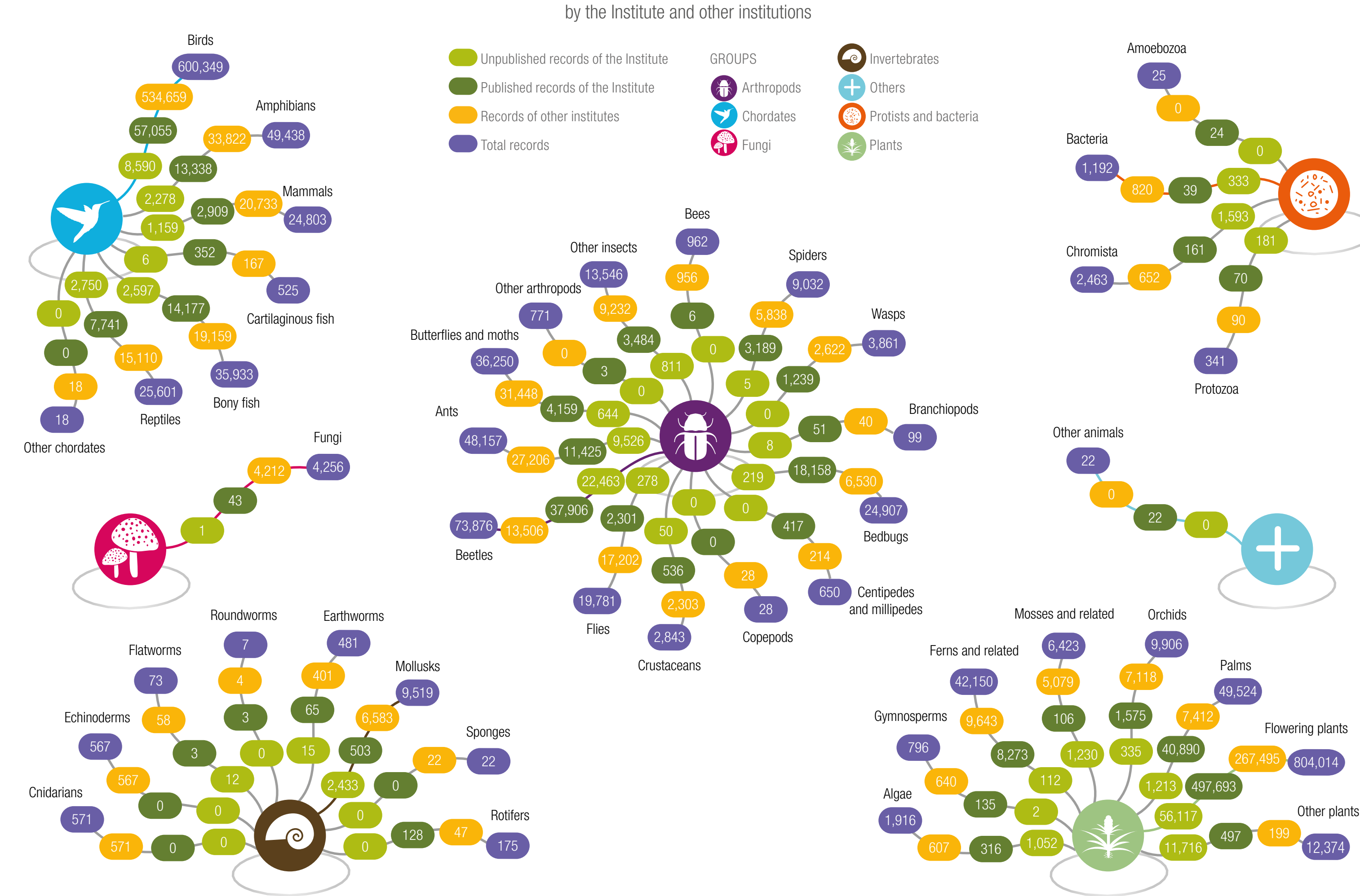
A total of 334 biological records have been incorporated in the I2D: 204 come from primary and secondary sources that equal to a total of 981,149 records of plants, animals, invertebrates, and fungi, among others.

More information on each of the records differentiated by publishers is available online

Resources and biological records included in the Institutional Infrastructure of Data

RECORDS PER YEAR: Secondary biological records; Primary biological records; Accumulated

RESOURCES PER YEAR: Resources



Biological records by taxonomic group generated by the Institute and other institutions

Unpublished records of the Institute; Published records of the Institute; Records of other institutes; Total records

GROUPS: Arthropods; Chordates; Fungi; Invertebrates; Others; Protists and bacteria; Plants

Institutions: a. *Instituto de Investigación de Recursos Biológicos Alexander von Humboldt.*

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Camera Trapping

A tool for sampling medium and large mammals

Angélica Díaz-Pulido[a], Melissa Abud[b], Angela Alviz[c], Andres Arias[d], Carlos Aya[e], Angélica Benítez[f], Alejandra Bonilla[d], Sebastián Botero[d], Elisa Bravo[f], Humberto Calero[b], Marcela Acevedo[g], Juan S.Duque[b], Camilo Fernández-Rodriguez[h], Germán Forero-Medina[i], Andrea Galeano[g], Sebastián García[d], Daisy Gómez[d], José F. González-Maya[j], Valentina Hernández[k], Azucena Cabrera[g], Hugo López[l], Juan P. López[m], David Marín[d],Elsa Mazabel[g], Santiago Monsalve[g], Gina Olarte[n], Lain E. Pardo[o], Esteban Payán Garrido[f], Karen Pérez[c], Diosa L. Quintana[g], Adriana Reyes[p,r,s], Miguel Rodríguez[h], Daniel Rodríguez[p,r,s], Cesar Rojano[q], Estefanía Salazar[d], Sergio Solari[d], Carolina Soto[f], Diana Stasiukynas[f], Gustavo Suarez[f], Carlos Valderrama[f], Stephanie Valderrama[b], David Valencia-Mazo[d], Leonor Valenzuela[i], Mauricio Vela[j], and Diego Zárrate-Charry[j]

The geographic range covered with records from camera trapping is still less than those with other sampling techniques. However in only seven years, 65.5 % of states sampled with other techniques in the last 70 years have been sampled with camera trapping.

Biological records obtained by camera trapping versus other techniques

- Camera trapping
- Other techniques

Between associated members of the network, the work of the mammal collection of the *Instituto de Ciencias Naturales* (Institute of Natural Sciences) of the Universidad Nacional de Colombia is highlighted due their work in including an accessory digital collection with camera trapping records as biological records.

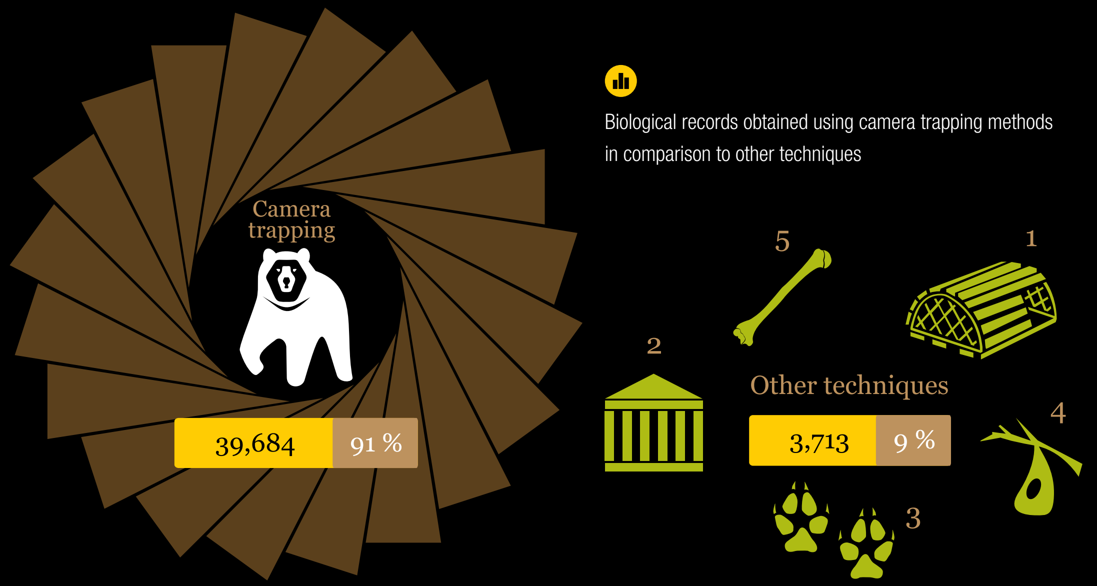
EN

Tapir
Tapirus terrestris
Distribution: Arauca, Meta, Casanare, Vichada, Guainía, and Guaviare.

Camera trapping has contributed to the discovery of new species of olinguito[7] and tapir[8] by showing individuals that had morphological variations from that known until the moment. Such morphological differences were then corroborated by other sampling techniques. Similarly, camera trapping has allowed for records of species in areas where their presence was previously unknown or records were only anecdotic.

Source: Map developed with the collaboration of BioAp y Poligrow Ltda, Centre for Tropical Environmental and Sustainability Science (TESS) and College of Marine and Environmental Sciences, James Cook University, Conservation International, *Corporación Universitaria Lasallista, Fundación Colibrí, Fundación Cunaguaro,Fundación Orinoquia Biodiversa*, Panthera Corporation, *Fundación Reserva Natural La Palmita, Centro de Investigación, Fundación Wii, Grupo Mastozoología, Universidad de Antioquia*, Research Institute on Biological Resources Alexander von Humboldt, *ProCAT-Colombia, Samanea - Fundación de Apoyo Educativo e Investigativo, Universidad Distrital Francisco José de Caldas, Universidad Nacional de Colombia*, Wildlife Conservation Society (WCS).

Biological records obtained using camera trapping methods in comparison to other techniques



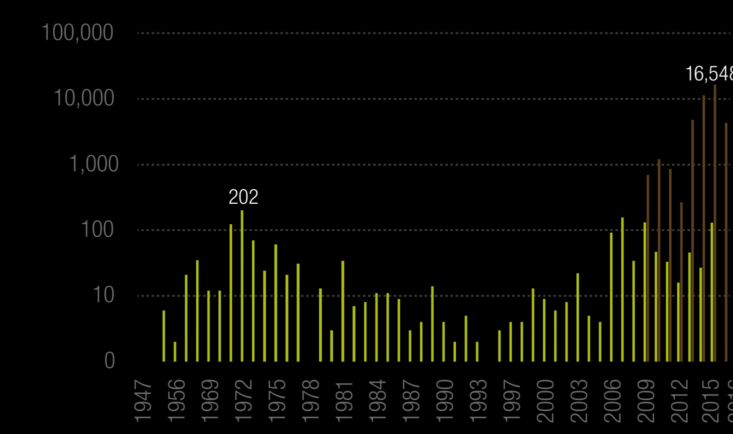
1. traps 2. preserved museum specimens 3. sightings and traces such as footprints, odors 4. dens 5. skeletal remains

With camera trapping techniques the following species have been recorded: opossums, Northern Naked-tail Armadillo, Armadillo, Giant Armadillo, honey bears, anteaters, ocelots, jaguars, pumas, foxes, skunks, Gray-headed Tayras, Tayras, ferrets, otters, weasels, giant otters, olinguitos, coatis, bush dogs, Crab-eating Fox, Spectacled Bears, tapirs, peccaries, deer, squirrels, porcupines, agoutis, guinea pigs, capybaras, and rabbits. However, some genera such as *Chironectes, Lutreolina, Urocyon*, and *Microsciurus* have not been recorded with this technique.

THE SUCCESS IN THE USE OF CAMERA TRAPPING TO KNOW ABOUT MAMMAL ACTIVITY STILL REQUIRES THE STRENGTHENING OF WORKING NETWORKS AND INFORMATION MANAGEMENT IN ORDER TO SUPPORT THE CREATION OF CONSERVATION STRATEGIES THAT COMBINE BOTH MODERN AND LOCAL KNOWLEDGE.

Number of records with camera traps versus other techniques in time

Camera trapping
Other techniques



Records with camera traps have significantly increased since the last seven years because this technique has become more popular and acquiring the necessary equipment is easier. On the other hand, the number of records obtained with other techniques has decreased, historically representing a much lower number than those produced by camera traps.

500 species of mammals have been recorded for Colombia[1,2]. However, the current state of knowledge for this group is considered to be incomplete[2]. This is partly due to the armed conflict, which has prevented access to large and important areas of the territory, and also to difficulties associated with research methods for the taxonomic group. Mammal diversity is greatest in bats (205 species) and rodents (124 species). The other 171 species of mammals need sampling methods with a certain degree of specialization.

Land mammals, both medium and large, need big research efforts. The sampling techniques to study them are based on traps, preserved **specimens**, sightings, and traces such as footprints, dens, odors, and skeletal remains. These data have been recorded in the *Sistema de Información sobre Biodiversidad* (Biodiversity Information System Colombia). The database includes information on mammals from the year 1947 to the date.

In this collection, the data that stand out are those produced in the decade of the 70s by the *Instituto Nacional de los Recursos Naturales Renovables y del Ambiente* (National Institute of Renewable Natural Resources and Environment)[3] and the 1,058 records of capybaras in 2003, that were sighted in a project designed to evaluate their population status[4]. Between the years 2006 and 2009 most records were registered by Isagen as part of sightings in hydroelectric dams in Antioquia and Caldas[5]. Other records are occasional and are not part of a project focused solely on this taxonomic group, except the mammal inventories completed in 2015[6,7].

Since 2009, there are also records produced by **camera trapping**, a sampling method that is not invasive and obtains data of medium and large land mammals in a short period of time. Therefore, camera trapping is a tool for conserving biodiversity that may quickly generate information about presence, distribution, and population sizes. Yet in some cases data processing may take longer than usual due to the amount that is collected.

The information that is available in Biodiversity Information System Colombia includes data of medium and large land mammals for the last 70 years and represents 29 states and 20 % of the country's municipalities. Despite this coverage, there are no records for Guaviare, La Guajira, and Sucre. In the seven years of camera trapping records 19 states and 7 % of all municipalities in the country have been sampled. In both cases, the low number of sampling localities in the Amazon region and its transition to the Orinoco is evident. There is greatest coverage of camera trapping data for the Caribbean region, and other sampling techniques mainly cover the Andean and Pacific regions.

Nationally, many institutions have used camera trapping as a tool to sample this taxonomic group, but until now there was no formal articulation or preliminary analysis of the information. The analysis presented here is the result of a consolidated dataset in which 20 institutions and 45 researchers participated. The challenges for the use of this technique in Colombia are centered around increasing geographic and taxonomic representation, combining and proposing new sampling and analysis methods, reducing data processing times, and searching for ways to effectively reach decision makers, who require useful and specialized information to design ideal strategies of conservation and management.

Institutions: a. *Instituto de Investigación de Recursos Biológicos Alexander von Humboldt.; b. Samanea - Fundación de Apoyo Educativo e Investigativo, c. Fundación Orinoquia Biodiversa; d. Universidad de Antioquia; e. Universidad Distrital Francisco José de Caldas; f. Panthera Colombia; g. Corporación Universitaria Lasallista; h. Fundación Reserva Natural La Palmita, Centro de Investigación; i. Wildlife Conservation Society (WCS); j. Proyecto de conservación de aguas y tierras – PROCAT Colombia; k. Fundación Colibrí; l. Universidad Nacional de Colombia; m. Conservación Internacional Colombia; n. BioAp y Poligrow Ltda; o. James Cook University-Centre for Tropical Environmental and Sustainability Science (TESS) and College of Marine and Environmental Sciences; p. Fundación Wii; q. Fundación Cunaguaro; r. Corpoguavio; s. Empresa de Acueducto de Bogotá.*

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Oak Tree Forests

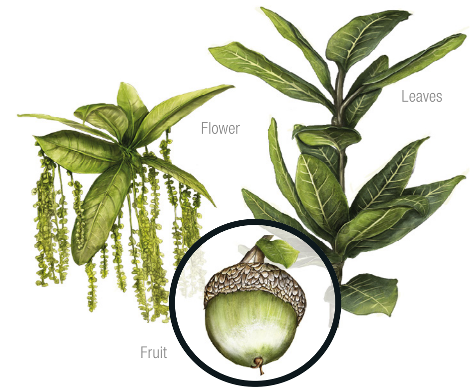
Diversity and conservation

Andrés Avella[a,b] and Orlando Rangel[a]

VU

BLACK OAK

Colombobalanus excelsa
Mountainous regions between 1,350 and 2,200 m.a.s.l.
Colombian Endemic



VU

ANDEAN OR WHITE OAK

Quercus humboldtii
Mountainous regions between 750 and 3,450 m.a.s.l.
Species that is almost exclusive to Colombia, it is also present in the Darién region of Panama.

MANAGEMENT RECOMMENDATIONS AND CHALLENGES

Oak forests are important at a socioeconomic scale due to their potential as timber products and ecosystem services (hydric regulation, soil protection, and refuge for threatened species[7,20,21]). In consequence to intensive timber exploitation, various prohibitions have been established[15,22,23,24]. However, degradation and deforestation of oak forests persists. It is therefore necessary to design inclusive conservation and forestry management strategies that combine the protection of biodiversity and ecosystem services to actions that promote a sustainable timber supply to satisfy the wood and firewood necessities peasant communities have.

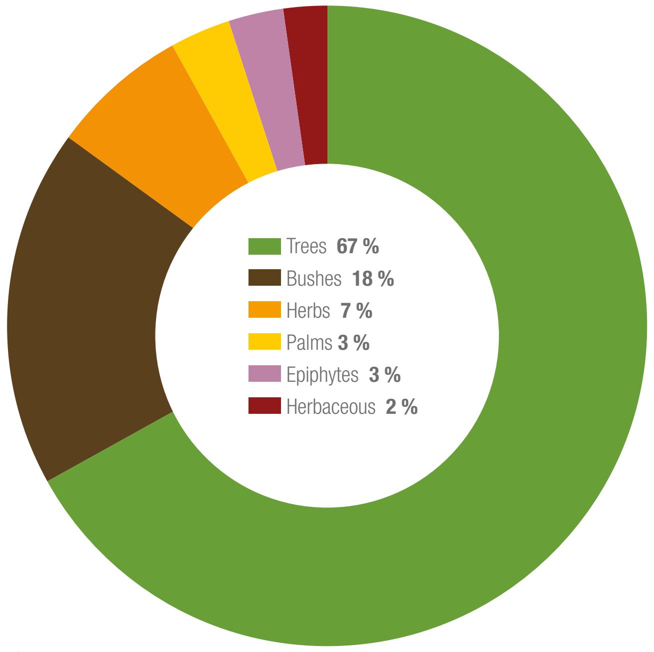
Floral richness in the oak forests of Colombia

805 species

Species grouped in

304 genera

124 families



Oak forest profile
Andean of *Quercus humboldtii*

Richness: **198** species
12 x Richness in each data collection
Abundance **59** individuals
Dominance **51** %
Distribution area: Andean and some presence in Sub-Andean.
Phytosociological class: *Myrsino coriaceae-Quercetea humboldtii*

Oak forest profile
Humid Sub-Andean of *Quercus humboldtii*

Richness **574** species
25 x Richness in each data collection
Abundance **94** individuals
Dominance **26** %
Distribution area: Sub-Andean below 2,400 m.a.s.l. in good conditions of humidity and precipitation (greater than 2,000 mm per year).
Phytosociological class: *Myrsino coriaceae-Quercetea humboldtii*

Oak forest profile
Dry Sub-Andean of *Quercus humboldtii*

Richness **137** species
13 x Richness in each data collection
Abundance **60** individuals
Dominance **68** %
Distribution area: Sub-Andean below 2,400 m.a.s.l. and precipitation lower than 2,000 mm per year
Phytosociological class: *Myrsino coriaceae-Quercetea humboldtii*

Oak forest profile
Sub-Andean of *Colombobalanus excelsa*

Richness **190** species
21 x Richness in each data collection
Abundance **146** individuals
Dominance **47** %
Distribution area: Sub-Andean between 1,337 and 2,166 m.a.s.l. in humid and sub-humid climates. Phytosociological class: *Conceveibo pleiostemonae-Colombobalanetea excelsae*

Oak forest profile
Andean of *Quercus humboldtii*

See photos of the types of oak trees
reporte.humboldt.org.co/biodiversidad/2016/cap1/105/galeria

CLASSIFYING DIFFERENT TYPES OF OAK TREE FORESTS IN COLOMBIA[1] GENERATES TOOLS TO DEFINE THEIR CONSERVATION STATUS, DIRECT THE PROCESS OF FOREST MANAGEMENT AND PROPOSE STRATEGIES FOR PRESERVATION, SUSTAINABLE USE, AND RESTORATION IN ORDER TO IMPROVE THE QUALITY OF LIFE OF COMMUNITIES THAT BENEFIT FROM THESE TREES.

In Colombia, around 40 % of the territory has been transformed due to demographic growth and changes in the use of soils[2]. In the Andean region, deforestation has affected and transformed at least 60 % of the original area of ecosystems[3,4,5,6]. Forests of oak trees have also been part of this phenomenon.

Oak tree forests are found between 750 and 3,450 m.a.s.l. on the three Andean mountain ranges and some isolated massifs in the Colombian Caribbean[7]. One of two species generally dominate such forests: the Andean or White Oak and the Black Oak. Many national contributions have increased knowledge about the **floral composition** and distribution of oak tree forests[8,9,11,12], as well as the ecological characterization of the forests in the Eastern[10,12,15,16], Central[12,13,14], and Western[17] Andes mountain ranges and recently also in the Caribbean massifs[18,7].

In the synthetic study of the Colombian oak forests which was based on floral composition, species **richness**, structure (height of canopy), **relative coverage** by strata, dominant species, aerial biomass, and timber exploitation, it was established that there are three big types (or phytosociological classes) of oak forests that vary in their floral composition depending on local characteristics. One type is composed of *Myrsino-Quercetea*, and is generally found in the Andean region, in some locations of the sub-Andean region that are influenced by rainshadow phenomena, or in sub-humid slopes. This type of oak forest has a lower species richness, greater **dominance**, and existing timber goods.

In the sub-Andean region the other two classes of oak forests are found. *Billio-Quercetea*, which has a greater species richness and lower dominance of oak species, additionally to having characteristic associated species, and is found in conditions of high humidity and precipitation over 2,000 mm per year; *Conceveibo-Colombobalanetea*, Black Oaks, located between 1,335 and 2,166 m.a.s.l. in humid and sub-humid climates of Bolivar, Santander, Huila, and Valle del Cauca. This class has a lower species richness and greater values of dominance and biomass.

Statistical analyses identified altitude as a determining factor in how temperature influences floral composition and structure of oak forests. In some localities, the water regime (precipitation) is also a significant factor. These ecological considerations are relevant in defining conservation statuses and directing processes of **forestry planning** to achieve long-term management of forests and those ecosystem services they offer and are coveted by society at large.

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Topics
Forests | Species distribution | Conservation | Communities

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Functional Diversity in the Forests of Colombia

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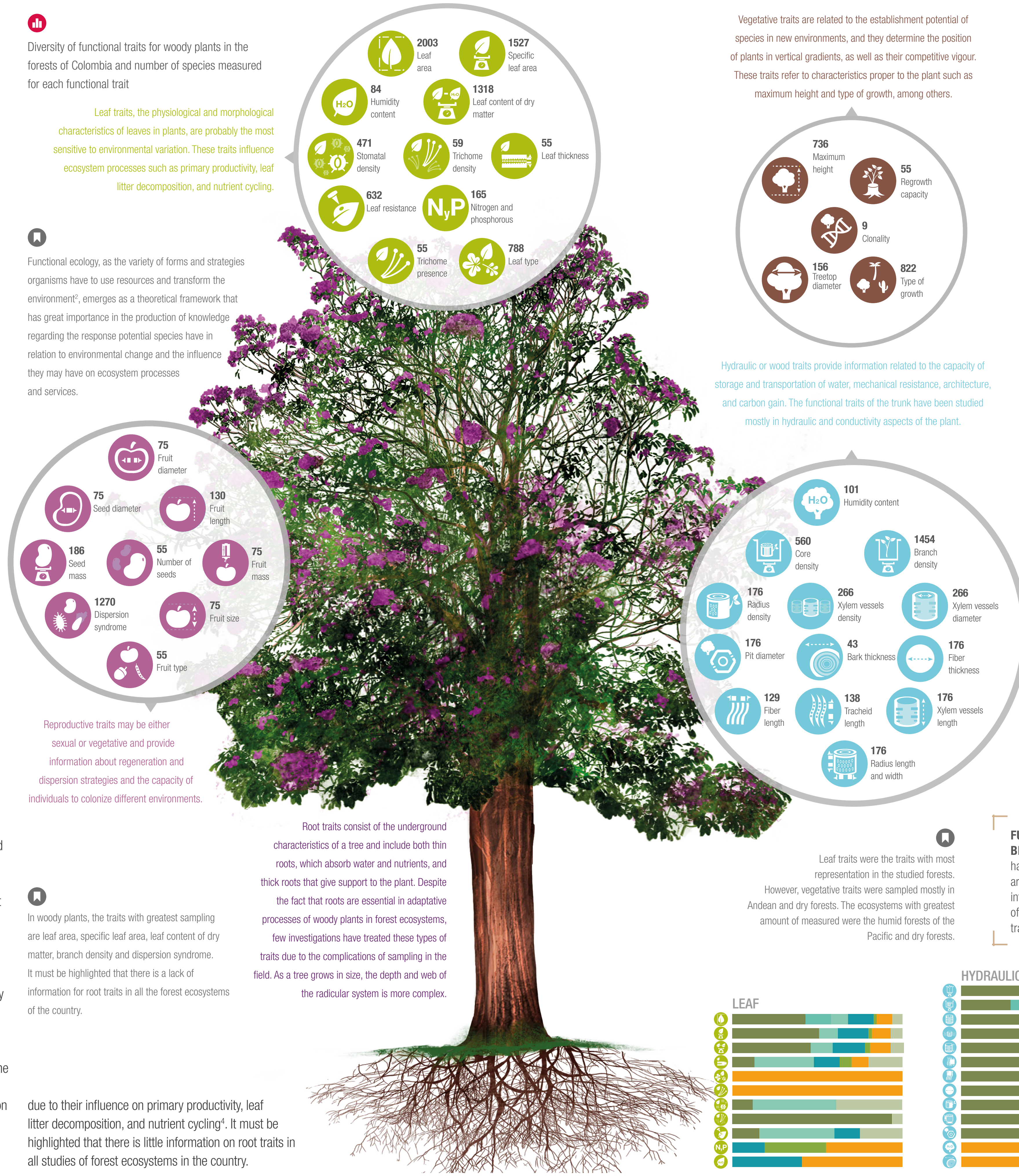
FUNCTIONAL TRAITS OF WOODY PLANTS ARE ESSENTIAL TO UNDERSTAND THE VULNERABILITY OF FORESTS TO CLIMATE CHANGE, THEIR CAPACITY TO OFFER ECOSYSTEM SERVICES, AND TO GUARANTEE THEIR ADEQUATE MANAGEMENT AND CONSERVATION. IN SPITE OF THIS, THERE ARE GREAT INFORMATION GAPS FOR ALL FOREST ECOSYSTEMS OF THE COUNTRY.

Forests in Colombia cover close to 53 % of the territory[1] and offer **ecosystem services** as important as the regulation of climate and water cycles, on which human populations depend. The offer of these services relies on ecosystemic processes, which are affected by the characteristics of tree species that live in those areas. In other words, the offer of ecosystem services is determined by the functional diversity of plants species, which refers to the variety of forms and strategies that plants have to use resources and transform the environment[2].

The functional features of plants may be grouped according to their functions: 1. Leaf traits that are related to carbon sequestration and hydrological relations of plants; 2. Stem and root traits that are important for water and nutrient transport and the mechanical support of plants[3]; 3. Vegetative and root traits that determine the access to light and growth rates; 4. Reproductive traits related to the dispersal and establishment of individuals. Although there is still no complete regional data or analysis regarding the **functional traits** of woody plants in Colombia, studies on the **functional diversity** of forest ecosystems in the country have increased in the past years. The growing interest in incorporating this dimension of biodiversity in forest ecological studies in the country is evidenced here.

This analysis was developed based on the information collected by around 60 researchers working on 2,265 tree species that are distributed in the different forests of Colombia. Leaf traits had the best representation in the data of all studied forests. These traits are important due to their influence on primary productivity, leaf litter decomposition, and nutrient cycling[4]. It must be highlighted that there is little information on root traits in all studies of forest ecosystems in the country.

Diversity of functional traits for woody plants in the forests of Colombia and number of species measured for each functional trait



Leaf traits, the physiological and morphological characteristics of leaves in plants, are probably the most sensitive to environmental variation. These traits influence ecosystem processes such as primary productivity, leaf litter decomposition, and nutrient cycling.

Functional ecology, as the variety of forms and strategies organisms have to use resources and transform the environment[2], emerges as a theoretical framework that has great importance in the production of knowledge regarding the response potential forests have in relation to environmental change and the influence they may have on ecosystem processes and services.

Vegetative traits are related to the establishment potential of species in new environments, and they determine the position of plants in vertical gradients, as well as their competitive vigour. These traits refer to characteristics proper to the plant such as maximum height and type of growth, among others.

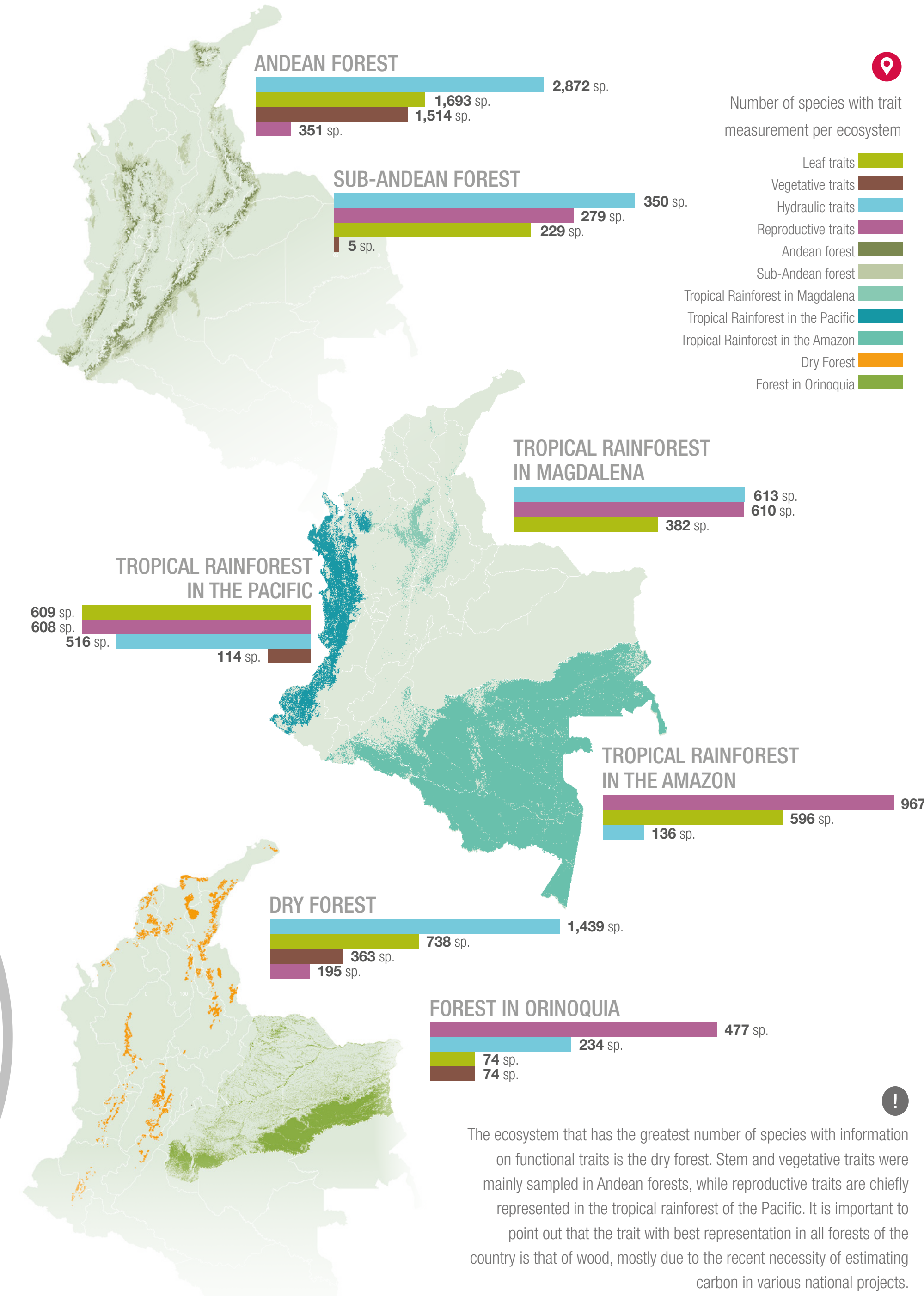
Hydraulic or wood traits provide information related to the capacity of storage and transportation of water, mechanical resistance, architecture, and carbon gain. The functional traits of the trunk have been studied mostly in hydraulic and conductivity aspects of the plant.

Reproductive traits may be either sexual or vegetative and provide information about regeneration and dispersal strategies and the capacity of individuals to colonize different environments.

Root traits consist of the underground characteristics of a tree and include both thin roots, which absorb water and nutrients, and thick roots that give support to the plant. Despite the fact that roots are essential in adaptative processes of woody plants in forest ecosystems, few investigations have treated these types of traits due to the complications of sampling in the field. As a tree grows in size, the depth and web of the radicular system is more complex.

In woody plants, the traits with greatest sampling are leaf area, specific leaf area, leaf content of dry matter, branch density and dispersion syndrome. It must be highlighted that there is a lack of information for root traits in all the forest ecosystems of the country.

Number of species with trait measurement per ecosystem

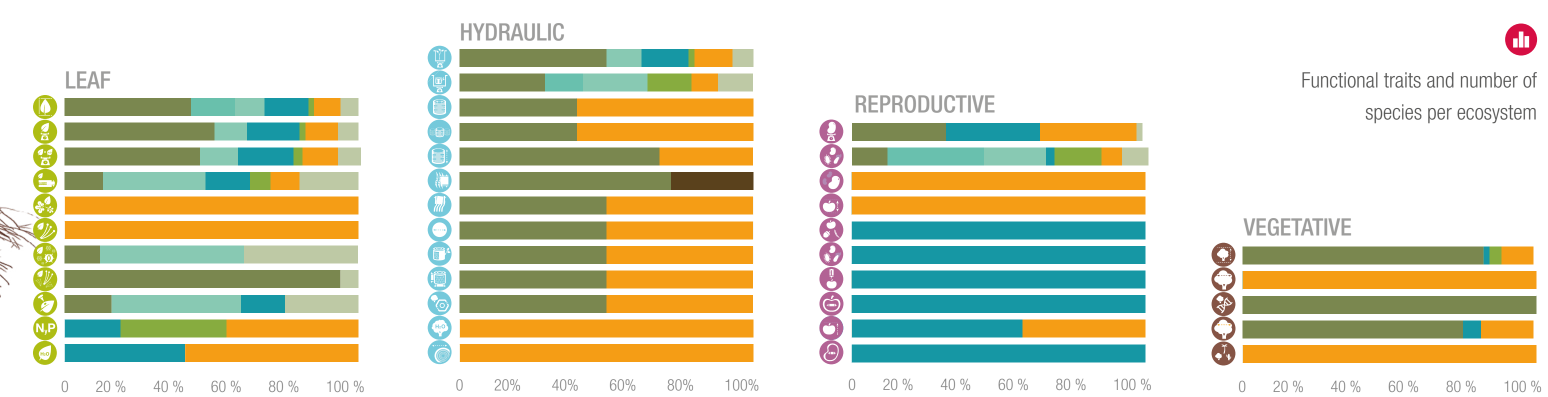


The ecosystem that has the greatest number of species with information on functional traits is the dry forest. Stem and vegetative traits were mainly sampled in Andean forests, while reproductive traits are chiefly represented in the tropical rainforest of the Pacific. It is important to point out that the trait with best representation in all forests of the country is that of wood, mostly due to the recent necessity of estimating carbon in various national projects.

Leaf traits were the traits with most representation in the studied forests. However, vegetative traits were sampled mostly in Andean and dry forests. The ecosystems with greatest amount of measured were the humid forests of the Pacific and dry forests.

FUNCTIONAL DIVERSITY FOR THE MANAGEMENT OF BIODIVERSITY. Although the focus on functional ecology has been adopted by many institutions in Colombia, there are still groups of key traits and ecosystems that are lacking information. The challenge is not only to increase the number of species and ecosystems with information on functional traits, but also to relate this knowledge with research and management questions at different biological scales such as: identification of priority conservation areas, ecosystem restoration to recover ecosystem processes, management of biological invasions, and adaptation to climate change, among others. This information should be available to the scientific community, translated, and incorporated in strategies for decreasing the loss of ecosystem functions.

Functional traits and number of species per ecosystem



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CHAPTER

2

Information file **201 to 205**

FACTORS OF BIODIVERSITY TRANSFORMATION AND LOSS

In the second chapter, different topics about the transformation and loss of biodiversity in the country have been presented. These include the use of threat categories in a national (BIO 2014) and global (BIO 2016) context for chosen biological groups such as reptiles (BIO 2016), tropical cycads, magnolias, palms, and some endemic plant species of dry forests (BIO 2016) as well as the analysis of the impact of Red List Books of freshwater fishes (BIO 2015). Also, the problem of species trafficking (BIO 2014) as a threat factor was presented and the effect on wildlife of bushmeat consumption. The richness, provision, and threats to fishing resources were also evaluated (BIO 2015).

In the subject of changes in land use, which is currently the major factor of transformation and loss of terrestrial biodiversity, its effect on species composition under different climate scenarios was presented (BIO 2016).

Biological invasions were treated according to their origin, susceptible areas in the national territory, and influence of climate change (BIO 2014). Specific subjects include the risk of transplanted exotic species and the analysis of the situation and challenges of this issue in relation to climate change scenarios.

At an ecosystem scale, the transformation of strategic ecosystems was presented. Such is the case of the dry forest, for which three volumes of the report evidence an established research agenda and a baseline is proposed to determine its location and conservation status is set. Also, the current status of plants, dung beetles and amphibian records are given, as are management strategies and the role and representativeness of protected areas. Regarding paramos and wetlands, the threats that affect these ecosystems are presented in addition to the main anthropic activities developed in wetland areas (BIO 2015). In the volume of 2015, the IUCN criteria for assessing the risk of terrestrial ecosystems was presented and the percentages of remaining covers through the time lapse of five decades for forests, savannas, and paramos was shown. Forests covers and their effects on biodiversity and probability of collapse were addressed in BIO 2014.

Climate change and its general effects on biodiversity and biomes, as well as its associated new challenges for conservation (BIO 2014) and effects on mountain summit extinctions (BIO 2016), is included.

The causes of transformation from different sectors, such as cattle raising, were analyzed. Also, the relation of cattle raising to biodiversity as a potential source of conservation according to cattle raising landscapes (BIO 2014 and 2015) and coca crops and their impact in humid tropical forests (BIO 2014) were presented.

In the future, subjects such as the status of ecosystems and groups of species may be included according to type or location, in addition to the more detailed analysis of causes and thresholds of loss and, specially, a broader base of knowledge about those sectors that have an impact on the transformation and loss of biodiversity.

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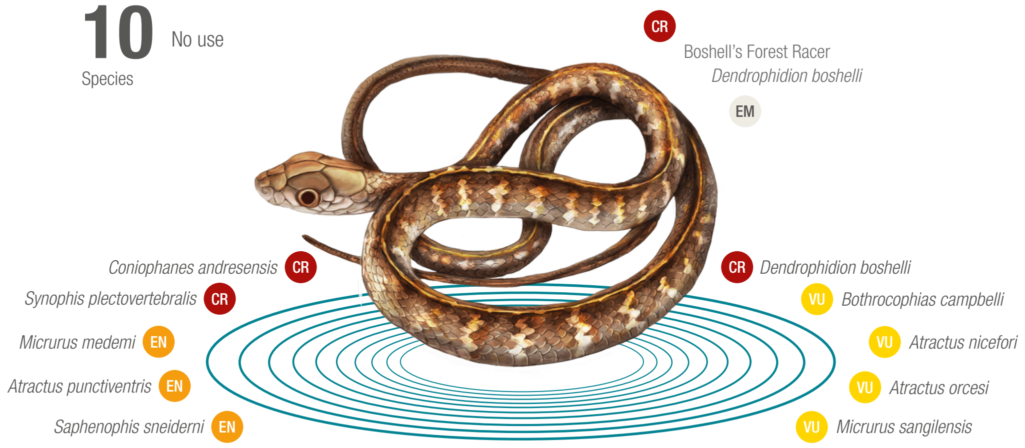
Threatened Reptiles of Colombia

Updates in the evaluation of extinction risks

Mónica A. Morales-Betancourt[a], Carlos A. Lasso[a],
Vivian P. Páez[b], and Brian C. Bock[b]

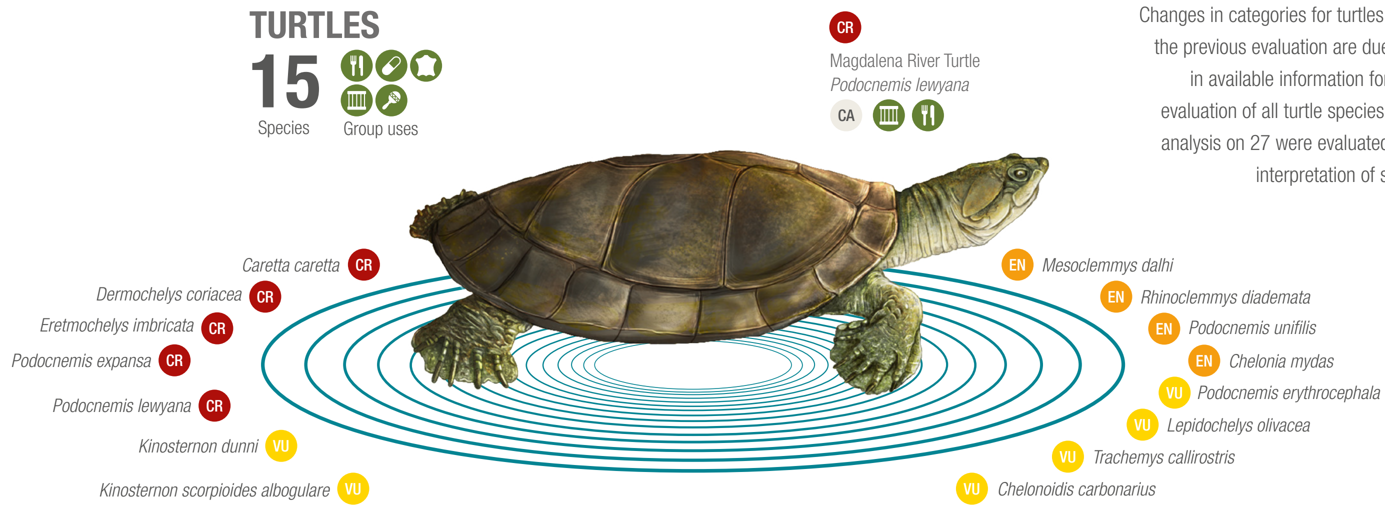
SNAKES

10 Species — No use



TURTLES

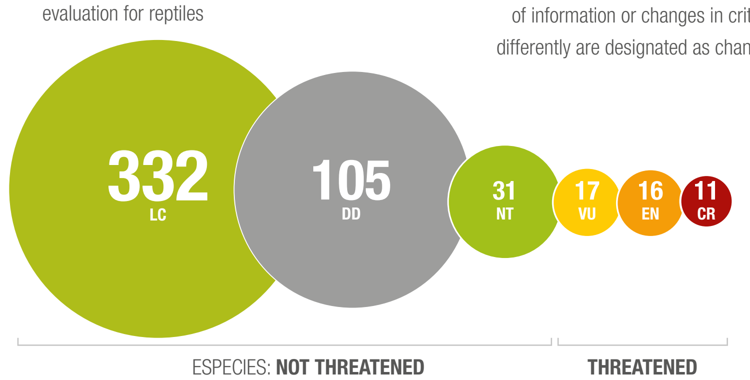
15 Species — Group uses



Changes in categories for turtles in relation to the previous evaluation are due to: increase in available information for the country, evaluation of all turtle species (in the 2002 analysis on 27 were evaluated), and a new interpretation of some criteria.

THE EVALUATION OF THE REPTILIAN SPECIES OF COLOMBIA SHOWED THAT 50 % OF CROCODILIAN AND 37 % OF TURTLE SPECIES ARE THREATENED AND THERE IS NOT ENOUGH INFORMATION TO CATEGORIZE 20 % OF ALL REPTILE SPECIES. IT IS THEREFORE NECESSARY TO STRENGTHEN CONSERVATION AND MANAGEMENT EFFORTS FOR THREATENED SPECIES, AS WELL AS DEVELOP MORE RESEARCH CONCERNING THOSE THAT LACK INFORMATION.

Results of the risk of extinction evaluation for reptiles



Changes in categories due to the existence of larger amounts of information or changes in criteria that have been interpreted differently are designated as changes with non-genuine reasons.

Colombia is the fourth country in the world with greatest reptile species richness, after Australia, Mexico, and Brazil. Historically, reptiles have suffered great anthropic pressures since some species are captured for consumption, held as pets, and seeked for the use of their skin. In other cases, reptiles are also sacrificed because people fear them. To all of these threats are also added the loss, transformation, and degradation of their habitat, which especially affects those species in the Caribbean slopes and the basin of the Magdalena-Cauca Rivers because 80 % of the human population, and thus th the economical development of the country, is located there.

In 2002, the first extinction risk evaluation for reptiles was developed. In that time, crocodilians and turtles were mostly evaluated since for snakes and lizards there was still no complete species list for Colombia. According to the guidelines of the International Union for Conservation of Nature (IUCN), these evaluations must take place every eight years; however, the second evaluation for the extinction risk of reptiles in Colombia was only completed after thirteen years, in 2015.

Of the 510 species and 2 subspecies that were evaluated, 9 % (43 species and one subspecies) were categorized under a threat category: 2 % (11 species) are Critically Endangered, 3 % (16 species) are Endangered, and 3 % (17 species) are Vulnerable. It is also worrisome to know that 20 % of reptiles in Colombia do not have information of any kind, eluding proper evaluation. These species are categorized as Data Deficient (DD)[1].

¿WHAT ARE THREATENED SPECIES?

9 % of reptiles in Colombia are threatened. Planning and conservation strategies, such as the risk extinction evaluation, are needed. Here the species information (distribution, demography, and population threats) is gathered and analyzed, in addition to the knowledge of researchers, to evaluate each species according to IUCN criteria. The results show what species should be the focus of research and management efforts (those that are threatened or are data deficient). Although various countries can share the distribution of a single species, each of them must develop their own evaluation since conservation status differ. In Colombia, evaluations are published in Red Books and are officially presented by updating the Endangered Species Act by the Ministry of Environment.

Threatened Species of Reptiles in Colombia

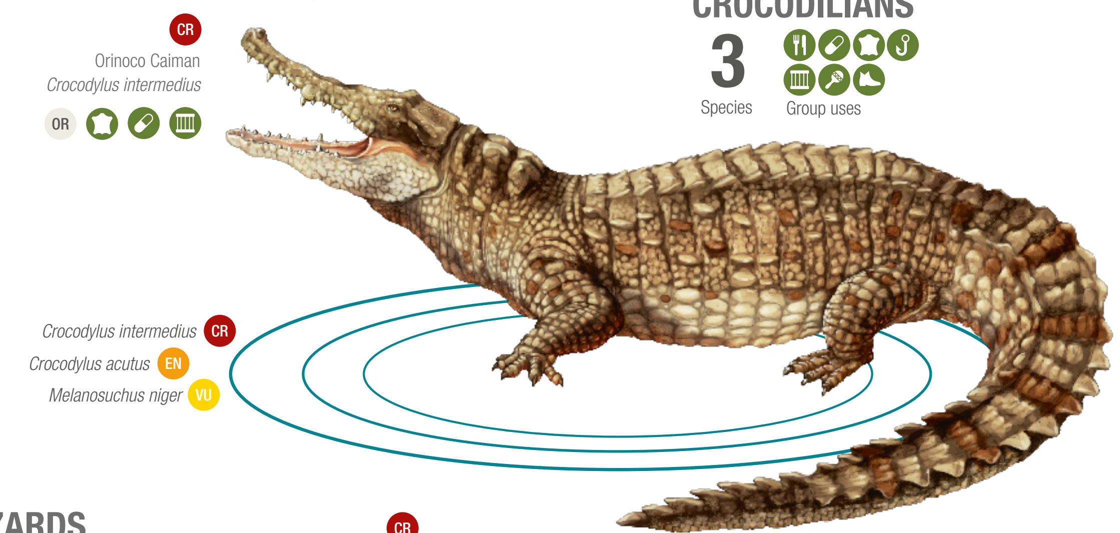
Number of species

Distribution
- EM Eastern Mountain Range
- MA Magdalena and Cauca Rivers basin
- OR Orinoco River basin
- CA Caribbean water catchment

Use
Food, Ornamental, Bait, Cultural, Medicinal, Pet, Skin

CROCODILIANS

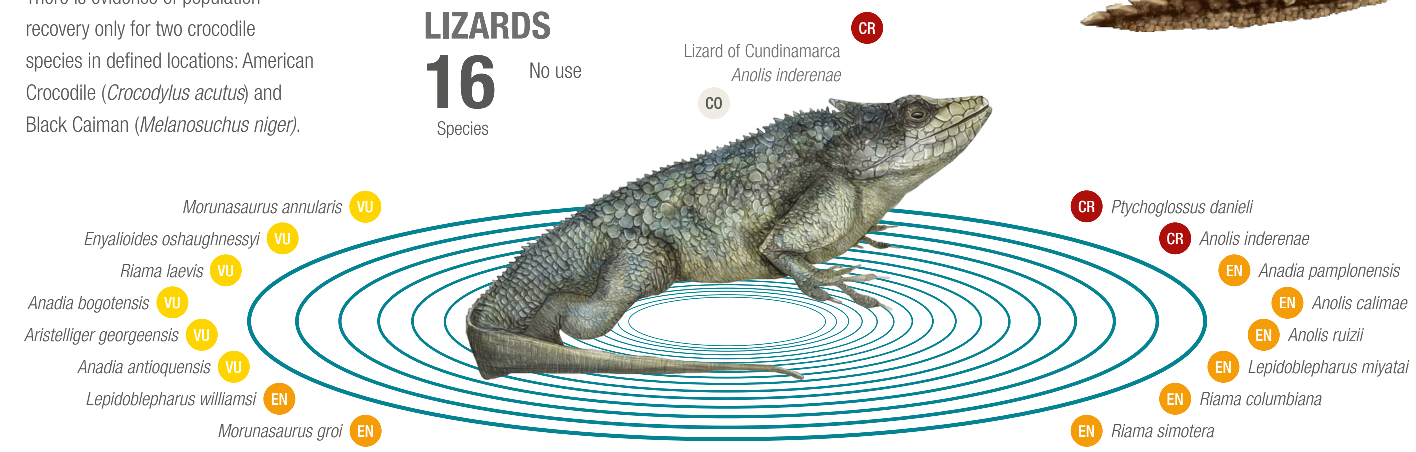
3 Species — Group uses



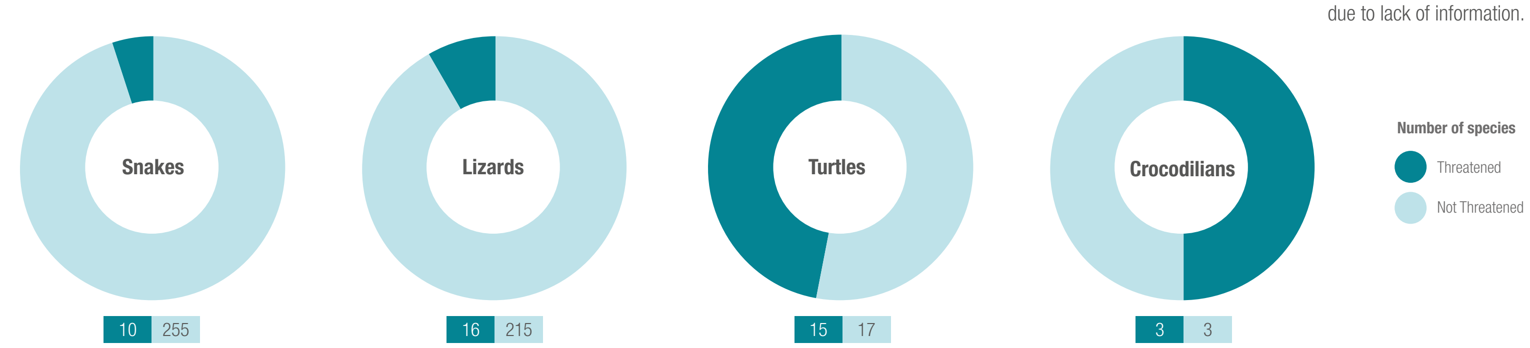
There is evidence of population recovery only for two crocodile species in defined locations: American Crocodile (*Crocodylus acutus*) and Black Caiman (*Melanosuchus niger*).

LIZARDS

16 Species — No use



Number of threatened and non-threatened species by taxonomic group



The number of threatened species increased from 22 to 50 when information about lizards and snakes (squamates) was included in the analysis. This group was initially not included due to lack of information.

The groups with the greatest number of threatened species are turtles and lizards. However, the most affected groups (percentage of threatened species over total species in the group) are crocodilians (50 % of species threatened), followed by turtles (37 %)[1].

Based on the information analyzed, it may be concluded that it is essential to start generating standardized population data, as well as evaluating and quantifying the threats that affect different species. These aspects are the most relevant while applying IUCN criteria. It is therefore recommended to prioritize species with greatest threat status and those categorized as DD. Similarly, a heads up is important because for all species habitat degradation, transformation, and loss is a constant threat[1].

CONSERVATION STRATEGIES

To appease threats, different strategies have been developed. Conservation plans (at species or group scales) have been created, and the establishment of protected areas is also considered as a conservation effort, although these have not been reaching expected results. In addition to threats that are particular to each species, all reptiles, especially those distributed in the regions of the Caribbean and Magdalena, are threatened in great part due to habitat degradation, transformation, and loss. This shows that there is not a rigorous implementation of environmental norms inside of the territory, nor is there an integrated management of ecosystems.

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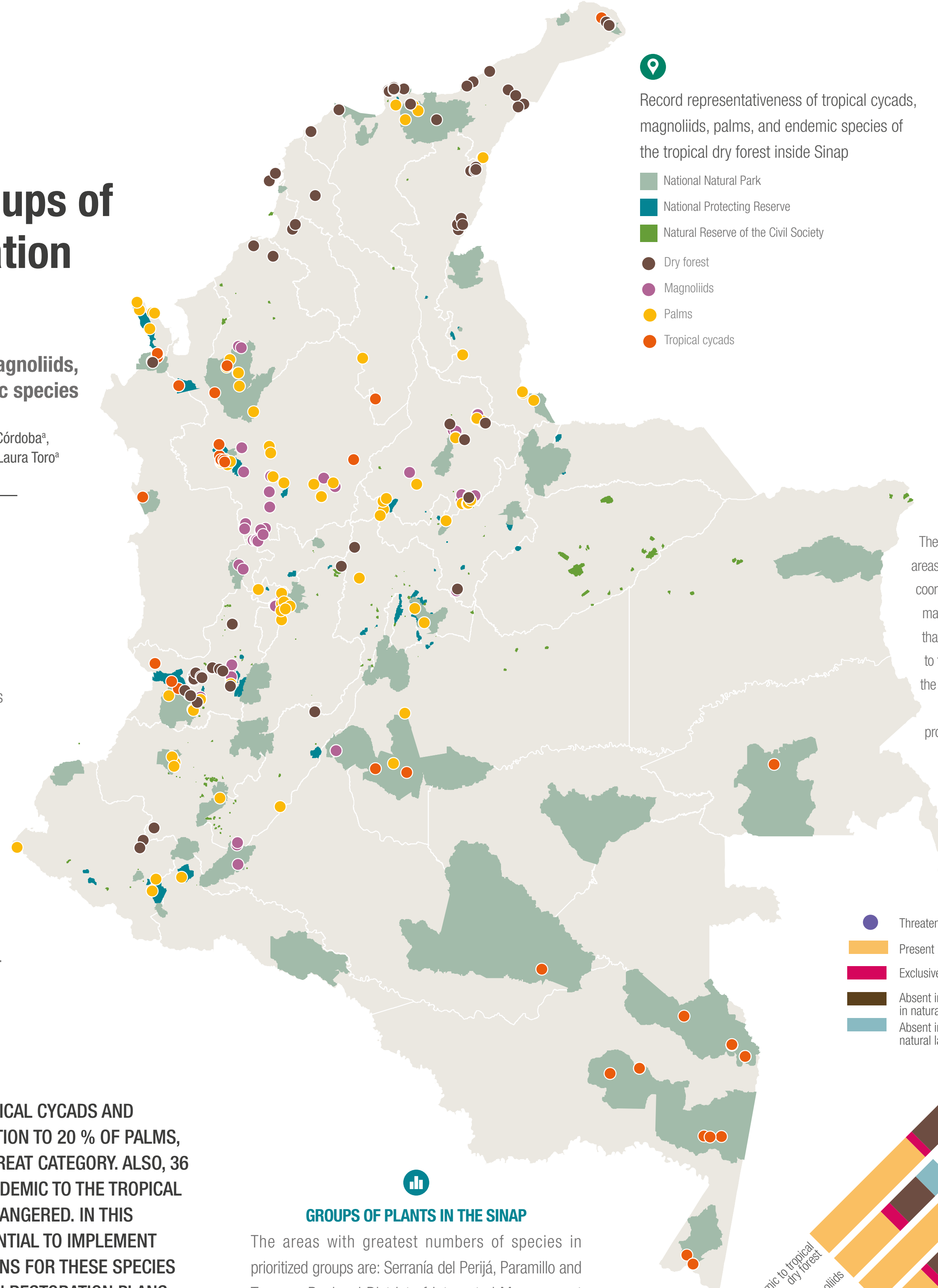
Plant Groups of Conservation Interest

Tropical cycads, magnoliids, palms, and endemic species

Carolina Castellanos[a], Diego Córdoba[a], Cristina López-Gallego[b], and Laura Toro[a]

Propagation for 6 tropical cycad species[1], 7 magnoliids in CORANTOQUIA jurisdiction[3], and more than 10 propagation and ex situ conservation for palms[2] have been implemented in the country. In these, the *Colección Nacional de Palmas* (National Palm Collection) stands out, with 190 species of native palms.



Record representativeness of tropical cycads, magnoliids, palms, and endemic species of the tropical dry forest inside Sinap

- National Natural Park
- National Protecting Reserve
- Natural Reserve of the Civil Society
- Dry forest
- Magnoliids
- Palms
- Tropical cycads

What is RUNAP?

The collection of protected areas, social actors, and the coordinating strategies and management instruments that contribute as a whole to the accomplishment of the country's conservation goals. It includes all protected areas of public, private, or community governance and national, regional, or local management.

ALL SPECIES OF TROPICAL CYCADS AND MAGNOLIIDS, IN ADDITION TO 20 % OF PALMS, ARE UNDER SOME THREAT CATEGORY. ALSO, 36 SPECIES THAT ARE ENDEMIC TO THE TROPICAL DRY FOREST ARE ENDANGERED. IN THIS SCENARIO, IT IS ESSENTIAL TO IMPLEMENT CONSERVATION ACTIONS FOR THESE SPECIES AND INCLUDE THEM IN RESTORATION PLANS.

GROUPS OF PLANTS IN THE SINAP

The areas with greatest numbers of species in prioritized groups are: Serranía del Perijá, Paramillo and Tayrona, Regional District of Integrated Management of paramos Guantiva - La Rusia and oak forests and neighboring areas, Anchicaya River, and Dagua River.

In Colombia, plants are a common element of the landscape, even in houses and cities. Yet not all plants are the same: some have restricted distributions while others are abundant in all of the territory. Plants also differ in that some species were once amply distributed, but now are scarce due to their commercial and cultural uses or the effects of territorial transformation.

Avoiding species extinction is a global priority, as is improving the conservation status of threatened species, especially those with greatest population declines (Aichi Target 12 for 2020). In Colombia about 80 % of plant species lack information regarding their conservation status; consequently, it is necessary to develop conservation strategies for species that are a priority due to their biological, socio-economic, and cultural importance. Those that have a restricted distribution, such as endemic species, could also be prioritized since their disappearance from the territory would signify extinction.

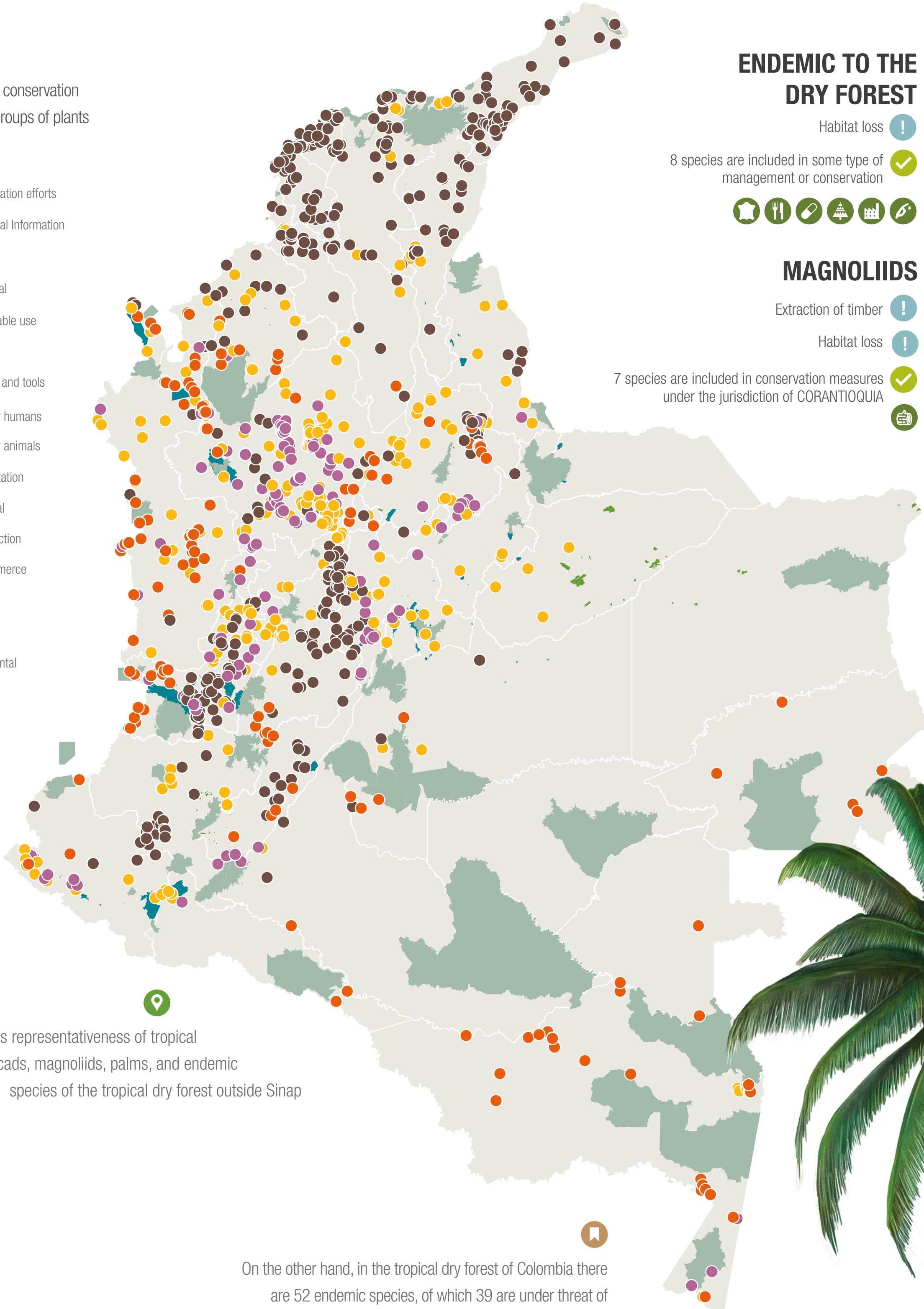
Conservation efforts to ensure the preservation of these species require updated and available information about their distribution, ecology, and use. In this sense, there has been an increase of information for the groups of palms, tropical cycads, and magnoliids in Colombia. Currently, all of the tropical cycads[1] and magnoliids[2] of the country are threatened, and 53 species of palms[3] are in the same situation. In the tropical dry forest, research has been carried out in order to increase the amount of knowledge about **endemic** species of this ecosystem. There are 54 endemic species for tropical dry forests, and 36 of these are threatened.

Threats and conservation efforts per groups of plants

- Threats
- Conservation efforts
- Additional Information

Uses

- Medicinal
- Sustainable use
- Fuel
- Utensils and tools
- Food for humans
- Food for animals
- Reforestation
- Industrial
- Construction
- Biocommerce
- Wood
- Cultural
- Ornamental



Records representativeness of tropical cycads, magnoliids, palms, and endemic species of the tropical dry forest outside Sinap

ENDEMIC TO THE DRY FOREST

Habitat loss

8 species are included in some type of management or conservation

MAGNOLIIDS

Extraction of timber

Habitat loss

7 species are included in conservation measures under the jurisdiction of CORANTIOQUIA

TROPICAL CYCADS

Habitat loss

Action Plan for the Conservation of Tropical cycads in Colombia

PALMS

Habitat loss

Damaging harvest of species

161 with registered use

Conservation, Management, and Sustainable Use Plan for the Palms of Colombia

National Palm Collection, Quindío Botanical Garden

On the other hand, in the tropical dry forest of Colombia there are 52 endemic species, of which 39 are under threat of extinction. It is therefore essential to include these species in restoration and conservation plans for the ecosystem.

EN

Andean Wax Palm
Ceroxylon ventricosum
Distribution: Eastern slope of Southern Colombian Andes (Sibundoy Valley, Putumayo, and Nariño) and Central and Western Andes Mountain Range in basin of Cauca River[4]. Between 2,000 and 3,000 m. a. s. l.

Evaluating the representativeness of these species in the *Sistema Nacional de Áreas Protegidas* (National System of Protected Areas-SINAP for its initials in Spanish) and the Nature Reserves of the Civil Society may give a clue to whether conservation measures are being effective. Although representativeness indexes are encouraging, they also show that a significant percentage of species require **complementary conservation measures**, especially those that are out of SINAP or natural areas (inside agricultural and artificial areas). Complementary conservation measures include collecting individuals **ex situ**, as well as developing protocols for reintroduction and propagation in their natural habitat or promoting their sustainable use. In general, research about wild populations should increase for all species, in such a way that all of the parts involved in plant conservation in the country are working in conjunction.

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Species Composition and Changes in Land Use

Considerations under a climate change scenario

Paola Isaacs[a], Susy Echeverría-Londoño[b], Nicolás Urbina[c], and Andy Purvis[b]

IN THE COUNTRY, BIODIVERSITY HAS ON AVERAGE DECREASED BY 18% DUE TO CHANGES IN THE USE OF THE LAND. THIS NUMBER COULD INCREASE IF CURRENT PATTERNS OF EXPLOITATION AND CONSUMPTION ARE MAINTAINED.

Changes in land use are currently the main factor in terrestrial biodiversity transformation and loss[1]. These changes impact the **composition** and diversity of ecosystems as well as their ecological processes and services. Identifying changes in species composition over gradients of natural and anthropic land covers allows for measuring the current transformation impact on natural ecosystems and making forecasts for certain socio-economic and climate change scenarios. Such predictions are decisive in a country such as Colombia, which is the second most diverse in the world in its ecosystems but it is also highly vulnerable[2,3].

Within the case studies evaluated by the PREDICTS[3] initiative, which aims to measure and predict the impact of changes in land use on biodiversity, Colombia resulted to be a priority case. Based on the four **climate change** scenarios (Representative Concentration Pathways) proposed by the Intergovernmental Panel on Climate Change (IPCC), models were made for the trends of biodiversity in the face of climate change for the years from 1500 to 2100 according to the availability of historic information[4]. Using secondary data and variables associated to the four scenarios, the list of species in areas with varying amount of human intervention (late and new **secondary vegetation**, crops, grasslands, and urban areas) was compared to the list of species in primary native vegetation[3]. Then, these differences in diversity between habitats were linked to projections in changes of land use under the four scenarios of climate change[5] in order to forecast changes in biodiversity under distinct socio-economic scenarios.

It was therefore evidenced that **primary vegetation** has been replaced by homogeneous vegetation covers such as crops and grasslands. This transition has caused a 18 % change in species composition over the whole country (due to decreasing species numbers or replacement by **invasive species**), particularly in areas where anthropic presence is more extensive, such as the Andean region.

Between different forms of land use, the presence of crops and grasslands has a greater impact on biodiversity. In other words, crops and grasslands hold the smallest proportion of species in comparison to areas without transformation. The decrease in diversity caused by grasslands is resulting in a "biotic homogenization"[6] process due to the large expansion of these areas. Such biotic process is characterized by dominating generalist species and homogeneous areas that put the diversity of ecosystem functions at risk.

Given the similarity of existing habitats, species composition does not vary much between primary and late secondary vegetation. This suggests that there is a dependant relation between spatial distribution of the landscape and the natural regeneration of the forest, which in turn would ensure the availability and conservation of ecosystem services that could lessen impacts caused by human disturbances. Those patches closest to primary forests would have a bigger regeneration capacity caused by the presence of species and proximity in terms of dispersal. In relation to climate change scenarios, the scenario "without socio-economic changes" presents the greatest local reduction in species complexity and thus causes the largest impact on biodiversity. Under this scenario, species composition would reduce on an average of 79 % to 2090, chiefly owed to the expansion of agricultural and cattle raising areas that respond to an increasing population demand.

Taking into account the **rate of change** in land use in Colombia, and specially considering those areas that are vulnerable, databases of samples that follow protocols and are comparable[7,8,9] must be generated and combined in order to understand patterns of change in biodiversity at different spatial and temporal scales. Similarly, information gaps in models must be strengthened by field research, notably in areas of low rates of scientific publications such as the Amazon, Orinoquía, and Chocó.

Scenarios of climate change (RCP)[3]

- Scenario of biofuels (IMAGE-RCP2.6)
- Scenario without socio-economic changes (MESSAGE-RCP8.5)
- Scenario of population growth (AIM-RCP6.0)
- Scenarios with carbon marke (GCAM-RCP4.5)

Scenario of biofuels (IMAGE-RCP2.6)

1. Clean technologies and efficient policies based on renewable energy and biofuels are assumed
2. Loss of primary forest
3. Increase in areas of crops
4. Urban areas and grasslands are stable

Scenario without socio-economic changes (MESSAGE-RCP8.5)

1. Assumes mitigation is based on development of technology
2. Growing economy and population densities
3. Decreasing area of primary forests and grasslands
4. Increasing area of secondary forests and crops
5. Larger urban areas

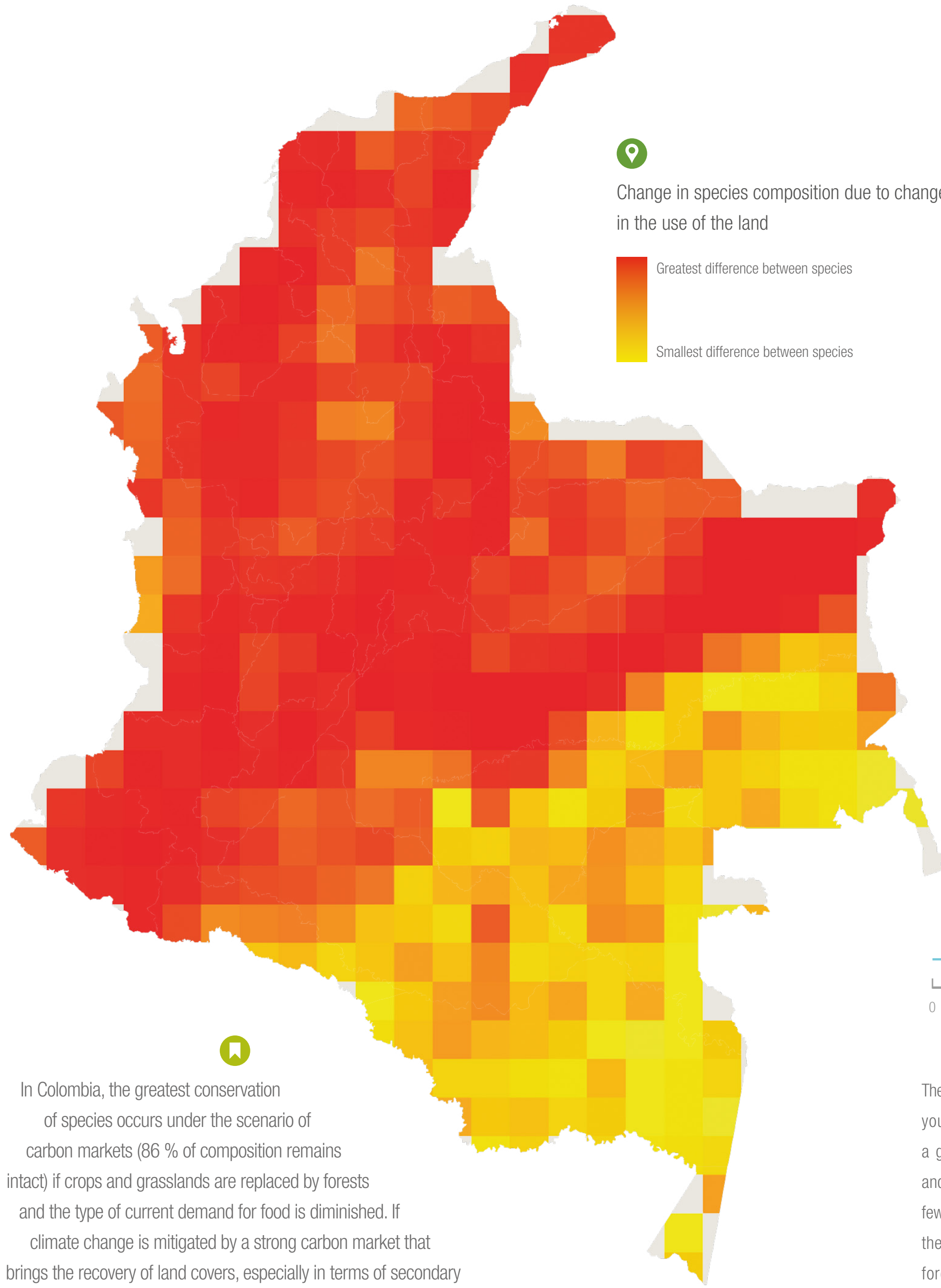
Scenario of population growth (AIM-RCP6.0)

1. No policies for the mitigation of greenhouse gases emissions
2. Reduced technological advances
3. High growth rates of human populations
4. Ecosystem transformations with high rates of deforestation of primary forests
5. Urban growth
6. Intermediate rates of increasing grasslands and crops

Scenarios with carbon marke (GCAM-RCP4.5)

1. Assumes that greenhouse gases mitigation is completed with forest carbon credits
2. Changes in patterns of consumption and food
3. Improvement in efficiency of crops and energy use
4. Loss of primary forest and crop area
5. Urban areas are maintained
6. Increasing areas of secondary forest

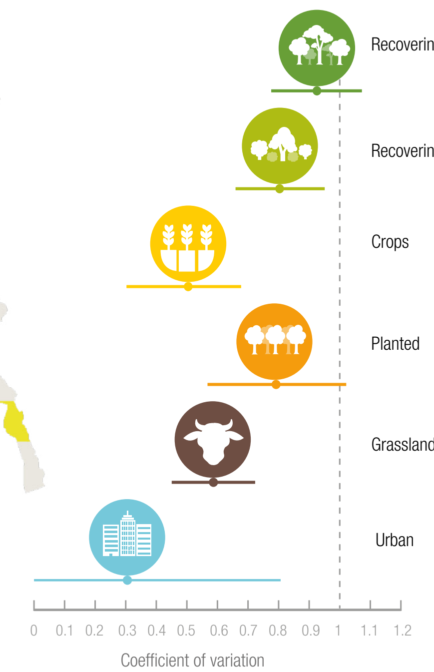
The scenario of biofuels is usually considered as the most effective to counteract climate change because it implies a change in the traditional forms of exploitation. However, it may have great impacts on the use of the land.



Regions with red colors represent locations where the difference in species between areas with anthropogenic uses and natural areas is greatest, thus there is a lower proportion of intact sites.

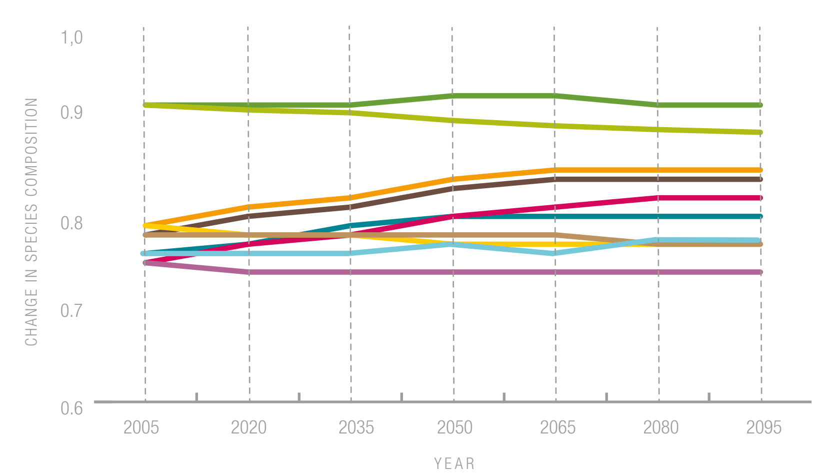
In Colombia, the greatest conservation of species occurs under the scenario of carbon markets (86 % of composition remains intact) if crops and grasslands are replaced by forests and the type of current demand for food is diminished. If climate change is mitigated by a strong carbon market that brings the recovery of land covers, especially in terms of secondary vegetation, Colombian biodiversity could partially recover for 2095.

Similarity of communities for each type of use in comparison with primary vegetation[3]



There is a close similarity with secondary young and mature vegetation, and a great dissimilarity with grasslands and crops. Since urban areas provide few habitats for species these present the greatest differences with mature forests. Assemblages of species in forest plantations and young secondary vegetation vary in comparison to primary and mature secondary forests. The responses of different taxonomic groups are yet to be understood, since some species may respond favorably to forest plantations (p.e. birds) whereas others negatively (p.e. beetles, ants, amphibians, and reptiles)[7].

Projections of changes in biodiversity for each region in Colombia under biofuels and carbon markets scenarios. A greater reduction in species composition is evidenced for the zones of the Andes and the Caribbean. Also, the Amazon shows a lower reduction, making it the most stable and conserved area. The scenario of biofuels is the least favorable for the recovery of species composition.



The Andean region is most susceptible of losing its biodiversity in an accelerated fashion and the Amazon region is the least susceptible. The scenario of carbon markets would allow for the recovery of biodiversity, especially for the Andean region. Under the scenario of no socio-economic changes the continuous decrease of values of biodiversity is evidenced[3].

Institutions: a. *Instituto de Investigación de Recursos Biológicos Alexander von Humboldt;* b. *Natural History Museum;* c. *Pontificia Universidad Javeriana.*

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Threatened Species in Colombia

Global category

Iván González[a], María Cecilia Londoño[a], and Jorge Velásquez-Tibatá[a]

THE RED LIST INDEX SHOWS A GREATER EXTINCTION RISK FOR SPECIES GLOBALLY THREATENED IN COLOMBIA AND ALERTS ABOUT THE NEED TO WORK ON ACHIEVING TARGET 12 OF THE STRATEGIC PLAN OF THE CONVENTION ON BIOLOGICAL DIVERSITY IN THE COMING FOUR YEARS.

The Red List of Threatened Species of the International Union for Conservation of Nature (IUCN) assigns a threat category to each species according to its risk of extinction. This category is selected based on standardized criteria that are evaluated for each species according to its characteristics of **vulnerability** and threat[1].

Evaluations for risk extinction are developed in international processes in which experts assess the global threat for the species (global evaluations) and in national processes in which the risk for species in each country is assessed (national evaluations). In Colombia, national evaluations are published in Red Books. Globally, evaluations are completed for each taxonomic group, preferably every four years, and an effort is made to evaluate all of the species in each group. In Colombia, national evaluations arise from a predetermined list of species and there is only one evaluation per taxonomic group. Only birds, fishes, and reptiles have been evaluated two times in the country.

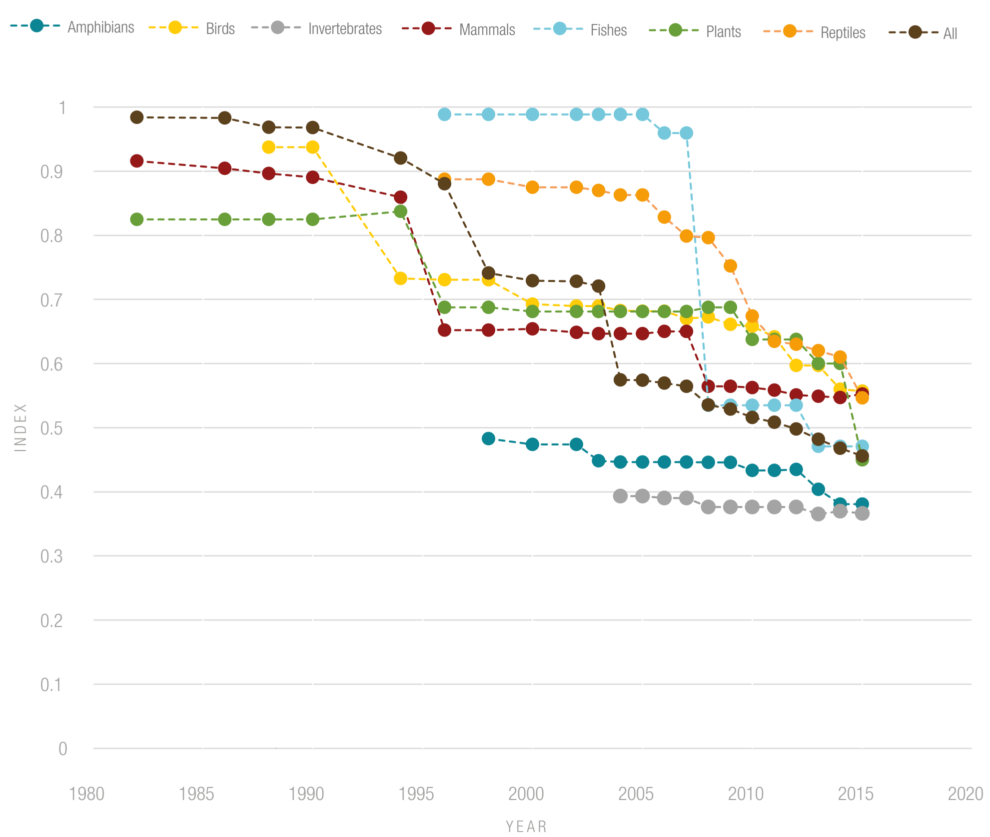
The Red List Index[2] is a complementary tool for evaluations of extinction risk since it summarizes the values of extinction risk for a group of species in a single value between 0 and 1, where 1 equals a better conservation status of the evaluated species. The Index is calculated once a new evaluation of extinction risk for a group of species is completed. With the Index, it may be determined if the condition of such group improved or declined in comparison to the previous evaluation. Additionally, the types of threats for different taxonomic groups may be compared.

For different taxonomic groups (amphibians, birds, invertebrates, mammals, fishes, plants, and reptiles) the Red List Index was compared by using the results of global evaluations for 6,165 species that are present in Colombia. For all taxonomic groups there was a decline in the Index, suggesting an escalation in the risk of extinction at a global level. This may be caused by increasing threats to species, lack of conservation measures that target threatened species, or a low effectiveness of implemented measures[3].

Threatened species inhabiting the country seem to not be improving their global conservation status. In order to reduce extinction risks at a global scale, it is necessary to invest in conservation efforts in those countries with greatest biodiversity that also face significant threats of persistence. Colombia is one of the eight countries with greatest responsibility in the rise of extinction risks, particularly due to a decline in amphibian species[4].

An analysis of the Red List Index based on national evaluations may give evidence regarding the situation of species in Colombia and its possible similarities to global evaluations or advances in conservation statuses. However, calculating the Index at a national scale is not possible because there are no periodic evaluations for the same species or some previous evaluations were completed without complete information, rendering them invalid[5]. The great challenge is that of stimulating risk extinction evaluations in Colombia so there may be periodic results that allow for monitoring trends of extinction risks for different taxonomic groups in the country.

Changes in Red List Index for some taxonomic groups



The Red List Index of the IUCN measures the conservation status trend for a group of species. It is used as an indicator of international conservation goals and Sustainable Development Objectives (especifically Goal 12) from the Strategic Plan for Biodiversity.

If all species of the group are under the category of Least Concern (LC) and thus it is not expected that any species becomes extinct in the near future, the Red List Index value equals to 1.0. A value of 0 in the Red List Index means that all evaluated species are extinct.

A decreasing trend in the Index equals to an increasing expected extinction rate, caused by a greater number of species changing to a greater extinction risk category in comparison to those that transition into a lower risk category. This implies an increased loss of biodiversity for the group of species. A horizontal line represents a non-changing extinction rate. Lastly, an increasing trend signifies less expected extinct species in the near future, reducing the loss of biodiversity. It must be evaluated if transitions in extinction risk categories for a species are actually genuine. In other words, if the change in category is not due to real changes in the species or its habitat and instead responds to a greater amount of information and knowledge about the species, the change in category is not considered to be a genuine change and it must not be included in the calculation of the Index.

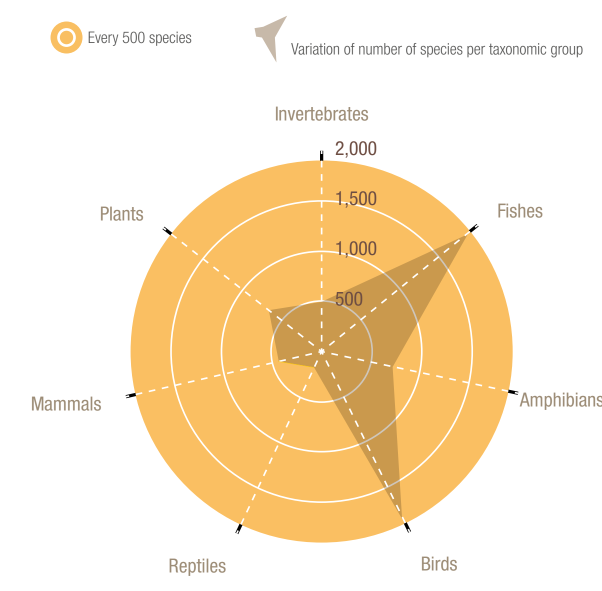
CR

Variegated Spider Monkey

Ateles hybridus

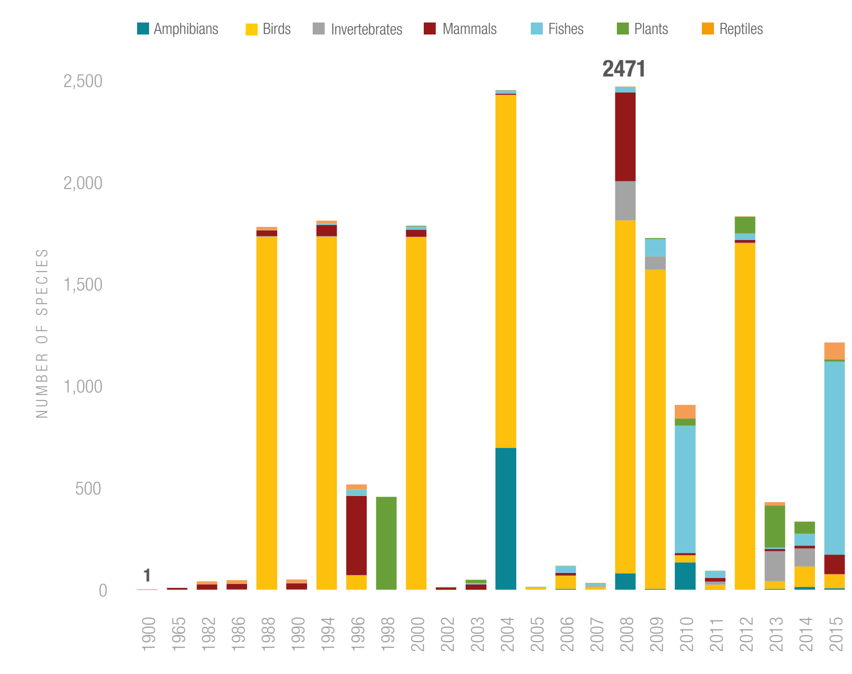
Distribution: Magdalena River in the states of Magdalena, César, La Guajira, Caldas, and in Cundinamarca, Norte de Santander, and Arauca. Mature or intervened wet forests up to 1,300 m.a.s.l.

Number of species evaluated per taxonomic group and time periods.



Exact values of graph available online

Number of species per taxonomic group included in the analysis



Institutions: a. Instituto de Investigación de Recursos Biológicos Alexander von Humboldt.

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Climate Change and Extinctions on Mountain Summits

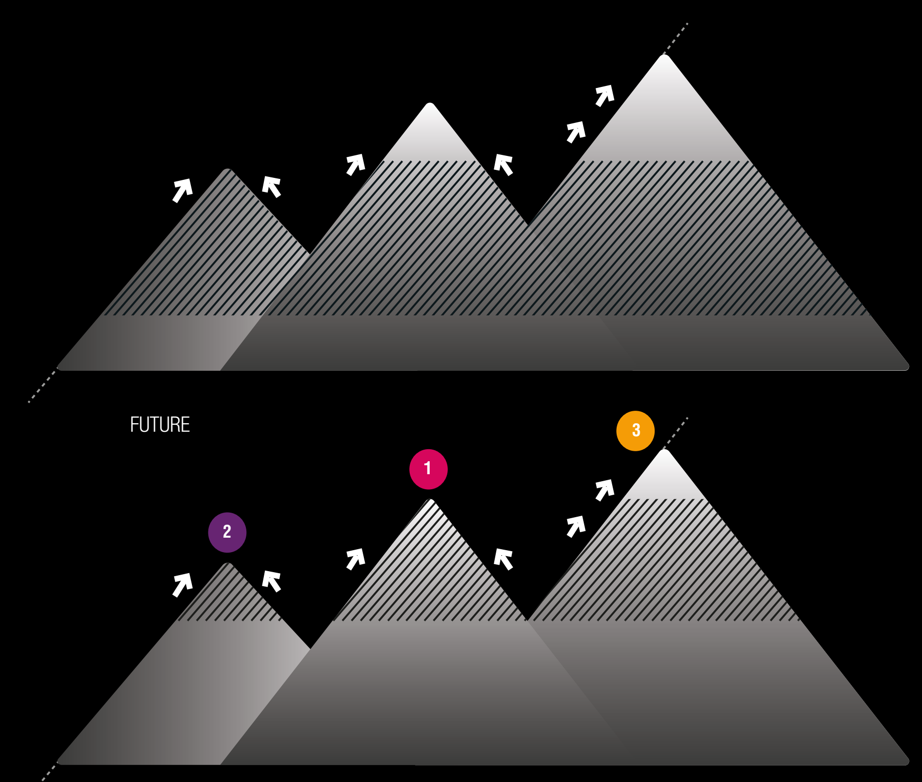
Effects on montane ecosystems

Germán Forero-Medina[a]

Pristimantis sanctaemartae
Distributed in the cloud forests up to the paramos of the northwestern slope of the Sierra Nevada de Santa Marta, between 1,100 and 2,727 m. a. s. l.[7].

THE COMPLEX TOPOGRAPHY OF THE ANDES MOUNTAIN RANGE RESTRICTS THE ALTITUDINAL MOVEMENTS THAT SPECIES MAY HAVE IN RESPONSE TO CLIMATE CHANGE. THIS PHENOMENON COULD INCREASE THE NUMBER OF THREATENED SPECIES IN TROPICAL MOUNTAINS AND CAUSE EXTINCTIONS.

Possible movements of species to higher elevations



1 Altitudinal movement of ranges to lower summits (future thermal traps)
2 Movement towards a thermal trap
3 Movement of range towards unsuitable land covers
Distribution range of the species

One of the responses of species to global **climate change** is the movement of altitudinal ranges to greater elevations[1,2]. This phenomenon is of special importance in the tropical region, where the latitudinal gradient of temperature is not marked, so attaining lower temperatures in order to maintain optimal conditions is achieved by ascending in altitude.

Many tropical species have reduced altitudinal ranges and thermal tolerances. As local temperatures increase, many of these species will not be able to survive unless they move to greater altitudes. Species of insects, birds, and amphibians have already started to move upwards in tropical mountains[3,4,5].

Two possible effects of altitudinal movements of species are reduced ranges and **extinction**. The reduction of ranges is caused by restrictions due to topography and inadequate land covers such as urban areas, crops, or barren land[6]. More specifically, it may be the case that some individuals move to higher elevations inside their current range, but these areas would become isolated if warming continues, preventing individuals to reach higher elevations and causing a possible reduction in the area of distribution.

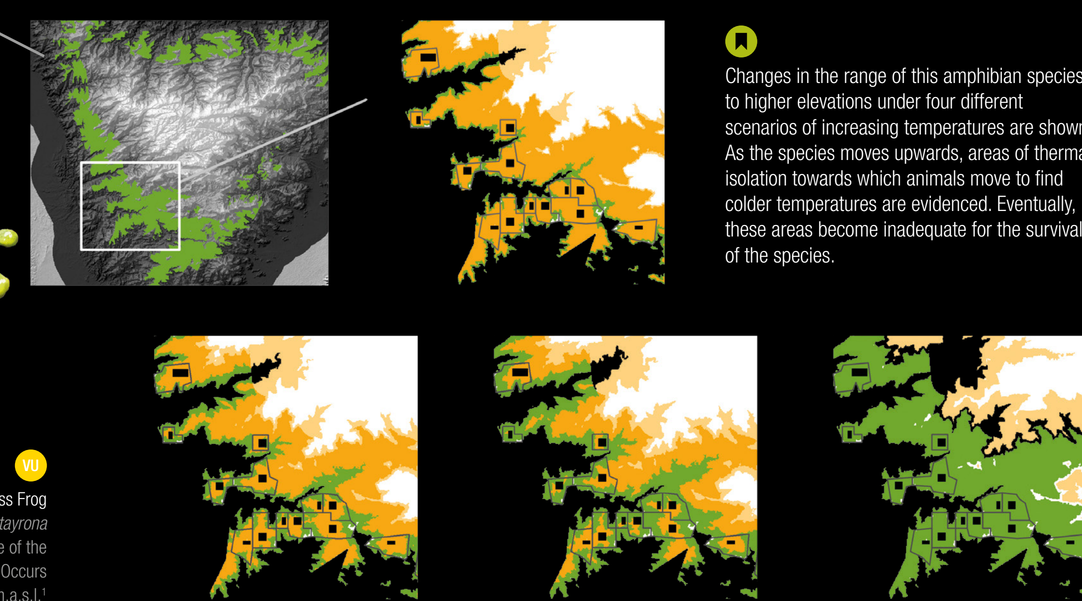
Extinction would affect those species that inhabit areas closest to mountain summits and reduced altitudinal ranges. As temperature **isoclines** move upwards, the current environment they inhabit, in terms of temperature, could disappear. This implies habitat reduction or loss, which in turn may cause extinctions. These type of extinctions are also known as mountain summit extinctions[2].

The two scenarios mentioned above are effects of global climate change. In complex landscapes such as the Andes mountains connectivity along altitudinal gradients should be maintained to ensure species movement and reduce pressures on those species that inhabit mountain summits.

VU
Magdalena Giant Glass Frog
Ikakogi tayrona
Distribution: Cloud forests in the western slope of the Sierra Nevada de Santa Marta, in Magdalena. Occurs between 980-2,000 m.a.s.l.[1]
Endemic species of the Sierra Nevada de Santa Marta

Movements in ranges of *Ikakogi tayrona*

Current range | New area | Area that overlaps with current range | Areas of thermal isolation

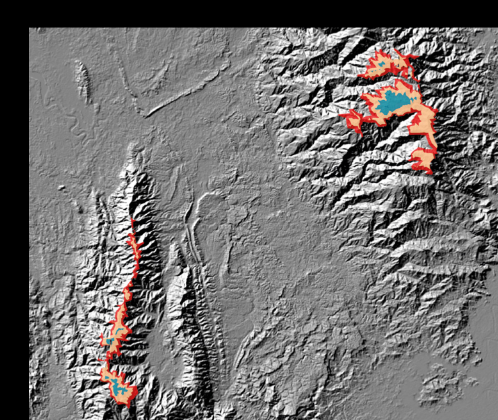


Changes in the range of this amphibian species to higher elevations under four different scenarios of increasing temperatures are shown. As the species moves upwards, areas of thermal isolation towards which animals move to find colder temperatures are evidenced. Eventually, these areas become inadequate for the survival of the species.

DISTRIBUTION REDUCTION AND ISOLATION FOR AMPHIBIANS IN THE SIERRA NEVADA DE SANTA MARTA. Amphibians are one of the groups that may be mostly affected by restrictions of altitudinal movements and isolation of parts of their distribution. In the Sierra Nevada de Santa Marta, an area that has more than 15 endemic species of amphibians, the complexity of the topography and transformation of land covers will impact altitudinal movements of amphibians. For 21 out of the 46 studied species, 30 % of the current range will move to areas of low relief that will become isolated as temperature increases. Three of these species are endemic. For 13 of the species studied, including an endemic one, 30 % of the current distribution will move to unsuitable areas such as crops or urban areas. For 7 species, more than 70 % of the range can be reduced as temperature increases.

Altitudinal movements of *Basileuterus ignotus* in the Serranía del Darién

Current | 2 °C | 5 °C



The polygon shows changes in distribution as temperature increases 2ºC and 5ºC. The movement of the species equals 40 % of the movement of temperature isoclines. If temperature increases by 5ºC and the species movements equals that of the isoclines, the current temperatures of the species' range would disappear, potentially causing a summit extinction.

VU
Pirre Warbler
Basileuterus ignotus
Distributed in the cloud forests up to the paramos of the Northwestern slope of the Sierra Nevada de Santa Marta, between 1,100 and 2,727 m. a. s. l.[7]

SUMMIT EXTINCTIONS IN BIRDS.
Under the scenario of an increase in temperature of 2ºC, which corresponds to a 364 m.a.s.l. escalation of isoclines, no bird species would move its range completely or be in imminent risk of extinction. On the other hand, if temperature increases by 5ºC isoclines would move 909 meters upwards; therefore, the habitat of five bird species would completely disappear, potentially causing extinction. These five species are: *Basileuterus ignotus, Asthenes perijana, Odontophorus dialeucus, Chlorostilbon olivaresi,* and *Tangara fucosa.* All possible extinctions would occur in relatively isolated mountains of low elevation such as Darién, Perijá, and Chiribiquete.

Institutions: a. *Wildlife Conservation Society (WCS).*

CHAPTER

3

Information file **301 to 307**

RESPONSES OF SOCIETY TO THE LOSS OF BIODIVERSITY

Chapter 3 of the report of the year 2014, titled Governance, included a series of information files that evidence institutional and legal responses in an international context, as is the case of CITES.

The chapter also exposes national responses such as: the Pollinators Strategy (BIO 2015), institutional responses to climate change and mitigation and adaptation actions, conservation plans for tropical cycads as a prioritized group due to its threat level, National Strategy for Plant Conservation, monitoring of dry forest permanent plots as a management tool for that ecosystem (BIO 2016), and public and community strategies in paramos and legal instruments (BIO 2015).

A series of information files develop the initial scenario of the role of protected areas from the viewpoint of governance and effectiveness in management (BIO 2014). Beyond protected areas, complementary strategies and networks of protected areas (BIO 2015), including conservation corridors and connectivity at a large scale (BIO 2015), were presented, as well as the role of areas that are not protected in relation to large animals (BIO 2016).

Urban environmental management has been approached in BIO 2014 and 2016 from the perspective of the issues related to the subject, those responsible for the urban development of the country, borders between urban and rural areas as is the case of the Eastern Mountains of Bogotá, and integrated management of urban biodiversity as a tool to strengthen decision making in the areas of land use planning, urban development, human well-being, and economic development.

In terms of ecosystems, the great challenges for ecological restoration in Colombia (BIO 2015), cattle raising landscapes of the Orinoquia as a potential source for biodiversity (BIO 2015 and 2016), relation between management of biodiversity and governance in the face of climate change (BIO 2014), and the relationship between biodiversity and land use planning (BIO 2014) have been exposed. Also, the concept of an integrated assessment of ecosystem services to give a perspective of valuation of biodiversity management (BIO 2014) was presented.

Most responses of involved actors are geographically limited initiatives. In a near future, the responses of society must include more situations of transformation and loss and increase the participation of actors in number and level of involvement in order to show a more complete setting of who, where, and what tools are being used to contest the loss of biodiversity.

301

Biodiversity and Climate Change

Institutional responses and actions

María E. Rinaudo[a]

PROCESSES OF POLITICAL INCIDENCE AND TOOLS FOR SCIENTIFIC INNOVATION STRENGTHEN INSTITUTIONAL GOVERNANCE AND ARE ESSENTIAL FOR THE MANAGEMENT OF BIODIVERSITY AND CLIMATE CHANGE. COLOMBIAN RESEARCH INSTITUTES THAT ARE ASSOCIATED TO THE *SISTEMA NACIONAL AMBIENTAL* (NATIONAL ENVIRONMENTAL SYSTEM-SINA FOR ITS INITIALS IN SPANISH) PLAY AN IMPORTANT ROLE IN LEADING SUCH PROCESSES.

The direct and indirect effects of **climate change** affect ecosystems and species differentially, thus increasing the **vulnerability** of biodiversity. Under the development of the *Tercera Comunicación Nacional de Cambio Climático para Colombia* (Third National Climate Change Communication for Colombia) the *Instituto de Hidrología, Meteorología y Estudios Ambientales* (Institute of Hydrology, Meteorology, and Environmental Studies-Ideam for its initials in Spanish) guided the development of the report *Nuevos escenarios de Cambio Climático para Colombia 2010 - 2100*' (Novel scenarios of climate change for Colombia 2010-2100). This report provides detailed information at a national scale and additionally makes projections for the regional effects of climate change according to hydro-climatic criteria.

The report identifies a greater increase in temperature for states such as Arauca, Vichada, Vaupés, and Norte de Santander as one of the major effects of climate change. Consequences produced by these temperature rises will include increasing sea levels, accelerated melting of snowy summits and glaciers, shrinking of paramo areas, and reduced agricultural productivity.

Research institutes associated to the Sina have therefore developed initiatives to respond to national, regional, and local necessities, preferring processes that use land planning management with the support of indigenous and local knowledge in order to achieve climate change adaptation and mitigation. The goal is to create political tools and improve decision making related to the subject.

Institutional initiatives and advances for integrating biodiversity and climate change

Initiatives

Advances

IDEAM

Institute of Hydrology, Meteorology, and Environmental Studies

Initiatives

Generate information to calculate habitat loss caused by **deforestation**

» Indicators « of biodiversity loss with climate change criteria

Model adaptation and mitigation measures with local communities

Advances

2001
First National Climate Change Communication

2010
Second National Climate Change Communication

2015
Third National Climate Change Communication
Novel scenarios of climate change for Colombia 2011-2100

2015
Third National Climate Change Communication
National Inventory of Greenhouse Effect Gases Colombia 2011-2100

2015
First Biennial Update Report for Colombia regarding United Nations Framework Convention on Climate Change

SINCHI

Amazonian Institute of Scientific Research

Initiatives

Highlight the role of the Amazon as a natural solution for climate change

Determine the conservation status of the **Amazonian biome** and its major factors of transformation: cattle raising, illicit crops, and timber exploitation

Evaluate impacts of **climate change** on Andes-Amazon connectivity

Establish permanent biodiversity and ecosystem services monitoring plots

Characterize ecosystems and species in order to strengthen food security in the region

Advances

Climate change scenario **modeling** in the Amazon to evaluate **vulnerability, adaptability, and mitigation**

IIAP

Environmental Research Institute of the Pacific "John von Neumann"

Initiatives

Collect regional information on diversity of ethnic groups and ancestral knowledge

Connect environmental **institutions** and sectors in subjects of biodiversity and climate change

Monitor the conservation status of strategic ecosystems of the middle and high mountains of Biogeographical Chocó

Strengthen community participation processes for local conservation efforts

Integrate and strengthen forms of collective property of indigenous and Afro-descendant peoples for the conservation of biodiversity

Advances

2016
Integrated Climate Change plan for the State of Chocó

INVEMAR

Marine and Coastal Research Institute "José Benito Vives de Andreis" / Source: Anny Zamora, Chief of research Global Change and Politics of the Sea

Initiatives

Include topics of oceanic and coastal ecosystem services in the ministerial agenda

Promote climate change adaptation and mitigation actions that are focused on marine and coastal ecosystems

Research about mangrove ecosystems and their potential as CO_2 sinks

Advances

2012
Guidelines for the climate change adaptation of Cartagena de Indias

2014
Adaptation to climate change in the coastal cities of Colombia: a guide for formulating adaptation plans

Creation of the Climate Change Plan for Maritime Ports

HUMBOLDT

Biological Resources Research Institute Alexander von Humboldt

Initiatives

Internally position the subject of climate change as a scientific and political axis in the different institutional programs and projects

Develop platforms of climate change learning and modeling

Recognize the existence of records and evidences in territorial transformations due to **climate change** and the need to influence environmental **decision making**

Advances

2010
Climate change and its relation to land use in the Colombian Andes

2011
Biodiversity and Territory: adaptative management innovations in global change
Technical input for the PNGIBSE

2014
Biodiversity 2014
Status and trends of the continental biodiversity of Colombia

2016
National Experts Workshop on Biodiversity and Climate Change

Document about biodiversity and climate change synergies in the country

Creation of technical input for strategic ecosystems for the integrated management of the territory and adaptation to climate change

RELATIONSHIP BETWEEN BIODIVERSITY AND CLIMATE CHANGE BASED ON INTERNATIONAL CONVENTIONS

Source: Ministerio de Relaciones Exteriores- Dirección de Asuntos Económicos, Sociales y Ambientales (Ministry of International Relations--Direction of Economic, Social, and Environmental Topics)

The United Nations Framework Convention on Climate Change (UNFCCC) and the Paris Agreement establish international guidelines to reduce emissions of **greenhouse gases** and promote adaptation to adverse impacts that rising global temperatures may have. The Convention on Biological Diversity (CBD) includes in its objectives the conservation and sustainable use of biodiversity and the just and equal participation in the benefits that derive from it. To accomplish the objectives proposed by the UNFCCC and CBD, actions that target increasing ecosystem resilience, and thus guarantee biodiversity conservation, must be implemented. Considering that climate change is one of the main causes in biodiversity loss, effectuating strategies of **adaptation** and **mitigation** to protect biodiversity is a crucial goal while implementing CBD and UNFCCC to achieve sustainable development.

Institutions: a. *Instituto de Investigación de Recursos Biológicos Alexander von Humboldt.*

302

Conservation Plans for Threatened Plants

The tropical cycads of Colombia

Cristina López-Gallego[a]

Tropical cycads by biogeographical region: Status, threats, and proposed actions

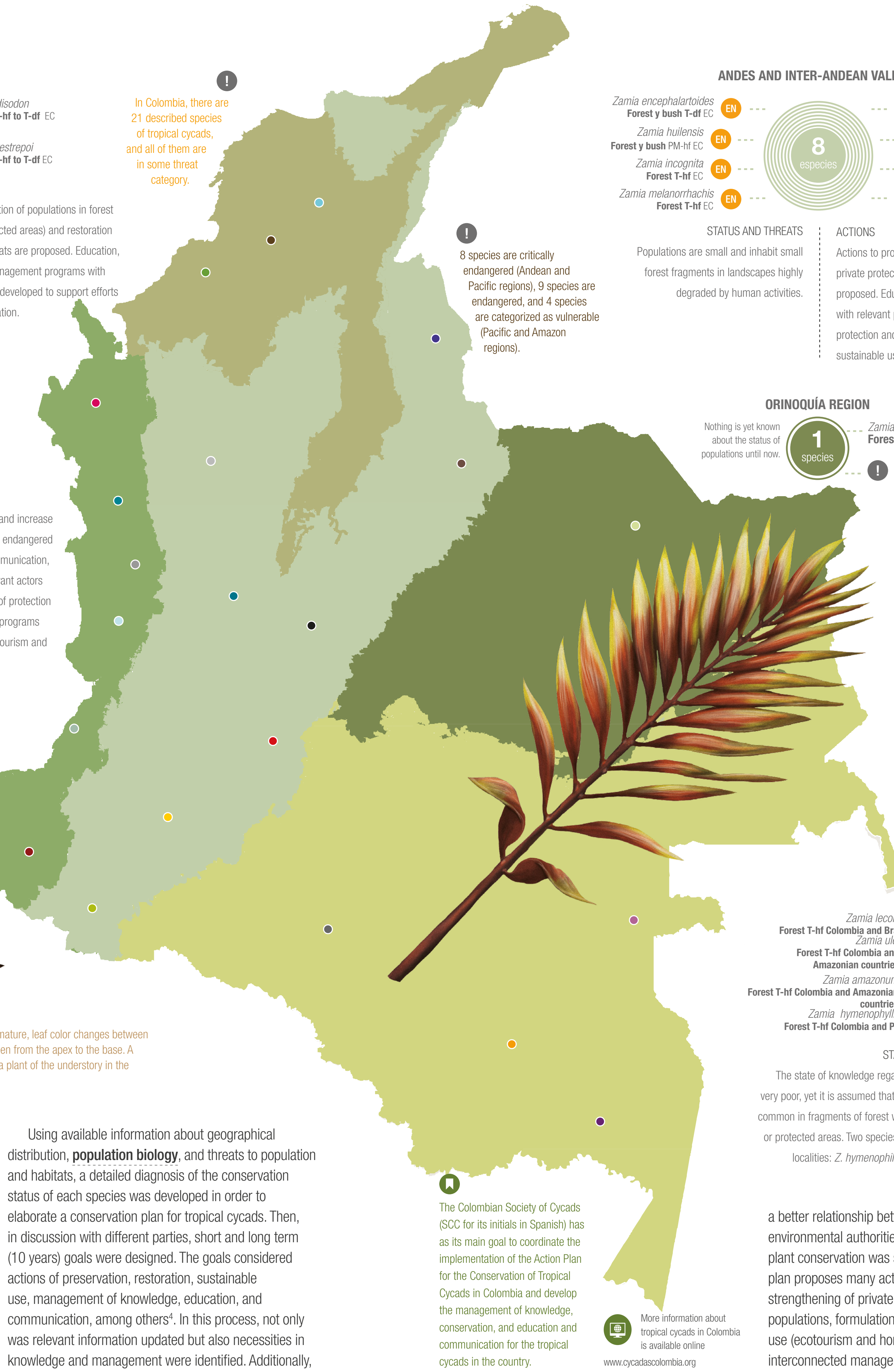
- *Zamia disodon*
- *Zamia muricata*
- *Zamia restrepoi*
- *Zamia encephalartoides*
- *Zamia huilensis*
- *Zamia incognita*
- *Zamia melanorrhachis*
- *Zamia montana*
- *Zamia oligodonta*
- *Zamia tolimensis*
- *Zamia wallisii*
- *Zamia amplifolia*
- *Zamia chigua*
- *Zamia manicata*
- *Zamia obliqua*
- *Zamia pyrophylla*
- *Zamia roezlii*
- *Zamia amazonum*
- *Zamia hymenophyllidia*
- *Zamia lecontei*
- *Zamia ulei*
- *Zamia sp.nov.*

Habitat-region of life

- **T-hf** Humid Tropical Forest
- **T-df** Tropical Dry Forest
- **PM-hf** Premontane Humid Forest
- **T-rf** Tropical Rainforest

Origin

- **EC** Endemic to Colombia
- **EE** Endemic to Ecuador
- **EP** Endemic to Panama
- **EV** Endemic to Venezuela



CARIBBEAN REGION

3 species

- *Zamia muricata* — EN — **Located inside a National Natural Park Forest T-hf** EC and EV
- *Zamia disodon* — CR — **Forest T-hf to T-df** EC
- *Zamia restrepoi* — CR — **Forest T-hf to T-df** EC

STATUS AND THREATS

Populations are extremely small and inhabit small forest fragments in landscapes highly degraded by human activities.

ACTIONS

Actions for the preservation of populations in forest fragments (private protected areas) and restoration of populations and habitats are proposed. Education, communication, and management programs with relevant actors must be developed to support efforts of protection and restoration.

In Colombia, there are 21 described species of tropical cycads, and all of them are in some threat category.

PACIFIC REGION

6 especies

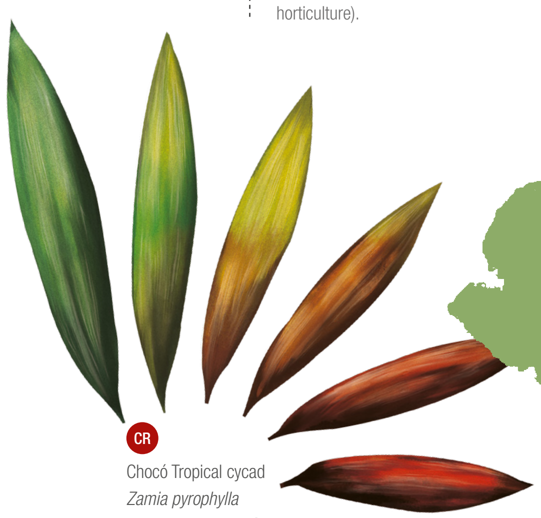
- *Zamia chigua* — EN — **Forest T-hf** EC
- *Zamia obliqua* — VU — **Forest T-hf** EC and EP
- *Zamia roezlii* — VU — **Forest T-hf** EC and EE
- *Zamia manicata* — EN — **Forest T-hf** EC and EP
- *Zamia amplifolia* — CR — **Forest T-hf** EC
- *Zamia pyrophylla* — CR — **Forest bp-T** EC
- ***2** species being described*

STATUS AND THREATS

Some species are common in forest habitats with low disturbance or protected areas, but two species have small populations in degraded forest.

ACTIONS

Actions to prevent forest degradation and increase protection and restoration for critically endangered species are proposed. Education, communication, and management programs with relevant actors must be developed to support efforts of protection and restoration. There should also be programs for sustainable use of some species (tourism and horticulture).



CR Chocó Tropical cycad *Zamia pyrophylla* **Forest (T-rf), Pacific** Endemic

As the leaves of *Zamia pyrophylla* mature, leaf color changes between brown, red, orange, yellow, and green from the apex to the base. A surprising color transformation for a plant of the understory in the tropical humid forests of Chocó.

8 species are critically endangered (Andean and Pacific regions), 9 species are endangered, and 4 species are categorized as vulnerable (Pacific and Amazon regions).

ANDES AND INTER-ANDEAN VALLEYS

8 especies

- *Zamia encephalartoides* — EN — **Forest y bush T-df** EC
- *Zamia huilensis* — EN — **Forest y bush** PM-hf EC
- *Zamia incognita* — EN — **Forest T-hf** EC
- *Zamia melanorrhachis* — EN — **Forest T-hf** EC
- *Zamia montana* — CR — **Forest T-hf** EC
- *Zamia oligodonta* — CR — **Forest PM-hf** EC
- *Zamia tolimensis* — CR — **Forest PM-hf** EC
- *Zamia wallisii* — CR — **Located within a PNN Forest PM-hf** EC

STATUS AND THREATS

Populations are small and inhabit small forest fragments in landscapes highly degraded by human activities.

ACTIONS

Actions to protect populations in forest fragments (public and private protected areas) and restore populations and habitats are proposed. Education, communication, and management programs with relevant parties must be developed to support efforts of protection and restoration. There should also be programs for sustainable use of some species (tourism and horticulture).

ORINOQUÍA REGION

Nothing is yet known about the status of populations until now.

1 species

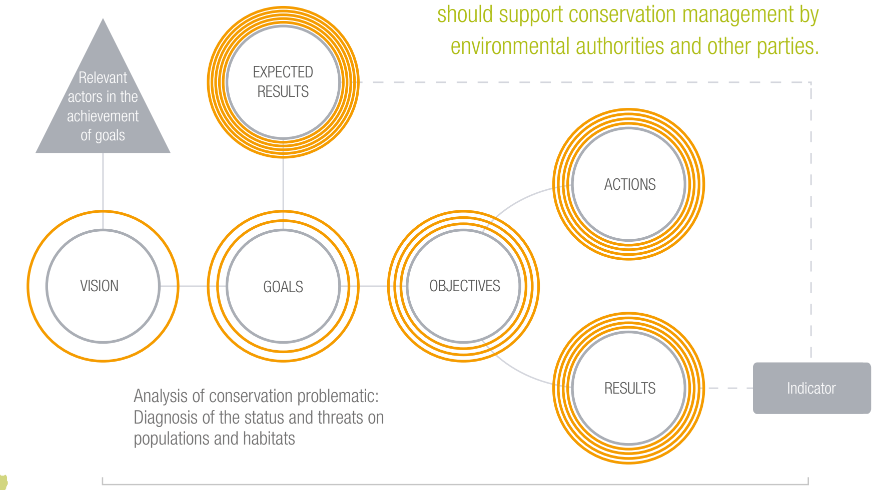
- *Zamia sp. nov.* **Forest T-hf** EC
- ***1** species being described*

Cycads are tropical gymnosperms that represent the most ancestral group of plants with seeds, so they are considered to be living fossils.

Cycads share characteristics with angiosperms, and it is probable that insect pollination, animal seed dispersal, and other ecological interactions appeared in this group of plants for the first time in evolutionary history.

Currently, cycads are not very diverse and are highly vulnerable. More than **60 %** of cycads around the world are in risk of extinction. They are therefore the group of organisms that are more threatened on the planet.

The implementation of conservation plans should support conservation management by environmental authorities and other parties.



Species conservation plans

AMAZON REGION

4 species

- *Zamia lecontei* — EN — **Forest T-hf Colombia and Brazil**
- *Zamia ulei* — VU — **Forest T-hf Colombia and Amazonian countries**
- *Zamia amazonum* — VU — **Forest T-hf Colombia and Amazonian countries**
- *Zamia hymenophyllidia* — EN — **Forest T-hf Colombia and Perú**
- ***2** species being described*

STATUS AND THREATS

The state of knowledge regarding populations is very poor, yet it is assumed that all species are very common in fragments of forest with low disturbance or protected areas. Two species have few recorded localities: *Z. hymenophillidia and Z. lecontei*, endangered

ACTIONS

Actions to prevent habitat degradation, and especially to increase the amount of knowledge about species biology and potential threats to populations and habitats are proposed.

According to the action plan for 2025, tropical cycads will be recognized as a charismatic group to gain support for species conservation and areas of interest for plants[4].

The Colombian Society of Cycads (SCC for its initials in Spanish) has as its main goal to coordinate the implementation of the Action Plan for the Conservation of Tropical Cycads in Colombia and develop the management of knowledge, conservation, and education and communication for the tropical cycads in the country.

More information about tropical cycads in Colombia is available online www.cycadascolombia.org

THE NATIONAL STRATEGY FOR PLANT CONSERVATION CONSIDERS STRATEGIC TAXONOMIC GROUPS FOR THE IMPLEMENTATION OF CONSERVATION PLANS. SUCH PLANS DERIVE INTO SPECIFIC ACTIONS AND HAVE CAPTURED THE ATTENTION OF IMPORTANT PARTIES TO ADVANCE IN CONSERVATION EFFORTS FOR A GREAT NUMBER OF SPECIES AND THEIR HABITATS.

Conservation plans define strategic actions and monitor the accomplishment of conservation goals in order to reduce the threats to and improve the status of species or ecosystems[1]. The plans are complementary to management strategies in areas that are protected or have special management. Since in Colombia there is a huge diversity of plants (more than 26,000 species[2]) it is not feasible to create conservation plans that comprise all of them. For this reason, the National Strategy for Plant Conservation[3] has defined strategic groups to implement conservation plans, which function as umbrella groups and allow for the development of conservation efforts that include a great number of plant species, their habitats, and associated organisms.

One such strategic group are the tropical cycads. With 21 species (and five in the process of description), Colombia is the most diverse country for this group. Tropical cycads in Colombia are distributed in all natural regions, and most are endemic[4]. Unfortunately, all of these species are in some threat category (according to the second evaluation for the Red List[4]). Tropical cycads (genus *Zamia*, family Zamiaceae) belong to the plant group of the cycads (order Cycadales), the most threatened group of plants on the planet and a strategic group for conservation at an international scale[5].

Using available information about geographical distribution, **population biology**, and threats to population and habitats, a detailed diagnosis of the conservation status of each species was developed in order to elaborate a conservation plan for tropical cycads. Then, in discussion with different parties, short and long term (10 years) goals were designed. The goals considered actions of preservation, restoration, sustainable use, management of knowledge, education, and communication, among others[4]. In this process, not only was relevant information updated but also necessities in knowledge and management were identified. Additionally, a better relationship between different actors such as environmental authorities and institutions interested in plant conservation was stimulated. The conservation plan proposes many actions, including the creation and strengthening of private reserves, restoration of some populations, formulation of programs for sustainable use (ecotourism and horticulture), and an integrated and interconnected management between relevant actors.

As part of this conservation plan, resources have been obtained to advance in actions to protect and restore populations, generate knowledge, and implement a program for **monitoring** and sustainable use. Conservation plans for plants in the country must be supported, for they are a priority because plants are the basis for terrestrial ecosystems and provide invaluable ecosystem services.

Institutions: a. *Universidad de Antioquia.*

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The Role of Non-Protected Areas in the Conservation of Large Vertebrates

Conservation beyond protected areas

Esteban Payán Garrido[a], Carlos A. Lasso[b], and Carlos Castaño-Uribe[c]

INCREASING MORTALITY INDICATORS OF LARGE VERTEBRATES IS DIRECTLY RELATED TO ANTHROPIC PRESSURES AND FORMS OF EXPLOITATION IN THE SURROUNDING AREAS OF CONSERVATION NUCLEI. MEASURES OF CONTROL, LAND USE PLANNING, INTER-INSTITUTIONAL COORDINATION AND POLICIES MUST BE CREATED, REINFORCED, AND ADJUSTED.

A jaguar (*Panthera onca*) is an animal with a mass of 75 kg that needs about 8,300 kg of prey biomass in its territory to live[1,2]. Such requirement is directly linked to its size and distribution area. Other large vertebrates in the Neotropics, like the Orinoco Caiman, Puma, Spectacled Bear, the large freshwater rays, and the catfish all experience similar limitations due to their large body size. In many cases, body size determines the survival of the species. In general, species of large vertebrates have suffered reductions in population sizes. Some even have become locally extinct because of uncontrolled hunting and local changes in economy, chiefly due to the unsustainable exploitation and transformation of habitats for agriculture and cattle raising[1].

Research related to some of these large vertebrates is presented in the inaugurative volume of *Serie Fauna Silvestre Neotropical "Conservación de Grandes Vertebrados en Áreas No Protegidas de Colombia, Venezuela y Brasil"* (Series of Neotropical Wild Fauna "Conservation of Large Vertebrates in Non-Protected Areas of Colombia, Venezuela, and Brazil), which was edited by the Humboldt Institute, Panthera Colombia, and the *Fundación Herencia Ambiental Caribe* (Caribbean Environmental Heritage Foundation). The published information goes beyond considerations of species populations and highlights the need of protecting such groups outside of areas of strict protection. It is evident that protected areas are not sufficient to conserve populations of large vertebrates on the long term[4,5,6]. Yet it is hard to determine how large a territory has to be in order for it to support a species of high mobility. Therefore, it is necessary to obtain detailed information regarding movement and habitat use for the species. Many of them have broad living areas and require extensive habitats or reduced localities with low disturbance[7,8]. Based on existing information, it may be argued that protected areas must be established and a minimum size to support viable populations that interact naturally may also be defined.

National Natural Parks and other reserves, which before offered a refuge for wildlife conservation, now have become non-functional in most cases and, as proven by species (paracanas and tapirs) viability models[9], are not sufficient for conservation in the future. Additionally, the protection of rivers and other wetlands is deficient since they are frequently considered as borders but are not included in said areas[10]. Although the role of indicator species in the status of the landscape and the requirements of protected areas in relation to available extensions for conservation have been documented, few studies in the region have approached the role of non-protected areas and buffer zones to understand the necessities of populations of large vertebrates in their boundaries.

As time goes by, the frontier of deforestation, penetration of roads, illegal demand of animals for consumption and pets, and reduction of non-protected natural ecosystems also advance. In the arms race between conservation and its threats there may only be victory of the former over the latter through knowledge, resources directed towards the management of animal species, civic education, and political will. Considering the information summarized here, management plans may be constructed and contingency actions taken to reach the adequate management that vulnerable species need.

Information about the group

- State of knowledge
- Major threats
- Gaps of knowledge
- Issue
- What has been done?
- Recommendations

Usos

- Commercial (Meat-Skin)
- Local consumption (subsistence)
- Cultural
- Medicinal
- Ornamental
- Skin

Other conventions

Pa: Protected areas

NPa: Unprotected areas

NNP: Natural Nationa Parks

« Manatees »

EN

Antillean Manatee

Trichechus manatus

- Hunting for consumption of meat and associated products
- Tangling in fishing nets
- Pollution
- Habitat loss
- Collisions with boats and vandalism

- Aquatic mammals (rivers, floodplains, estuaries and coastal areas aprox (45,000 km²)
- Reduction of hunting in last years.
- Population increases in some cases
- Distribution in major basins, tributaries, swamps, and floodplains of Orinoco, Guaviare, Meta, Atrato, Sinú, and Magdalena Rivers (33.265 Km²)
- Migratory

- Lack of information and research

- Just 9.15 % of its distribution is under PA
- Extensive distribution areas that are isolated and of difficult access
- Only maintaining protected areas would be insufficient
- Management plans for protected areas has chiefly had a terrestrial approach

- Conservation actions based on local communities
- Creation of protected areas in localities where species is emblematic
- Creation of Distrito Regional de Manejo Integrado (Regional District for Integrated Management)
- Protected River initiative in Bita River
- Biosphere Reserve "El Tuparro" where manatee is considered as an umbrell aspecies
- Plan of migratory species in Colombia 2009
- Indigenous reserves and forms of traditional use
- Collaboration of binational aquatic areas for conservation
- Creation of protocols for liberation of individuals
- Educational activities

- Monitoring of threats and distribution areas must be stimulated only 10.6 % in Sinap
- Carry out population censuses
- Generation of basic information for decision making in management and conservation
- Include local inhabitants in actions of monitoring, conservation, and management
- NPA are areas of intensive use, connectivity zones, and feeding reservoirs that are a priority for species survival
- Continue research about wild populations
- Create binational agreements
- Continue programs of rehabilitation and liberation of individuals in captivity
- Protected areas are key for conservation but in the case of manatees are insufficient. It is therefore necessary to propose other strategies

« Large freshwater fish »

CR

Barred Magdalena Catfish

Pseudoplatystoma magdaleniatum

Most threatened freshwater fish of the country

- Rivers where species are distributed serve as limits of National Natural Parks, but just some small areas of their distribution are protected
- National Natural Parks are not the most adequate figures to protect large species of freshwater fish

- Regulation measures for some species.
- General Statute of Fishing-Law 13 of 1990
- Red Book of Freshwater Fishes 2012
- RAMSAR Convention (6 sites in Colombia)

- A revision and update of norms is necessary regarding: prohibition periods, minimum sizes, areas of management or exclusive artisanal fishing, and commercialization of some species
- Fishes and non-protected aquatic systems must be included in the conservation objectives of National Natural Parks
- Cover all attributes of ecological integrity in POMCAS
- Consider fluvial corridors in conservation (migration with reproductive and trophic goals)
- Measures of compensation and investments with environmental licenses.
- Conservation of freshwater fishes implies the participation of all sectors (private, public, government, and citizenship).

- Lack of knowledge of current status in non-protected areas and relation to protected areas

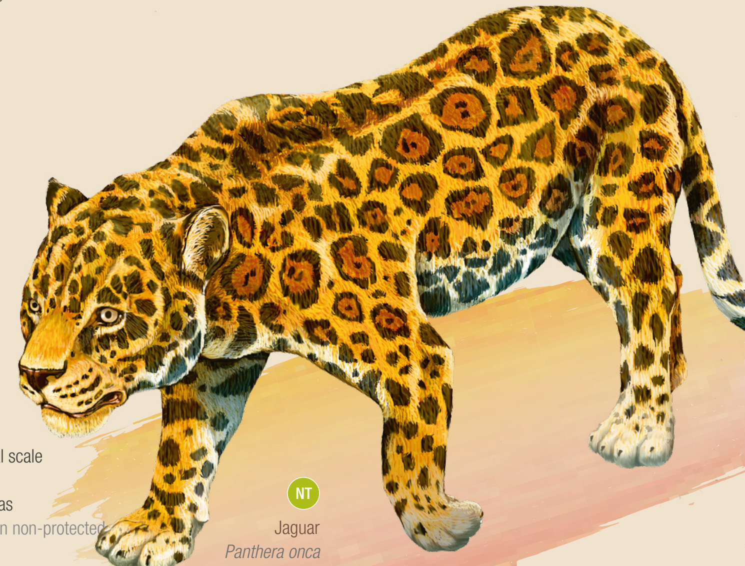
- Overfishing
- Degraded habitat both inside and outside protected areas
- Selective extraction (consumption and commercial)
- Mining, water pollution, and construction of dikes, obstructions, and dams (limit reproduction and dispersal or migration)

- Colombia is the second country with most diversity of freshwater fishes

1,430 species with **26 species considered as large**

- Most species distributed in Amazon and Orinoco River Basins
- Migratory species with large distributions

« Large Amazonian Mammals »



NT

Jaguar

Panthera onca

- The Amazon is the most important ecosystem for the survival of large mammals of neotropical lowland forests
- Focal species: large mammals (larger than 10kg)
- This study increased the state of knowledge about large species

- Information about the conservation status of large Neotropical mammals in the non-protected areas of the Amazon
- Absence of robust population data
- Difficulties in monitoring individuals and sampling techniques

- Destruction and transformation of the Amazon
- Anthropic pressures
- Exploitation
- Intensive hunting

- Network of protected areas is insufficient and they are isolated in a landscape of antrhopic. exploitation

- Implementation of a robust statistical model using camera traps (estimation of population parameters)
- This study reported 8 of 10 potential species
- Data for population densities of jaguars, armadillos, pumas, and short-eared dogs
- Jaguars 2.7/100 km²
- Jaguar Corridor

- Jaguars need non-protected areas for their long-term conservation at a national and continental scale
- Areas of 3000 km² have been proposed for maintaining viable jaguar populations
- Non-protected areas are key not only as conservation actions but also to connect protected areas
- Avoiding degradation caused by deforestation, illegal colonization, and unsustainable practices in non-protected areas
- Survival of large vertebrates will depend on the effective management of protected and non-protected areas

« Spider Monkey »

EN

Variegated Spider Monkey

Ateles hybridus

One of the 25 most threatened primates in the World

Endemic to Colombia and Venezuela

- 80 % of its natural habitat has been reduced and transformed
- They represents: 1. Quality indicators of tropical dry forests; 2. Key functions in the dynamics of such ecosystems; 3. Inhabitans of one of the most threatened regions of the Neotropics so their conservation must be a priority
- More than half of the primates in the world are in risk of extinction
- Vulnerable to ecosystem degradation and direct hunting.
- Distributed in the lowland forests of Colombia: basin of the Magdalena River, San Lucas Mountains, and Northern Eastern Andes Mountain Range

- Status of populations is unknown
- Effect of hunting on populations is unknown

- Habitat destruction and fragmentation
- Hunting
- Illegal trafficking of species
- Hydrocarbon and mining explorations for megaprojects, hydroelectric energy plants.

- In Colombia only 3 % of its distribution is under some figure of protected area and 1.5 % in the Sinap (Catatumbo National Natural Park and Parque Selva de Florencia)
- High rates of habitat conversions due to agricultural industry and extensive cattle raising

- Great advances in knowledge about species
- Two conservation strategies: a. Declaratory of protected areas in current areas of distribution and b. Management of habitats in productive matrices with the participation of governmental, economic, and social actors
- Exercises of niche modeling
- Studies on the effect of fragmentation of species ecology
- 5 conservation actions are being developed: 1. Research projects; 2. Private conservation agreements and reserves; 3. Private restoration agreements inside productive matrices (connectivity); 4. Informative projects; 5. Projects for sustainable economic alternatives
- Planting and restoration of forests
- GEF large scale projects
- Community projects
- Implementation of sustainable cattle raising

- The conservation of this species will guarantee the conservation of a diversity of species and ecosystems
- Conservation depends on what efforts are completed in non-protected areas
- Declaratory of new National Natural Parks inside strategic ecosystems or prioritized areas for conservation
- Local or regional conservation agreements or initiatives
- A National Conservation Program is necessary

« Sloths in Non-protected Areas »

LC

Three-toed Sloth

Bradypus variegatus

The highest population density is reported (0.72 ind/ha) in Isla Palma, located in biogeographical Chocó

- What to do with animals that are rescued and rehabilitated?

- Programs of rehabilitation and liberation
- Collaboration between actors involved in care of wild fauna

- Areas of liberation that have well developed forests with food, water, and areas sufficiently connected by ecological corridors
- Control and monitoring of individuals
- Educational workshops
- Active conservation and participation
- Processes of restoration and ecological corridors

- Arboreal mammals
- 6 species of sloths, in Colombia there are 3 (of two and three toes)
- Broad distribution
- LC due to their broad distribution
- CITES Appendix II

- Difficult to study

- Rapid disappearance and fragmentation of forest
- Hunting
- Expansion of agricultural and cattle raising frontiers
- Illegal use as pets

« Felines in the Caribbean »

- Felines are bioindicators of the status of ecosystems and associated conflicts
- Greater values for richness of medium and large sized mammals are reported outside protected areas
- The Caribbean region is one of the areas with greatest conflict between humans and felines, as well as largest amount of large carnivores deaths

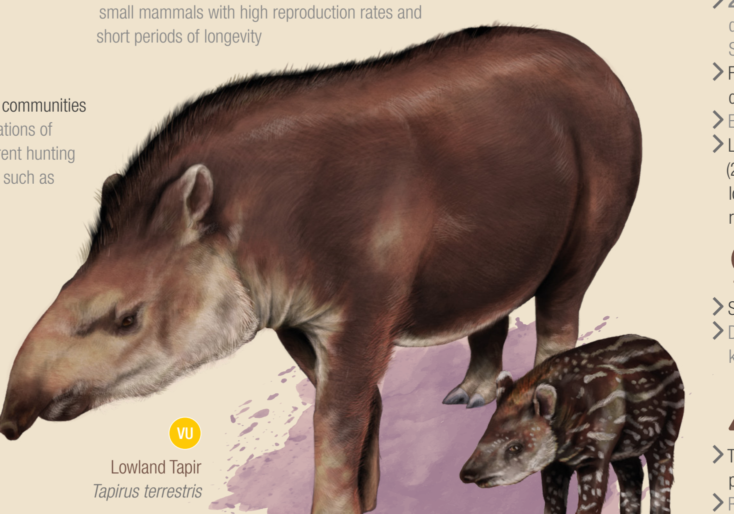
- Habitat fragmentation and loss
- Strangling of protected areas due to affected buffer zones and absence of an effective regulatory framework
- Increasing conflicts between felines and humans
- Conflict retaliation
- Decrease of natural covers

- Although protected areas are effective for conservation, many regions, independently of representativeness, are insufficient or size does not allow for many species to complete autoregulation functions
- Conservation problems in transition areas between protected landscapes and zones of agricultural or urban use
- Fragmentation of connections between protected areas, buffer zones, and few existing corridors

- Characterization and management of felines in Caribbean Region (FHAC and CI Colombia) 2007
- Conservation Plan for Felines in the Caribbean)
- Studies that show existing disarray between mobility requirements and distribution, as well as between surroundings and forest covers and intervened matrices
- Two case studies: Montes de María (Bolivar/Sucre) and Serranía de Perijá, Sierra Nevada de Santa Marta (La Guajira)

- Increase connectivity between habitats
- National Natural Parks and protected areas may be considered as relicts of isolated forests. A significant expansion is needed, as is the achievement of complementary strategies of functional connectivity
- Management measures and reorientation of strategies of land use planning are necessary
- Efficient connectivity measures and indicators

« Tapirs and Hunting »



VU

Lowland Tapir

Tapirus terrestris

- What is the effect of hunting on populations of *Tapirus terrestris*?
- Is conservation possible outside of protected areas?

- Traditional management by indigenous communities
- It is possible to maintain healthy populations of tapirs outside of protected areas if current hunting rates are kept, as well as source areas such as nearby protected areas
- The role of indigenous reserves is highlighted in the conservation of the Amazon

- Relations between protected and non-protected areas offers an opportunity to work with local communities
- The scientific and conservationist perspective must reconcile with the use indigenous communities may give to their resources

- Largest terrestrial mammal of the Neotropics
- Low reproduction rates and long periods of longevity

- Is subsistence hunting incompatible with the conservation of biodiversity in the Amazon?
- Effects of hunting varies between areas but affects tapirs more than small mammals with high reproduction rates and short periods of longevity

Tapirs of high mountains

- *Tapirus pinchaque* is the largest mammal of the tropical Andes
- **20.89 %** of this species distribution is inside the Sinap
- Flag species for conservation
- En Endangered
- Low reproduction rate (2 offspring per year) and low longevity, extensive range area

- Studied little in Colombia
- Distribution not well known

- Transformation of forests and paramos into crops and grasslands
- Reduction and fragmentation of original distribution
- Vulnerable species

- Climate change is an influencing factor in its distribution: it may cause reductions between 35 and 44 % of range

- National Plan for Conservation of genus *Tapirus* in Colombia
- Models of potential distributions

- Promote research in non-protected areas, specially in those with recovering forest cover
- Identify major threats and areas of distribution
- Create ecological corridors that enable local and regional connectivity between populations and current protected areas
- Present species as a key regional symbol (Jaguar, Condor, Andean bear, tapirs) in conservation campaigns

Online version
reporte.humboldt.org.co/biodiversidad/en/2016/cap3/303

Related searches
BIODIVERSITY **2014:** 106, 203, 204, 212, 213, 302, 307 | BIODIVERSITY **2015:** 201, 203, 303, 304, 306, 309

Topics
Protected areas | Complementary conservation strategies | Conservation | Communities

« Large Aquatic Reptiles »

> Colombia represents the second and first place in richness in South America, respectively
> Long-lived species and differentiated habitat use according to hydrological cycle
> Only the populations of the American Crocodile (*Crocodylus acutus*) have increased
> The greatest distribution percentage of these species is found outside protected areas
> The South American River Turtle is a critically endangered endemic species
> 75 % of assessed species are protected by either local or regional conservation plans

> Lack of research and monitoring of these species in their distribution
> Information is a limiting factor in effective conservation

> Overexploitation
> Fishing
> Cattle raising
> Energy generation
> Habitat alteration
> Deforestation and changes in vegetation covers
> Water pollution
> Climate change

CR
Tortuga del río Magdalena
Podocnemis lewyana

> Declaration of protected areas
> Species conservation plans
> Environmental permits
> PNN Chuinari (Amazonas): an effort of social participation for the conservation of the South American River Turtle South American River Turtle and Yellow-spotted River Turtle as valuable object of conservation in three PNN
> Crocodilians considered as valuable object of conservation in five PNN
> Monitoring research of American Crocodile in PNN Tayrona

> Of a total of 32 species of continental turtles and crocodilians, 12 species and one subspecies are under some threat category
> Proposed strategies have not been effective, for they have not been implemented in a continuous and integrated manner
> Areas of the Sinap exclude great parts of the distributions of continental species of turtles and crocodilians
> Protected areas are not sufficient to maintain viable populations
> It is not clear if rivers and other bodies of water (natural limits) are included inside protected areas

> A change of the current focus of implemented strategies and the inclusion of an ecosystem view adapted to fluctuating systems is recommended
> Include aquatic ecosystems in conservations figures and guarantee interconnection between PAs including rivers and adjacent floodplains
> The execution of conservation plans has not been adequately completed since only part, and not the entirety, of the plans have been approached (management of nests and community participation)

« Otters »

Giant Otter (*Pteronura brasiliensis*)
En Endangered
Based on genetic analyses, two management units were determined: one in the Orinoco and another in the Amazon, which are essential for management and reintroduction programs
Areas of natural distribution: tributaries of blackwater rivers, whitewater rivers, confluences, lagoons, and river rapids
Absence of robust numeric data to support apparent recovery of populations
Drastic reduction of population in the 50's and 60's for use of skin, which resulted in local extinctions
Hunting for conflict retaliation
Expansion of agricultural boundaries
Human presence

Apparent recovery of species in the Amazon and Orinoco is creating conflicts with local fisheries
Such conflicts are present in the Orinoco, Meta, Bita, Inírida, Guaviare, Caquetá, Putumayo, and Amazon Rivers
Very scarce in the Amazon and conflicts due to the species interrupting productive labor
Scarce in Caquetá and Putumayo Rivers have been reported
In the Orinoquia three areas with conflicts are reported: Biosphere Reserve El Tuparro, Casanare, and Estrella Fluvial de Inírida
Conflicts are present in commercial, sport, and ornamental fishing, which are all sources of income

Hunting prohibition 2969
CITES ratification 1972
Law decree 2811 of 1974
There is evidence regarding low level of overlap of food items with fisheries
It was concluded that interference with fisheries is relatively low and corresponds to areas with greater fishing pressures and bad practices
Evaluations and workshops with fishing authorities have resulted in fishing agreements
Management plan for the two species of otters in Colombia
Increase number of samples to strengthen genetic studies
Implement fishing management measures in regions of conflict
Collaboration between AUNAP (management of fishing resources), MADS (aquatic mammals), and CARs is essential

« Spectacled Bear »

> Inhabits Andean forests
> Found in the 3 mountain ranges of the country
> 76.4 % of its habitat is under the responsibility of 27 CARs
> Potential habitats include 83 fragments (each of 5,000 km²) located in the Andean slopes of the Pacific and the Amazon

> Abundance of individuals is not known

> Expansion of agricultural and cattle raising boundaries
> Hunting for conflict retaliation
> Roads infrastructure
> Absence of conservation practices
> Illegal crops
> Armed conflict

VU
Andean Bear
Tremarctos ornatus
Of the 32 states in the country, bears are present in 23

> 8 National Natural Parks have extensions between 1,000 and 5,000 m², therefore bear conservation must occur outside protected areas
> 26 CAR with 955 municipalities, 38 % with bears
> Eastern Andes mountain range has 50.8 % of protected areas that have bears (14 CARs), Central Andes mountain range with 15.9 % (8 CAR), and Western Andes mountain range 29 % (6 CAR).

> 4 CARs have developed conservation actions for bears
> Protected areas occur 24.4 % of bear habitat. The rest is not protected by any type of conservation figure
> Species is protected by Colombian legislation Resolution 192 of MADS
> CRC has developed conservation actions in the Western and Central Andes mountain ranges
> Corantioquia has legally prosecuted hunters
> In the Eastern mountain range bears have been mostly studied (alternatives of sustainable management, reconversion of land use, and environmental education)
> Corpoguajira and Corpocesar have developed conservation strategies and environmental education
> CAR, Corpochivor, Corpoboyacá, and PNN Chingaza y Pisba have invested in resources and conservation efforts in collaboration with private companies (Acueducto de Empresas de Bogotá and mining and energy companies)
> CAM has developed proposals of environmental sensibilization
> 16 graduation thesis about the species in different topics

> Conservation of Andean Bear is in the hands of the CARs
> Despite some strategies that have been developed, bears continue to die
> Research is required to know about the status of populations

Instituciones: a. *Panthera Colombia*; b. *Instituto de Investigación de Recursos Biológicos Alexander von Humboldt*; c. *Fundación Herencia Ambiental Caribe*.

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National Strategy for Plant Conservation

A strategy for implementation

Carolina Castellanos[a], Carolina Sofrony[b], Diego Higuera[c], Natalia Peña[a], and Natalia Valderrama[a]

COLOMBIA HAS ADVANCED IN IMPLEMENTING ACTIONS TO ACCOMPLISH THE GOALS ESTABLISHED IN THE *ESTRATEGIA NACIONAL PARA LA CONSERVACIÓN DE PLANTAS*[1] (NATIONAL STRATEGY FOR PLANT CONSERVATION), SIGNIFICANTLY ADDING TO THE GLOBAL STRATEGY FOR PLANT CONSERVATION.

Plant conservation is an imperative for the survival of human beings and all other species that live on the planet. Plants support an infinity of vital processes, including those that have not yet been discovered, and offer various benefits to human societies, which directly or indirectly owe great part of their development to their close relationship with plants.

The importance of biological diversity and its interest to humanity was recognized internationally in the Convention on Biological Diversity (CBD). This convention also recorded the responsability different states and society have in establishing actions for the conservation, sustainable use, and the just and equal distribution of the benefits that derive from the use of biodiversity. With the same purpose, other tools that aim to achieve the objectives of the CBD have been generated. One of these is the Global Strategy for Plant Conservation (GSPC), which was received by the Conference of the Parties of CBD in 2002 and constituted the first step towards the development and adoption of goals for the Strategic Plan for Biodiversity[2].

As a member of the CBD, Colombia has developed both institutional policies and strategies to contribute to the conservation of the biodiversity of the country. In 2001, Colombia pioneered in formulating a National Strategy for Plant Conservation as a guide for the implementation of actions directed towards increasing knowledge, conservation, and sustainable use of Colombian flora, thus creating spaces of integration and vinculating key figures with the topic.

In 2010, the implementation advances of the National Strategy for Plant Conservation were assessed and the initial main themes updated according to the objectives and goals proposed by the Global Strategy[3]. In the framework of this revision and as a methodological approach for the implementation of the National Strategy for Plant Conservation, a research and monitoring agenda that included procedures to prioritize species for conservation efforts was proposed because more than 25,000 species in the country must be prioritized. Using these procedures in regional workshops, 307 plant species have already been prioritized in the Caribbean, Orinoquía, and coffee growing region[4,5,6].

Even before its constitution, many initiatives leaded by academics, institutions, and society in general have contributed to the objectives of the National Strategy for Plant Conservation. However, developing an integrated follow-up of such advances has been a challenge.

With the aim of having more specific goals and actions for the implementation of the National Strategy for Plant Conservation in Colombia, in 2014 the Ministerio de *Ambiente y Desarrollo Sostenible* (Ministry of Environment and Sustainable Development), Humboldt Institute, and the *Red Nacional de Jardines Botánicos* (National Network of Botanical Gardens) started the process of formulating an Action Plan. Such initiative was conceived in order to create a tool that allows for the articulation of scientific knowledge with policies in decision making scenarios in order to manage Colombia's **native** flora and strengthen the use of the *Política Nacional para la Gestión Integral de la Biodiversidad y sus Servicios Ecosistémicos* (National Policy for the Integrated Management of Biodiversity and its Ecosystem Services).

The Action Plan evidences the major challenges regarding conservation, sustainable use, and education, among others. It is a tool that allows for different parts of society (p.e. civil society, government agencies, productive sectors) to identify their role in plant conservation and know about the variety of processes taking place at different levels and scales.

1. Updated list of flora that is available online with free and open access
2. Evaluation of conservation status for 25 % of plant species with natural distribution in Colombia AND available online
3. Sharing of information, research and associated results, and necessary methods to apply strategies
4. Information on diversity, distribution, and status of conservation of plants is incorporated into strategies, programs, and tools of territorial planning
5. Identification of most important areas for plant diversity are under efficient management plans for plant conservation
6. *In situ* conservation of all species that are a priority for conservation, especially those that are under a threat category
7. Ensure the ex situ conservation of at least 15 % of all species of plants that are a priority for conservation (threatened or endemic) of which at least 5 % should be included in recovery and restoration programs
8. Major agricultural sectors of the country incorporate sustainable practices that include the conservation of native plants and their habitats
9. Execution of efficient plans for eradication of invasive species and prevention of future invasions with an emphasis on species classified as highly invasive
10. Conservation of genetic diversity of 50 % of cultivated plant species and wild relatives, and of 10 % of species with socio-economic value, especially native species. At the same time, traditional knowledge that is relates is respected, preserved, and maintained
11. No wild plant species is threatened by national or international commerce
12. Implementation of management plans for sustainable exploitation of products that come from wild plants
13. Conservation and development of ethnic knowledge and practices linked to vegetal resources to support their customary use, forms of sustainable life, local food security, and health
14. Societal awareness about plants and their conservation
15. There are capacitated workers using appropriate facilities according to national necessity to reach established goals
16. Institutions, networks, and associations for plant species conservation have been established or reinforced at a national, regional, and international scale with the goal of reaching of this strategy

Outstanding advances in the accomplishment of the objectives of the National Strategy for Plant Conservation in the Global Strategy for Plant Conservation[7,8]

National advances
International advances

Objective 1

Catálogo de Plantas y Líquenes de Colombia (Catalogue of Plants and Lichens of Colombia)[9]:
180 specialist botanists
20 countries
13 years of research
24,528 vascular plant species — 769 are cultivated
Non-vascular plants: 13 anthoceros, 932 mosses, 704 liverworts, 1,674 lichens
Red Books Series of Colombia:
1,870 species with evaluations for threat status — 768 species in some threat category
391,000 vascular plant species — 21 % in some threat
Expansion of agricultural frontier and logging are the major factors of transformation and threats for plants
Online Flora Consortium: 20 institutions
Global Plants Initiative: 1.8 million type specimens and other type of resources available for research
Global Plants in JSTOR 2013: online database fed by scientific community and conservationists.
Tool that allows for the exchange of information, methodologies, and experiences published by the Global Strategy for Plant Conservation.

Objective 2

Registered Protected Areas up to 2015:
883 protected areas
48 million hectares conserved (aprox.)
535 publicly administrated areas
348 privately administrated areas (Nature Reserves of the Civil Society)
92 plant species as Object of Conservation in 43 National Natural Parks
Ex situ conservation:
21 Ex situ conservation in regions: 11 Andes, 3 Amazon, 3 Caribbean, 4 Pacific
National Network of Botanical Gardens: develops a project for the integrated conservation of 10 priority species of the Tropical Dry Forest (2014-2016) as well as capacitation processes and education of local communities.
1,771 areas important for plants — very few are under some type of conservation strategy
Alliance of botanical gardens for ecological restoration
10,000 globally threatened species are represented in living collections of botanical gardens
3,546 plant species globally prioritized are identified as wild relatives of cultivated species
Global Fund for Agricultural Diversity
10 of 14 biomes around the globe have decreased vegetal productivity productividad vegetal entre 2000 y 2013
4,979 plant species are categorized as invasive species at a global scale

Objective 3

400 species of native plants used as food
1,442 species used as medicine
114 species used for extraction of fibers
Management plans for the adoption of sustainable practices in the exploitation of vegetal resources: Quindío wax palm, palms, timber species, tropical cycads, and orchids (the last two groups in CITES appendices)
Manual of identification of timber species as a tool for trafficking control
300 species of plants in CITES Appendix I
30,000 in Appendix II
31,128 species of plants are exploited (around)
5,538 human food; 17,810 medicine; 1,621 fuel
11,365 provision of materials; 2,503 poison; 3,649 animal feeding
8,140 environmental uses; 1,382 social uses; 683 food for invertebrates
5,338 genetic uses

Objective 4

26 states with proyectos de educación ambiental
Programa de Educación Ambiental (Environmental Education Program) that promotes and strengthens Proyectos Ambientales Escolares (School Environmental Projects) in educational institutions

Objective 5

Study groups for plants exchanging of taxonomic information for species
National Network of Botanical Gardens
Colombian Network of Ecological Restoration
Colombian Botanical Association
Colombian Herbaria Association
Orchidology Associations
Global Alliance for Plant Conservation

Timeline of the National Strategy for Plant Conservation

Norm
Event
Publication

- 1985: Law 61 of 1985 establishes the Wax Palm as the national tree
- 1992: Adoption of Convention on Biological Diversity from Nairobi Conference
- 1994: Law 165 of 1994 Colombia ratifies CBD; Law 139 of 1994 Forestry Incentive Certificates
- 1996: Law 299 of July 26, 1996 Protection of Colombian flora, botanical gardens are regulated; Forests Policies; Decree 791 of 1996 Forestry exploitation regime of Forests Policies
- 1998: Law 464 of 1998 International Convention on Tropical Woods; Decree 331 of 1998 partially regulates Law 299 of 1996; Strategic plan for the ecological restoration and establishment of forests Colombia-Green Plan
- 2000: Biodiversity and plant varieties. The protection of new plant varieties and their relation to biological diversity; Declaration of Gran Canaria calls upon the development of the GSPC in the framework of the CBD
- 2001: Elaboration of National Strategy for Plant Conservation
- 2002: *Estrategia Nacional para la Conservación de Plantas* (National Strategy for Plant Conservation) 2001; Red Book of the Phanerogams of Colombia. Volume 1: Chryssobalanaceae, Dichapetalaceae, and Lecythidaceae; Red Book of the Bryophytes of Colombia
- 2005: Red Book of the Plants of Colombia. Volume 5; Red Book of the Plants of Colombia. Volume 4; Red Book of the Plants of Colombia. Volume 3: Bromeliads, Lamiaceae, and Passifloraceae); Red Book of the Plants of Colombia. Volume 2: Palms, Andean caulescent rosettes, and tropical cycads)
- 2007: Red Book of the Plants of Colombia. Volume 6, first part
- 2008: Alberto Gómez Mejía, president of the National Network of Botanical Gardens
- 2010: Resolution 383 of 2010 declares wild species that are threatened in national territory; Update of normative and political aspects and revision of advances. National Strategy for Plant Conservation; Methodology Guide for the Analysis of Extinction Risks for Species in Colombia
- 2011: Topics Agenda or the Conservation and Sustainable Use of Wild Relatives of Plant Species Used in Crops of Food Importance in Colombia; Guidelines for the Conservation and Sustainable Use of Native Medicinal Plants in Colombia; Regional workshop (Manizales): Construction of a common agenda for the Conservation of Threatened Plant Species; An updated GSPC is adopted with revised goals for 2020
- 2012: Regional Encounter (Villavicencio) for the Prioritization of Plant Species in Orinoquia
- 2013: Regional Workshop (Santa Marta) for the Prioritization of Plant Species in the Caribbean Region
- 2014: Workshop (Bogotá) for the development of an action plan for the National Strategy for the Plant Conservation; Action Plan for the Conservation of Tropical Cycads in Colombia; Population Monitoring of Plants for Conservation; Management Plan for the Conservation of Colombian Mahogany, Cedar, Rosewood, and Preciosa Trees; Conservation, Management, and Sustainable Use Plan for the Palms of Colombia
- 2015: Plan for the Study and Conservation of the Orchids of Colombia; Conservation, Management, and Sustainable Use Plan for the Wax Palm
- 2017: Publication of the action plan for the National Strategy for the Plant Conservation

Institutions: a. *Instituto de Investigación de Recursos Biológicos Alexander von Humboldt*; b. *Red Nacional de Jardines Botánicos de Colombia*; c. *Ministerio de Ambiente y Desarrollo Sostenible.*

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Biodiversity: Innovation in Response to Climate Change

Adaptation and mitigation

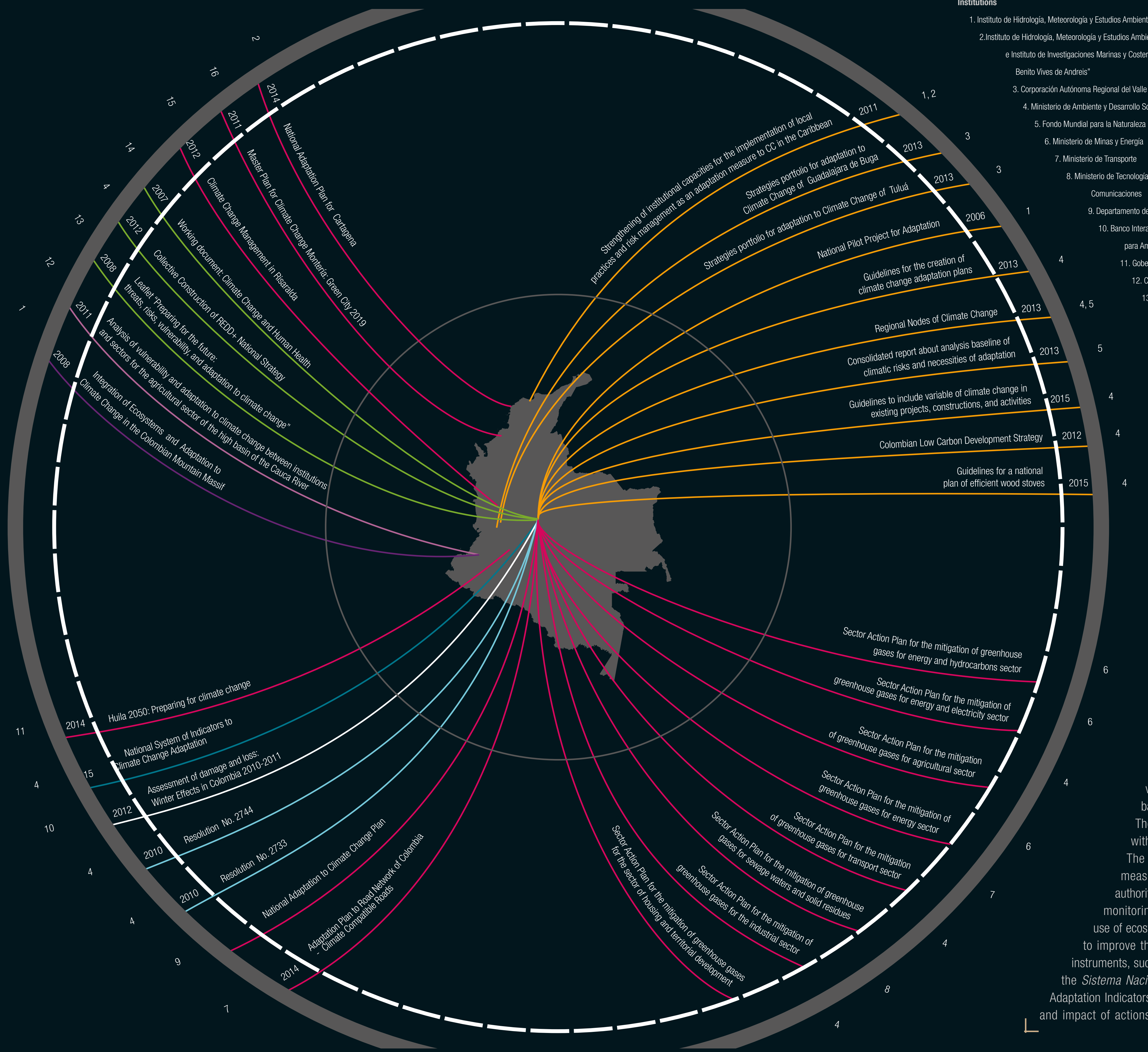
María E. Rinaudo[a]

BY DEVELOPING STRATEGIES OF ADAPTATION AND MITIGATION, THE RESISTANCE AND RESILIENCE OF ECOSYSTEMS IS FAVORED. IN THIS WAY, RISKS LINKED TO CLIMATE CHANGE ARE REDUCED AND CONSERVATION AND SUSTAINABLE MANAGEMENT OF ECOSYSTEMS AND SPECIES IN THE COUNTRY IS ENCOURAGED.

Beyond the scientific approach determined by the Intergovernmental Panel on Climate Change (IPCC), the management of biodiversity and **climate change** must be evaluated from both a conventional and innovative perspective. The conventional view highlights the vulnerability of biodiversity due to the impacts of climate change and its direct or indirect effects on ecosystem functionality, while the innovative view focuses on biodiversity as a solution for climate change through strategies of adaptation and mitigation that allow for an optimization of resilience capacities in the territory, thus favoring human well-being[1].

All **adaptation** and **mitigation** strategies for climate change must esteem biodiversity and its **ecosystem services** for their intrinsic value and include economic, cultural, and social criteria. Also, recognizing the knowledge of local and indigenous communities strengthens processes of impact and decision making, as well as the existence of **adaptive governance** at varying territorial scales.

Initiatives of climate change (CC) adaptation and mitigation according to topology



Institutions

1. Instituto de Hidrología, Meteorología y Estudios Ambientales
2. Instituto de Hidrología, Meteorología y Estudios Ambientales e Instituto de Investigaciones Marinas y Costeras "José Benito Vives de Andreis"
3. Corporación Autónoma Regional del Valle del Cauca
4. Ministerio de Ambiente y Desarrollo Sostenible
5. Fondo Mundial para la Naturaleza
6. Ministerio de Minas y Energía
7. Ministerio de Transporte
8. Ministerio de Tecnologías de la Información y las Comunicaciones
9. Departamento de Planeación Nacional
10. Banco Interamericano de Desarrollo y Comisión Económica para América Latina y el Caribe
11. Gobernación del Huila
12. Centro Internacional de Agricultura Tropical
13. Oficina de las Naciones Unidas contra la Droga y el Delito
14. Instituto Nacional de Salud
15. Gobernación de Risaralda
16. Alcaldía de Montería

ECOSYSTEM-BASED ADAPTATION

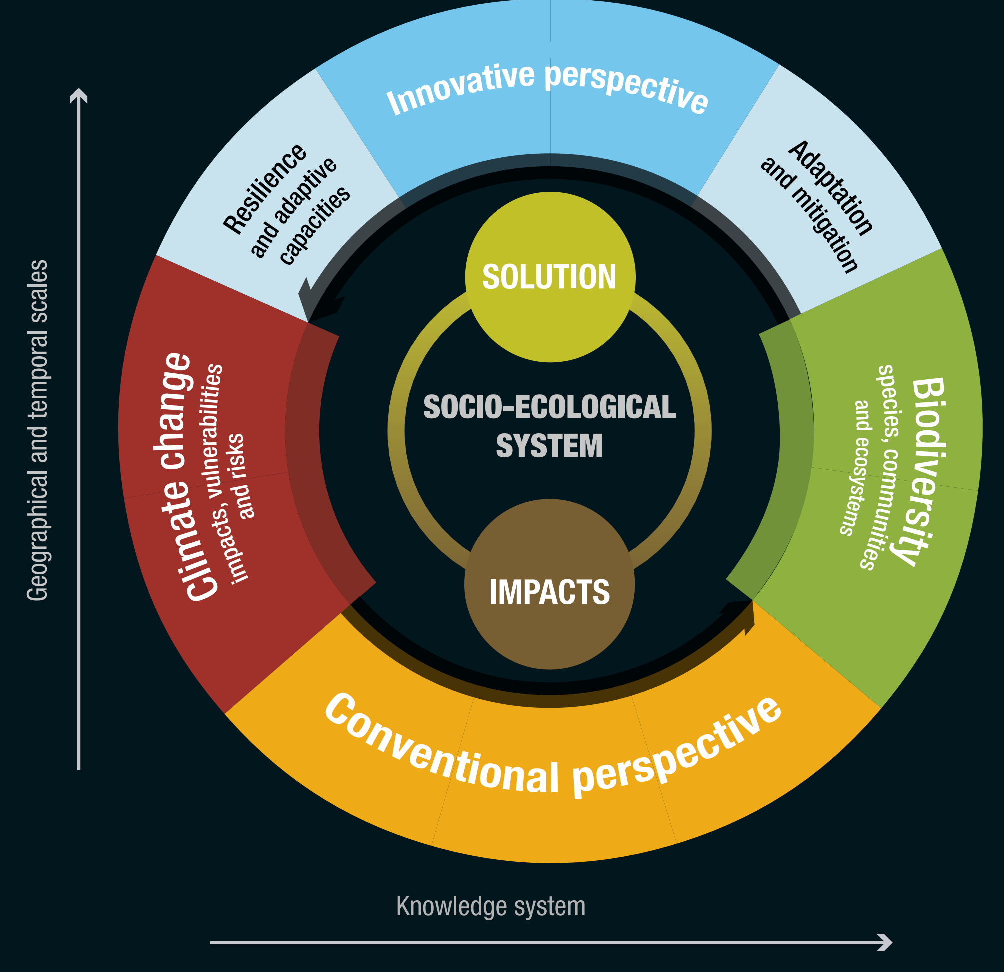
Source: Ministerio de Ambiente y Desarrollo Sostenible-Dirección de Cambio Climático

Ecosystem-based Adaptation (EbA)[2], considers that biodiversity is the major tool in increasing response capacity of ecosystems in the face of climate change. Under this perspective, people, economy, and culture all are part of ecosystems. In this way ecological systems and socio-economic systems are linked. Such vision encourages integration to sustainable management, conservation, restoration, functional connectivity between ecosystems, and resilience, as strategies to reduce vulnerability of communities that depend on ecosystem goods and services. Climate change is one of the major challenges to surpass in this century and it requires an analysis from various perspectives, strategies, and actions. In this sense, the *Plan Nacional de Adaptación al Cambio Climático* (National Plan for Adaptation to Climate Change)[3] acknowledges different views such as Adaptation based on Infrastructure, Adaptation based on Communities, and Adaptation based on Technology. These three are complementary and are used in conjunction with EbA to advance towards adaptation to climate change. The challenge is not only that communities implement EbA measures, but also sectors, territorial entities, environmental authorities, and the private sector. Like in any process, an adaptive monitoring that evaluates how the management and sustainable use of ecosystems improves adaptation to climate change is necessary to improve the design of EbA measures. Colombia already has some instruments, such as National Communications, for this purpose. Currently, the *Sistema Nacional de Indicadores de Adaptación* (National System for Adaptation Indicators) is being developed in order to monitor the management and impact of actions that are happening at different scales in the territory.

Climate change and biodiversity

Protected areas play an essential role as natural solutions to climate change.

The sustainable management of soils for cattle raising and agricultural production, ecotourism, and management initiatives of marine ecosystems in alliance with fishermen, are all adaptation practices that are based on biodiversity and are currently being developed in Colombia.



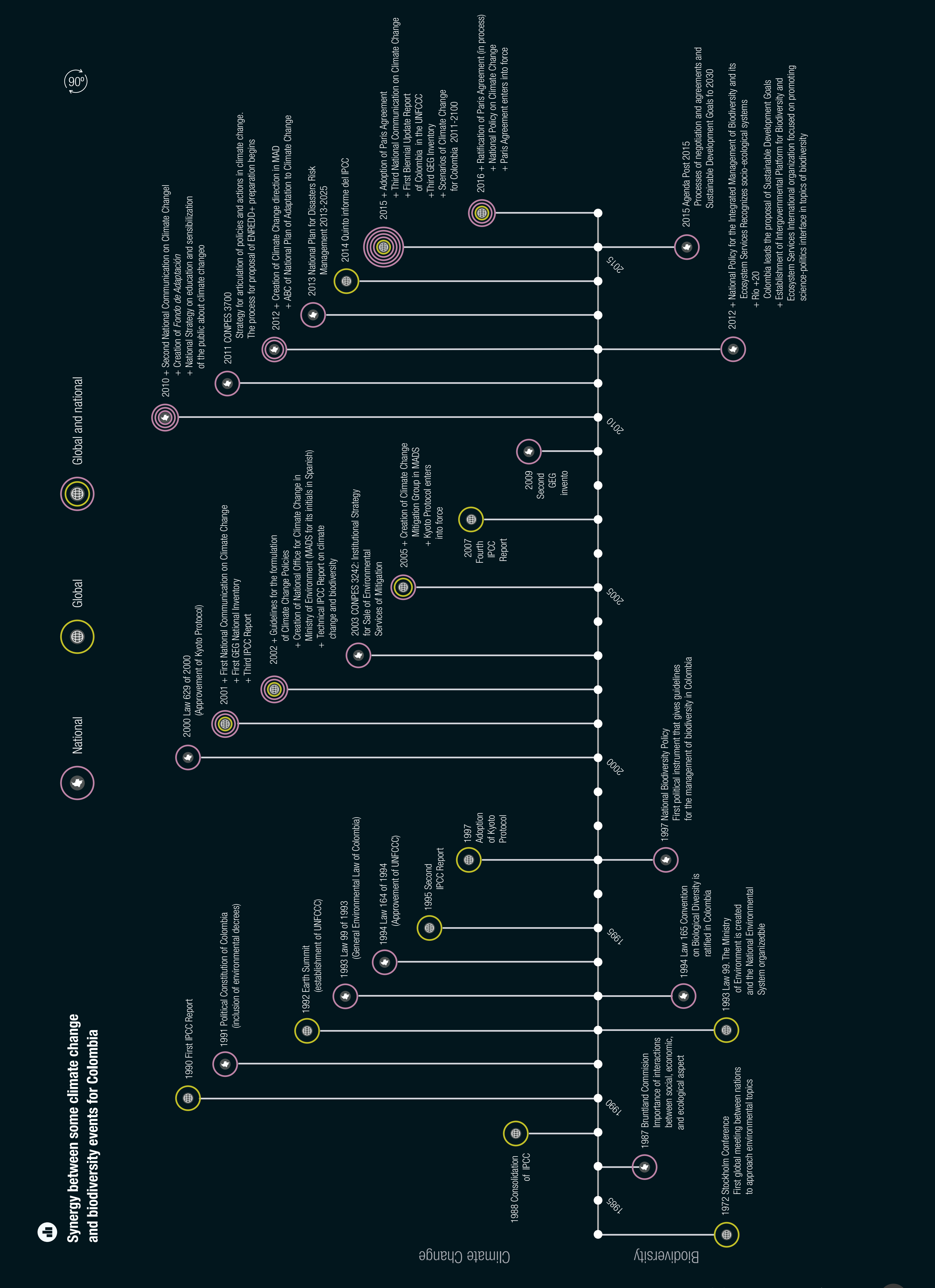
"Vetiver" is a herb with deep roots that is planted in the Andean region to avoid landslides that are caused by intense flooding due to climate change.

Biodiversity and climate change are a double-way synergy: biodiversity is affected by climate change and, at the same time, an integrated management of biodiversity represents an innovative solution to reduce this phenomenon at a global scale.

ECOSYSTEM-BASED MITIGATION

Source: Fundación Natura -Susana Vélez -Subdirección de Desarrollo Local y Cambio Global

Climate change **mitigation** is currently a priority for humanity. The consensus is that average global temperatures rising not more than 2 ºC, or even 1.5 ºC, depends on climate change mitigation. If this is achieved, it may be that irreversible damage on the biological resources of the Earth is prevented. There is also a general agreement on the benefits that mitigation brings. Mitigation can be done through the management, conservation, and restoration of forests, paramos, wetlands, or grasslands. On the medium term, this would cause a better adaptation or an increase of ecosystem resilience to droughts, which have become less unusual, or periods of heavy rain, also now more frequent. Some examples may be cited to support such dynamics: one example is focused on reforesting degraded zones because planting trees increases carbon reservoirs so that carbon is stored in plants and not liberated to the atmosphere. In this point, it is important to think about the recovery and protection of paramos, where great carbon reservoirs exist in the soil and ecosystem services such as the regulation of water cycles are offered. The Fundación Natura has been developing actions of ecosystem-based mitigation and adaptation. One of such initiatives is the project *Reducción de Emisiones por Deforestación y Degradación de los bosques REDD+ Corredor de Robles* (Reduction of Emissions by Deforestation and Degradation of Forests REDD+ Oak tree Corridors), that aims to conserve the last fragments of oak forests in the Eastern Andes mountain range and reduce **deforestation** rates in the conservation corridor Guantiva-La Rusia-Iguaque (Santander-Boyacá). This includes the participation of communities through productive activities and forestry management with the future goal of issuing **credit** for non-emitted carbon that is slowly being stored in those forests. With the Marine and Coastal Research Institute "José Benito Vives de Andreis" (Invemar) a project is being created in which the goal is to preserve mangrove ecosystems that store carbon in the bay of Cispatá (Córdoba), in addition to protecting coastal populations from possible impacts related to the sea. The project will also work on protecting sea grasslands, one of the most productive ecosystems on the planet in capturing **greenhouse gases** and fostering the reproduction of thousands of fish species. Both ecosystem-based mitigation and ecosystem-based adaptation are a real opportunity for the environment. They combine group work of rural inhabitants, care for the landscape, rehabilitation of biological resources, and regulation of our changing, rebel, and restless climate.



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Monitoring Vegetation in the Dry Forests of Colombia

A tool for the analysis and integrated management of the ecosystem at a national scale

Roy González-M[a,b], Camila Pizano[c], José Aguilar[a], Julián Aguirre[a,d], Adriana Barbosa[e], Alejandro Castaño[f], Álvaro Duque[d], Rebeca Franke[g], Robinson Galindo[g], Álvaro Idárraga[h], Rubén Jurado[i], René López[j], Jhon Nieto[a], Natalia Norden[a], Karen Pérez[k], Juan Phillips[l], Augusto Repizo[g], Gina Rodríguez[m], Beatriz Salgado-Negret[a,n], Alba Marina Torres[o], and Hernando García[a]

THE PERMANENT MONITORING OF CONSERVATION PRIORITY ECOSYSTEMS, SUCH AS THE DRY FOREST, IS ESSENTIAL TO UNDERSTAND ECOLOGICAL DYNAMICS AND PROPOSE ACTIONS FOR ITS INTEGRATED MANAGEMENT.

In the Neotropics, dry forests are regarded as ecosystems with high priority for conservation[1]. Some species inhabit exclusively this ecosystem, resisting high temperatures and marked water restrictions during great part of the year[1,2]. Yet the areas that contain dry forests have also supported large human settlements, creating a long history of transformation and loss of biodiversity[1,3].

Alarmed by the threats that affect dry forests in Colombia[4] and the lack of knowledge about their dynamics and functioning[5,6], regional investigators started a national strategy for monitoring the vegetation of dry forests (BSTCol) in 2013. The goal of this initiative is to generate scientific data that may be useful for the **integrated management** of the ecosystem, especially in the current situation of change and complex socio-ecological scenarios it faces[7].

These **monitoring** efforts contribute with high quality information that must be the base for decision making in terms od dry forest conservation. Consequently, it is considered that permanent monitoring of vegetation will account for a systematic process of obtaining and analyzing data that will not only explore trends in changes of **attributes** proper to the species and plant communities in time, but also allow for evaluating the effects different conservation strategies in Colombia have on the integrated management of its biodiversity.

Up to now, based on the analysis of recorded information for the first group of data obtained, 623 species of plants (33,559 individuals), including trees, bushes, palms, lianas, and cacti, have been monitored in all plots (62±29 species/ha). When overlapping the plots with the *Sistema Nacional de Áreas Protegidas* (National System of Protected Areas, Sinap for its initials in Spanish), it was found that both the areas with strict protection and private conservation initiatives shelter a greater number of species than the forests without management efforts. In Natural National Parks and Regional Parks there are approximately 72 species/ha, in Private Reserves of the Civil Society around 74 species/ha, and in private buildings 51 species/ha. Nevertheless, there is a high floral exclusiveness and unity in each monitored site and most regions contain endemic species. These facts highlight the importance of Sinap in the integrated management of biodiversity in dry forests and the need of proposing alternative conservation plans for plants in those private areas that currently lack a management strategy based on the integration to productive landscapes in each site.

Even though this initiative is still in its preliminary phase, in the future conservation needs derived from the analysis of plant dynamics, functioning, and response capacities in the face of transformation may be determined thanks to permanent monitoring.

Frequent species in monitoring plots

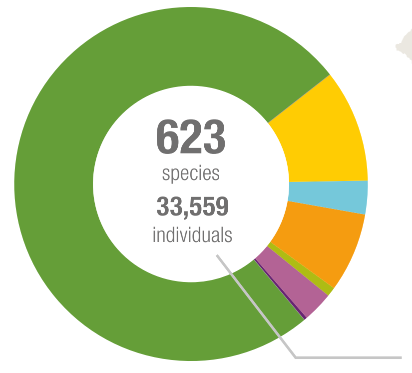
13 plots
Glassy wood
Astronium graveolens
844 individuals. Up to 1,300 m.a.s.l.

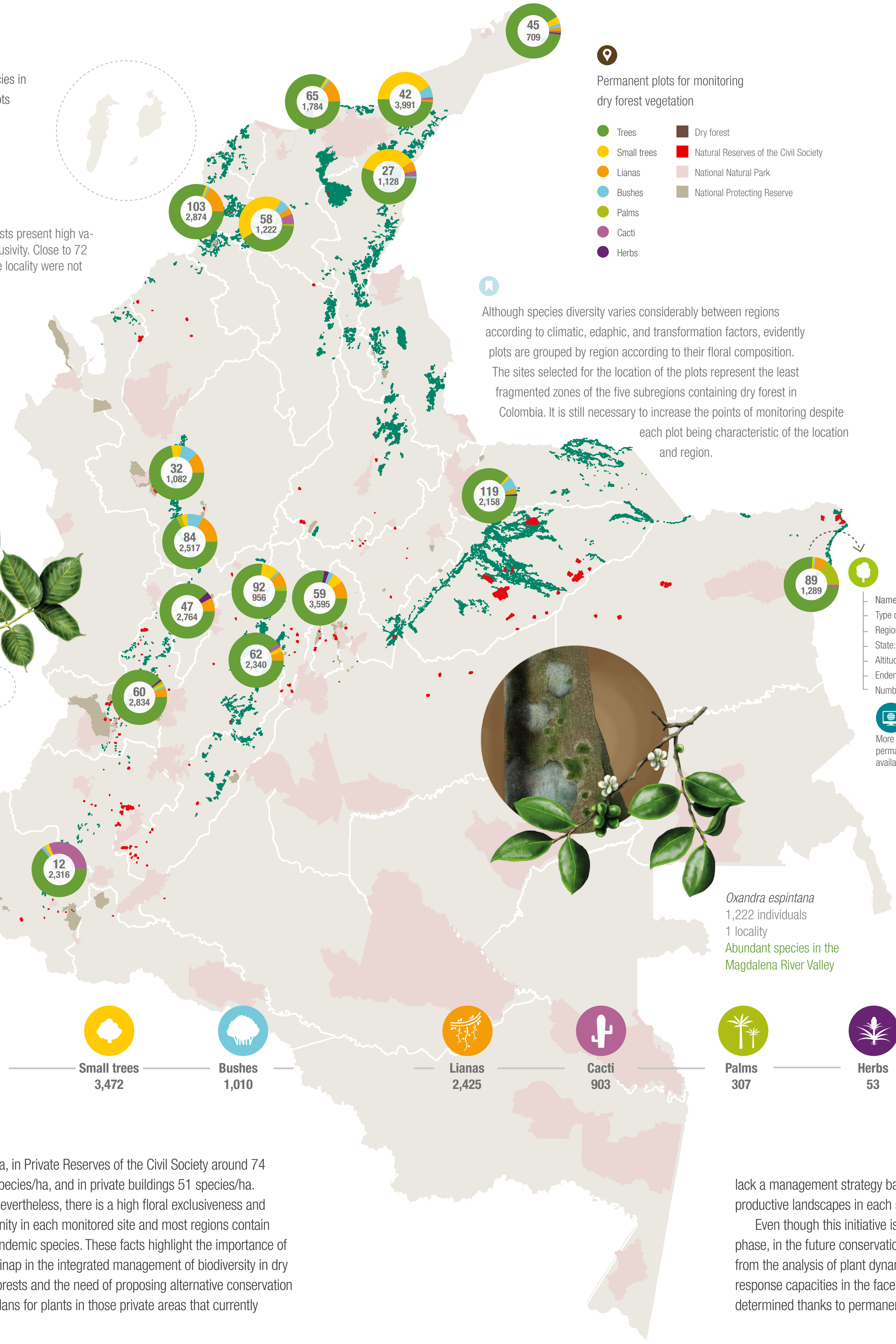
Monitored forests present high values of floral exclusivity. Close to 72 % of species of one locality were not reported in another.

Each plot is characterized by a great uniformity of plants. Only 5 % of the species are present in more than three localities.

10 plots
Gumbolimbo
Bursera simaruba
152 individuals
Up to 1,300 m.a.s.l.

Total number of individuals and species monitored per group of plants. With the obtained data of mortality, recruitment, and growth, the understanding about ecological dynamics and response capacities in the face of drivers of change, especially those related to climatic variability, may be improved.



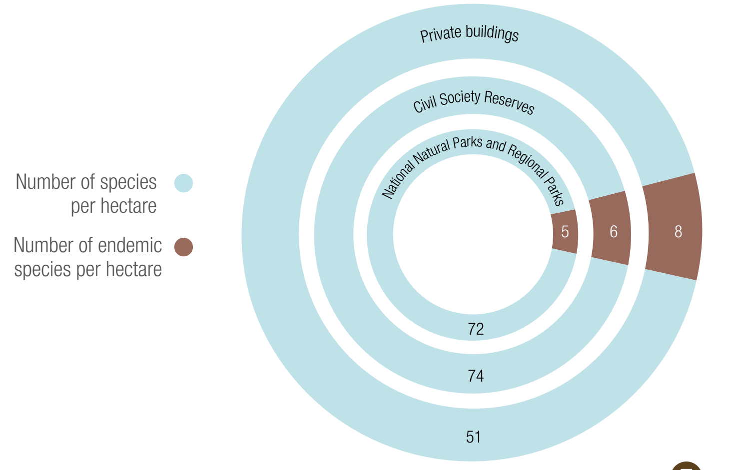


Although species diversity varies considerably between regions according to climatic, edaphic, and transformation factors, evidently plots are grouped by region according to their floral composition. The sites selected for the location of the plots represent the least fragmented zones of the five subregions containing dry forest in Colombia. It is still necessary to increase the points of monitoring despite each plot being characteristic of the location and region.

More information on each permanent monitoring plot is available online.

Oxandra espintana
1,222 individuals
1 locality
Abundant species in the Magdalena River Valley

Distribution of endemic species by type of governance. **4,817** individuals of **13** endemic plant species are being monitored. In the region of the Magdalena River Valley the greatest number (5) is present, two of which have a distribution restricted to the dry forests of the North of Tolima, making it necessary to strengthen conservation actions in these areas.



Red BST-Col is a monitoring and research initiative for dry forests in Colombia. More than 20 institutions and 40 researchers participate in the regions where this ecosystem is distributed.

Monitored endemic species with greatest abundance of individuals

1,952
Individuals
Coya colorado
Trichilia oligofoliolata
1 locality
Endemic species of the valley of the Magdalena River

The sites selected for the location of the plots represent the least fragmented zones of the five subregions containing dry forest in Colombia. It is still necessary to increase the points of monitoring despite each plot being characteristic of the location and region.

493
Individuals
Trichilia carinata
1 locality
Endemic species of the Magdalena River Valley

Online version
reporte.humboldt.org.co/biodiversidad/en/2016/cap3/306

Related searches
BIODIVERSITY **2014:** 102,103,211,212 | **BIO**DIVERSITY **2015:** 103,107,108, 202, 207,410

Topics
Endemic species | Dry forest | Conservation | Protected areas

Institutions: a. *Instituto de Investigación de Recursos Biológicos Alexander von Humboldt; b. Universidad del Rosario; c. Universidad Icesi; d. Universidad Nacional de Colombia; e. Instituto de Hidrología, Meteorología y Estudios Ambientales de Colombia; f. Instituto para la Investigación y la Preservación del Patrimonio Cultural y Natural del Valle del Cauca; g. Parques Nacionales Naturales de Colombia; h. Universidad de Antioquia; i. Asociación Gaica; j. Universidad Distrital Francisco José de Caldas; k. Fundación Orinoquia Biodiversa; l. Ministerio de Ambiente y Desarrollo Sostenible; m. Fundación Ecosistemas Secos de Colombia; n. Universidad del Norte; o. Universidad del Valle.*

Growing urbanization in Colombia poses new challenges and opportunities for managing environmentally sustainable territories that reconcile development with human well-being.

The role of biodiversity in this purpose is determinant due to the ecosystem services directly linked to the quality of life of all urban inhabitants.

General status of assessed cities:

+ Information about urban biodiversity and ecosystem services is incipient and needs reinforcement despite its importance in constructing a knowledge baseline about the territory, and hence in shaping decision making.

+ Creating cross-discipline thematic teams to strengthen technical capacities (both in populated centers and corporations) is key for managing, generating, and interpreting information layer.

+ Incentives based on the importance of the identification and preservation of urban biodiversity and ecosystem services must be created. They should also consider their technical and political avail in decision making or vinculations in land use planning.

+ Territorial functionality in relationships of cities with other urban centers or rural areas in planning and management is the most positive criterion of evaluation.

+ The commitment between entities is crucial so that they work together to reinforce environmental planning and management exercises to ensure continuity. Similarly, there must be links with academia, research centers, communities, and the general citizenship in order to create knowledge and social appropriation.

Online version
reporte.humboldt.org.co/biodiversidad/en/2016/cap3/307

Related searches
BIODIVERSITY **2014:** 205, 305, 308, 309, 310 | BIODIVERSITY **2015:** 401, 402, 404, 409

Topics
Urban management | Public policies | Environmental norms | Conservation

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Biodiversity Tools in Urban Planning

Juliana Montoya[a], Juan D. Amaya-Espinel[a], Paola Morales[a], Juan F. Tobón[a], Adriana Sinning[a], and Wilson Ramírez[a]

DEVELOPING AND IMPLEMENTING TOOLS AND STRATEGIES THAT ENSURE THE COMPREHENSIVE CONSERVATION OF BIODIVERSITY IS A PRIORITY IN COLOMBIAN CITIES. IN THIS WAY, BIODIVERSITY MAY BE INTEGRATED IN DECISION MAKING PROCESSES THAT ARE RELATED TO THE PLANNING AND ENVIRONMENTAL MANAGEMENT OF CITIES.

The Transversal Strategy for Green Growth established in the document *Bases del Plan Nacional de Desarrollo 2014-2018* (Bases for the National Plan of Development 2014-2018) identifies the inclusion of biodiversity and **ecosystem services** in urban planning as one of the necessary actions to ensure the sustainable use of natural resources in the country. Taking this into consideration, and motivated by the lack of knowledge and interest to support better decisions, the Humboldt Institute and the *Ministerio de Ambiente y Desarrollo Sostenible* (Ministry of Environment and Sustainable Development)[1] developed a conceptual framework for a plan of action. They identified three types of tools to facilitate the incorporation of biodiversity and ecosystem services criteria in urban planning and environmental management: 1. Management of knowledge, 2. Territorial management and 3. Social appropriation. It was a challenge for both entities to test such tools by technically accompanying and strengthening environmental authorities and metropolitan areas and municipalities, prioritizing the incorporation of the tools in the *Planes de Ordenamiento Territorial* (Land Use Planning Strategies--POT for its initials in Spanish) due to their impact on decisions related to the territory.

An essential goal that contributes to improving the quality of life in the cities is that of strengthening the technical and comprehension capacities regarding the importance of biodiversity inside urban areas of the involved actors, as well as those of the civil society. In this sense, the development of a conceptual framework produces a guide for the identification of goals and opportunities in biodiversity for urban planning and territorial management. The overarching aim includes facilitating the understanding of concepts and perspectives related to: 1. Meaning and significance of viewing urban areas as socio-ecological systems that function in regional contexts, 2. Forms in which urban biodiversity functions and expresses itself, 3. Roles of urban biodiversity in the offer of ecosystem services in cities and its relation to the wellbeing and quality of life of those people that live in the city, 4. Phenomena that currently challenge the survival of urban biodiversity and the opportunities that still exist for its persistence, 5. Concepts of integrated management for the conservation of biodiversity and ecosystem services in cities and its relation to urban land planning tools.

Generalized tools to incorporate urban biodiversity and ecosystem services in planning instruments

	KNOWLEDGE	TERRITORIAL MANAGEMENT	SOCIAL APPROPRIATION
What is it about?	+ Characterization of urban biodiversity and ecosystem services and management of information + Definition of analyses, diagnostics, objectives, outreach, criteria, and requirements when considering biodiversity and ecosystem services in planning	+ Establishment of priorities and optimization of implied actions when incorporating ecosystem services in urban planning + Some economic management instruments in the territory, such as compensations and incentives + Management actions that environmental authorities and territorial entities should develop so that biodiversity and its ecosystem services are effectively incorporated in urban planning + Interinstitutional alliances, technical assistance, concertation processes, monitoring and control strategies, etc	+ Oriented to facilitate and support the participation of interested actors in the process of decision making and planning
Phase	+ First phases of planning in urban territory	+ Transversal in phases of local planning. + Application is mostly evidenced in phases of formulation and management	+ Different phases of planning, execution, evaluation, and management + Special focus on last phases of process continuity with the community to ensure long term persistence
How it is achieved	+ Biodiversity manuals and inventories + Mapping of biodiversity + Creation of indicators + Identification, spacialization, and analysis/valuation of ecosystem services and social benefits associated with urban biodiversity + Geographic information systems + Cadastral survey of urban trees	**Environmental determinants** + Technical assistance from CAR to environmental entities + Definition of zones that are adequate for compensations for loss of biodiversity + Control of urbanization in areas of environmental importance + Creation of interinstitutional collaborations **Compensations** + Compensation funds + Transference or sale of building and development permits **Conservation Incentives** + Exemptions **Funding Mechanisms** + Environmental funds and financing + Corporate social responsibility + Alliances between public and private sectors	**Strategies of social appropriation** + Plans or projects of environmental education + Environmental classes + Diffusion of information **Institutional** + Environmental discussions + Urban environmental observatories **Collective** + Collaborative mapping + Citizens collectives

Challenges:

+ Success depends on the combined effort of territorial and environmental authorities in the management of information, land planning, and decision making directed towards an integrated management that ensures the conservation of biodiversity and ecosystem services in Colombian cities.
+ Recognizing the essential role of biodiversity and ecosystem services in the cities requires a short, medium, and long term management that includes monitoring indicators, budgets, and the improvement of technical and operative capacities of both territorial and environmental authorities.
+ It is an imperative to advance in the management of knowledge and information of urban areas so that updated data with good spatial and temporal resolutions is created. Also, the implementation of geographical information systems should be improved.
+ Biodiversity and ecosystem services in urban areas should play a major role in public agendas. Agreements between and within institutions should imply the planning and execution of the determined actions in the territorial management of a city or metropolitan area.
+ It is ideal to involve inhabitants in the process through citizen science in order to monitor the established tools before and after implementation. This contributes to governance through the comprehension of land planning and the construction of necessary information as a management tool for their own territory.

Institutions: a. *Instituto de Investigación de Recursos Biológicos Alexander von Humboldt.*

CHAPTER

4

Information file **401 to 412**

OPPORTUNITIES FOR TERRITORIAL MANAGEMENT OF BIODIVERSITY

Beyond the responses that emerge to the transformation and loss of biodiversity, the Report on the Status and Trends of Colombian Continental Biodiversity presents some experiences that present the opportunity of growing towards societal initiatives that impact the future of biodiversity at a thematic or local scale. The management of governance based on a local communal perspective in the Orotoy River basin (BIO 2015 and 2016), which is a proposal for social and ecological governance based on the identification of strategies for land management, is an example of such experiences. It characterized ecosystem services in an area of the foothills of the Orinoquía (BIO 2015) and in this volume evidences the existing relationship between floodplains and cattle raising (BIO 2016). Other examples include the novel approaches of a general vision regarding the connections between the post-conflict in Colombia and biodiversity (BIO 2015), some proposals for the resolution of environmental conflicts (BIO 2015), and the establishment of ecoregions with biogeographical criteria as a tool for territorial planning (BIO 2016).

Urban topics are once more included in BIO 2016, evidencing the status of urban development and the current capacities for incorporating biodiversity and ecosystem services in urban environmental planning and management. This is shown in the collective experiment of *Naturaleza Urbana* (Urban Nature), a project that calls upon the potential sustainability of cities and the need of using urban models that consider biodiversity in urban leadership, stimulation, and management.

In terms of the impact of different sectors, opportunities that include an integrated management of biodiversity and thus conciliate with development were presented (BIO 2015). The 2015 volume considers existing national strategies such as the introduction of transgenic crops and its relations with wild relatives of rice. In 2016, a reflection about implementing the *Manual de Asignación de Compensaciones por Pérdida de Biodiversidad* (Manual for the Assignment of Compensations for the Loss of Biodiversity) was included. Also, the importance of nature tourism is highlighted by exposing national priorities and the areas that are appropriate for avitourism (BIO 2016). Regarding relationships between water, energy, and biodiversity the need of including the component of biodiversity in project planning and operation is underlined (BIO 2016), and the management of an amphibian environment when managing risk and wetlands is featured. In the latter, it is clear that the duality of an amphibian territory requires a management of complexes that implies collaboration between different environmental entities at every scale (BIO 2016) and the existence of indicators of human well-being in wetlands (BIO 2015).

Those information files that have a social emphasis include paramo ecosystems and the social benefits that they bring, such as the water resources that they provide to aqueducts in the largest cities of the country, with the goal of guiding decision making in these areas. The volume of 2016 establishes a proposal beyond the sole delimitation of paramo and high mountain ecosystems to integrate adjacent territories and approach such ecosystems as dependent on their surroundings. Additionally, an analysis of policies, norms, challenges and commitments of ecological restoration, collective territories, and strategic ecosystems is presented (BIO 2015), as well as a consideration about investments from international cooperation in environmental topics (BIO 2016). Finally, the opportunity of managing diversity through a stronger market of plant nurseries in the state of Cundinamarca is featured, in which the importance of native species in commerce is pointed out.

Future presentations of biodiversity management opportunities in different ambits and sectors should include other initiatives. Most importantly, presentations should analyze the conditions that facilitate or hinder their escalation into societal responses, as well as innovation strategies to make this possible.

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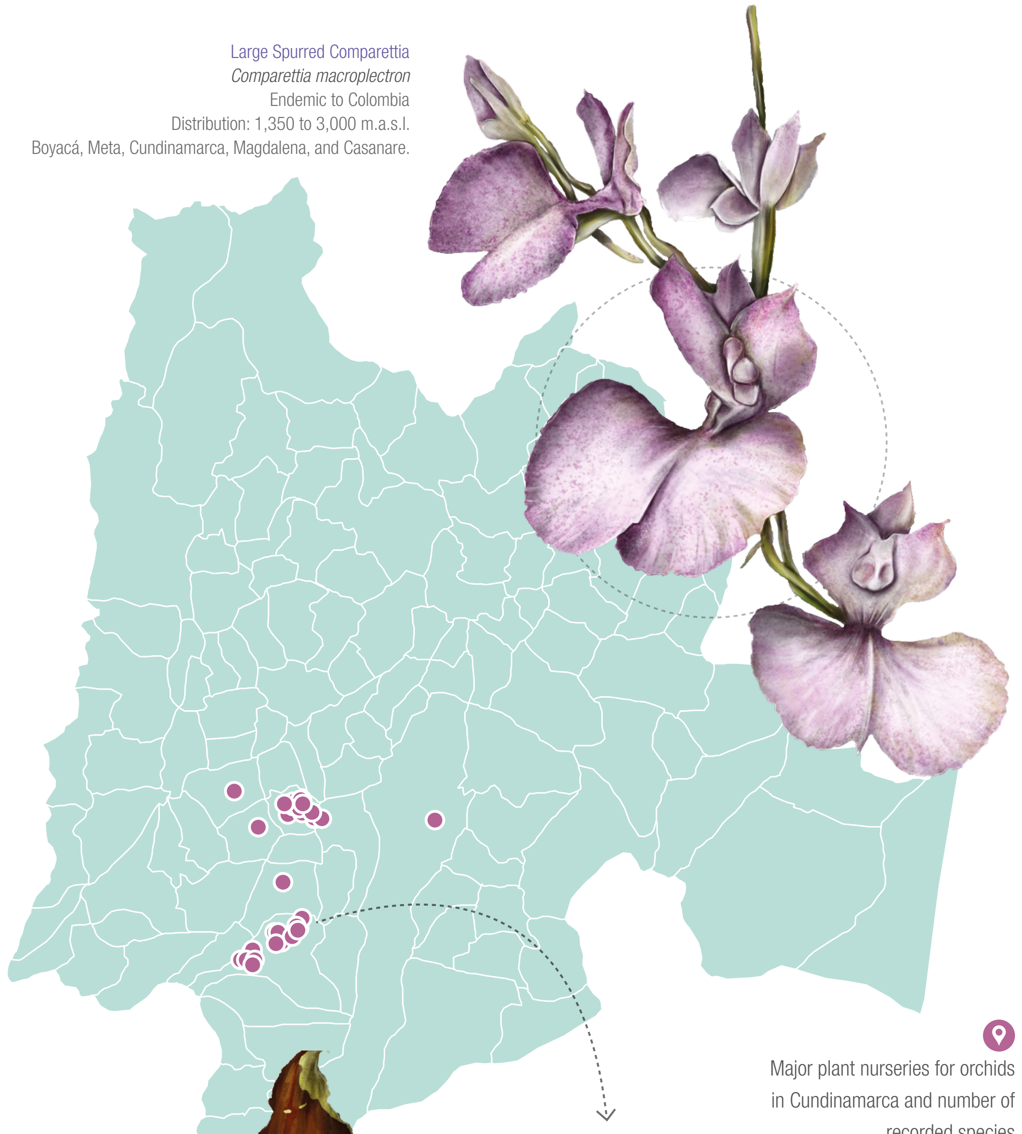
Diversity of Orchids in Cundinamarca

An opportunity for sustainable use

Carolina Castellanos-Castro[a], Cristian Castro[a], Yissel Rivera[a], Martha Vallejo[b], Diana López[b], and Diana Lara[a]

THE HIGH SPECIES RICHNESS OF ORCHIDS IN THE STATE OF CUNDINAMARCA AND THEIR HISTORICAL USE AS DECORATIVE PLANTS REPRESENTS AN OPPORTUNITY TO CREATE ALLIANCES OF PRESERVATION, RESEARCH, AND SUSTAINABLE USE.

Large Spurred Comparettia
Comparettia macroplectron
Endemic to Colombia
Distribution: 1,350 to 3,000 m.a.s.l.
Boyacá, Meta, Cundinamarca, Magdalena, and Casanare.



Species of orchids have been recorded in all the municipalities and altitudinal ranges of the country. Most species correspond to specimens found between 2,500 and 3,500 m.a.s.l..

Major plant nurseries for orchids in Cundinamarca and number of recorded species

Plant nursery ●

Plant nursery
SURTIPLANTAS
- Type of nursery: **cultivation and commercialization**
- Volume of production: **Marginal**
- Locality: **Fusagasugá**
- Altitude: **1,866 .a.s.l.**
- **Presence of native species**
- Number of species: **9**
- Species: ***Masdevallia coccinea, Masdevallia Ãgnea, Maxillaria luteoalba, Maxillaria sanderiana, Maxillaria speciosa, Oncidium alexandrae, Oncidium gloriosum,* and *Oncidium luteopurpureum***

More information about each of the plant nurseries of orchids in Cundinamarca and number of recorded species is available on line.

Yellow-purple Odontoglossum
Oncidium luteopurpureum
Endemic to Colombia
Distribution: 2,000 to 2,800 m.a.s.l.
Cundinamarca, Antioquia, Boyacá, Tolima, Caldas, Huila, Risaralda, Santander, Valle del Cauca, Cauca, Putumayo, and Quindío.

Due to the beauty and variety of shapes, sizes, and colors of their flowers, orchids are one of the most charismatic group of plants. Therefore, they have historically been used for decoration.

The greatest diversity of orchids in the world can be found in the tropical mountains of the Andes. In Colombia, Antioquia is the state with greatest species richness, followed by Cundinamarca, which has 940 different species recorded for its territory (100 **endemic** species)[1]. However, the uncontrolled extraction of orchids for commercialization, combined with the destruction of forests and the replacement of natural areas for productive land covers, has made natural populations become scarcer. Until now, the **conservation status** of only 73 **native** species in Cundinamarca has been evaluated. 51 % (37 species) of these are under some threat category[2]. This situation evidences that there is an imminent need for both ***in situ*** and ***ex situ*** conservation actions that must be developed by the academia, NGOs, environmental authorities, and society at large.

In this sense, plant nurseries play an important role in holding and propagating those species that are under some threat category. Currently, the production and commercialization of orchids is done by such plant nurseries and merchandisers. According to data published by Convention on International Trade on Endangered Species of Wild Fauna and Flora (CITES)[3], between 1975 and 2015, 189 orchid species native to the state of Cundinamarca have been traded, their major destinations being Germany, United States, and Japan.

Consequently, and with the purpose of generating **synergies** between knowledge and conservation to promote the sustainable use of orchids native to the state of Cundinamarca, the Humboldt Institute, *Pontificia Universidad Javeriana* (Pontifical Xaverian University), *Jardín Botánico de Bogotá José Celestino Mutis* (Botanical Garden of Bogotá José Celestino Mutis), and the *Corporación Colombiana de Investigación Agropecuaria* (Colombian Corporation of Agricultural Research) are developing a project that aims to contribute to research, technological innovation, and social appropriation of scientific knowledge in this topic. The project is financed by the *Sistema General de Regalías* (General System of Royalties) through the *Secretaría de Ciencia, Tecnología e Innovación de la Gobernación de Cundinamarca* (Secretariat of Science, Technology and Innovation of the Government of Cundinamarca).

Preliminary results show that in the municipalities of San Antonio del Tequendama, Fusagasugá, La Mesa, Mesitas del Colegio, Cachipay, Supatá, Tena, and Bogotá there are 57 plant nurseries that produce and commercialize 86 different species of orchids, of which 63 are naturally distributed in the state of Cundinamarca and 23 in other regions of Colombia.

This represents a great opportunity to encourage the sustainable use of native orchids as an alternative to the current commercialization of **exotic** species. It is also a chance to improve cultivation methods of native species, decrease periods of growth and flowering, reduce productions costs, strengthen capacities of workers, and receive support from authorities that may promote such activity in the region.

5 reg. *Oncidium alexandrae* — Aguadija blanca
7 reg. *Miltoniopsis phalaenopsis* — Josefita
4 reg. *Oncidium luteopurpureum* — Flor de Bogotá
5 reg. *Maxillaria luteoalba* — Cangreja o Maxillaria
13 reg. *Miltoniopsis vexillaria* — Josefita rosada
7 reg. *Phragmipedium longifolium* — Josefita
4 reg. *Oncidium hastilabium* — Hastilabium
5 reg. *Phragmipedium warscewiczianum* — Zapaticos
7 reg. *Cattleya trianae* — Flor de mayo

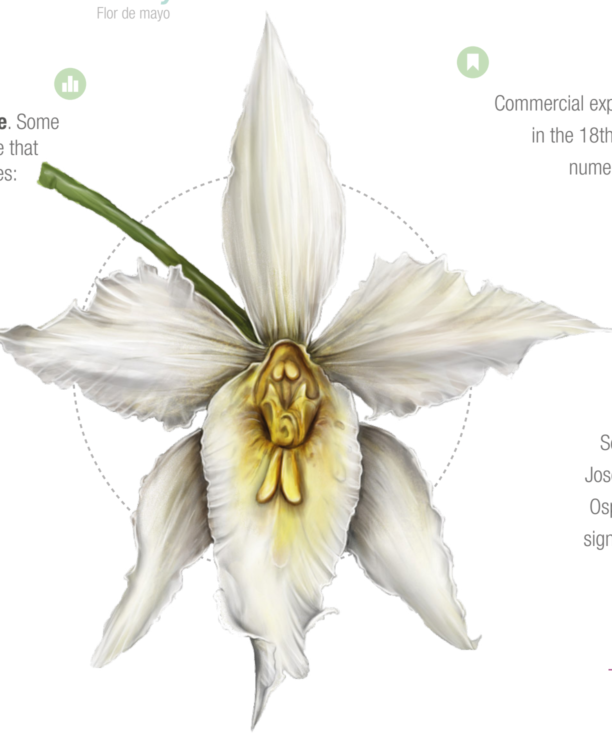
Most frequent native species in plant nurseries. Among the most common species, four belong to the genus *Cattleya*, three to *Oncidium*, three to *Phragmipedium*, and one to *Miltoniopsis*.

Most plant nurseries that produce and commercialize orchids do so as a complementary activity. They handle a broad variety of decorative species, fruit trees, and forest trees.

Commercial exploitation of orchids originates in the 18th century, and there are records of numerous extractions directed to Europe.

Native species with potential for commercial use. Some species of native orchids with potential for commercial use that were not recorded in the plant nurseries:

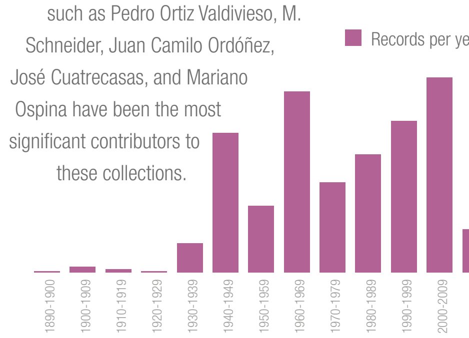
- + *Comparettia falcata*
- + *Cyrtochilum revolutum*
- + *Cyrtochilum densiflorum*
- + *Oncidium ornithorhynchum*



EN

Curled Odontoglossum
Oncidium alexandrae
Endemic to Colombia
Distribution: 1,700 to 2,700 m.a.s.l.
Cundinamarca, Boyacá, Caquetá, Cauca, Huila, Nariño, Santander, Tolima, and Putumayo.

Number of records in biological collections between 1890 and 2016. In botanical collections of Cundinamarca there are specimens from 1962 to 2015. Most specimens were collected in the decade of 1960 and the first decade of the 21st century. Investigators such as Pedro Ortiz Valdivieso, M. Schneider, Juan Camilo Ordóñez, José Cuatrecasas, and Mariano Ospina have been the most significant contributors to these collections.



NATIONAL SCENARIO FOR ORCHIDS

In Colombia, there are 4,270 native species of orchids[1], of which 1,572 are endemic and 207 are categorized under some threat category[2] mainly due to habitat destruction and followed by extraction of wild populations for commercial motives. Orchids may be found in all of the territory, yet 77 % of species are found in the Andean region[1] and are associated to Andean forests and paramos. Colombia currently has a National Plan[1] that includes goals and guidelines to generate and expand knowledge, conserve, use sustainably, educate, and strengthen laws related to this group of plants by highlighting exploitation as a countrywide opportunity. Implementing the plan implies promoting the integration of local and regional initiatives so that activities currently being developed in Colombia may contribute to other initiatives in the country.

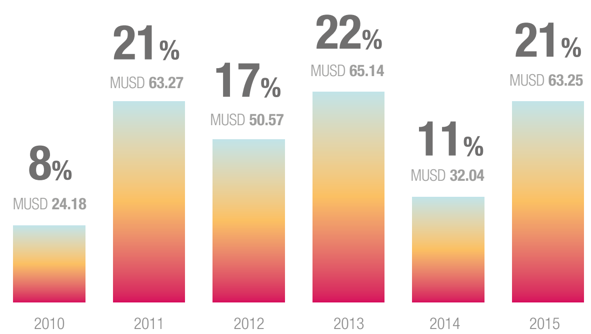
Species with most records in Cundinamarca. Herbarium records that are assumed to be of wild individuals, although some may correspond to cultivated individuals.

55 reg. *Elleanthus aurantiacus*
48 reg. *Epidendrum erosum*
42 reg. *Stenorrhynchos vaginatum*
42 reg. *Epidendrum oxysepalum*
54 reg. *Pleurothallis phalangifera*
44 reg. *Epidendrum frutex*
42 reg. *Stelis pulchella*
275 reg. *Epidendrum chioneum*
149 reg. *Epidendrum elongatum*
51 reg. *Oncidium ornithorhynchum*
43 reg. *Epidendrum cylindraceum*
47 reg. *Epidendrum excisum*
40 reg. *Epidendrum scytocladium*
51 reg. *Telipogon nervosus*
41 reg. *Epidendrum megalospathum*

Institutions: a. *Instituto de Investigación de Recursos Biológicos Alexander von Humboldt*; b. *Pontificia Universidad Javeriana*.

International cooperation for the period 2010-2015 related to GIBSE according to ODA

Annual international cooperation as a percentage and in Millions of USD (MUSD)

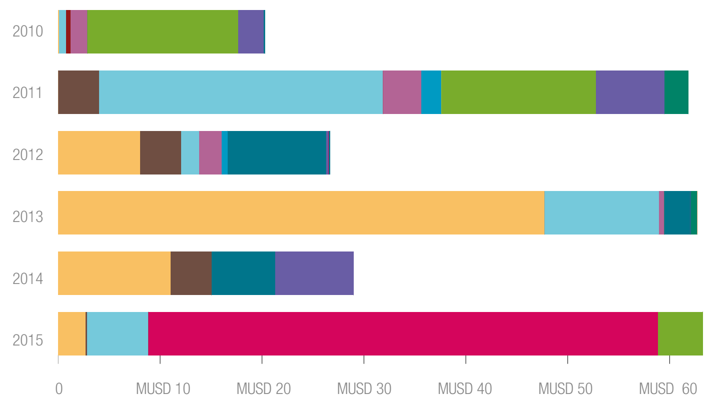


From 2010 to 2015, the major sources of income were from bilateral cooperation for the Integral Management of Biodiversity and Ecosystemic Services. 2011, 2013 and 2015 were the years with greatest movement of international cooperation resources for the Gibse (64 % of the total), in which United States; Germany and Norway were the countries that made more contributions. The reason for this phenomenon is that the armed conflict in Colombia represents part of the agenda of such donors, particularly in the case of the United States, a country that is committed with instability and subjects linked to the conflict[7].

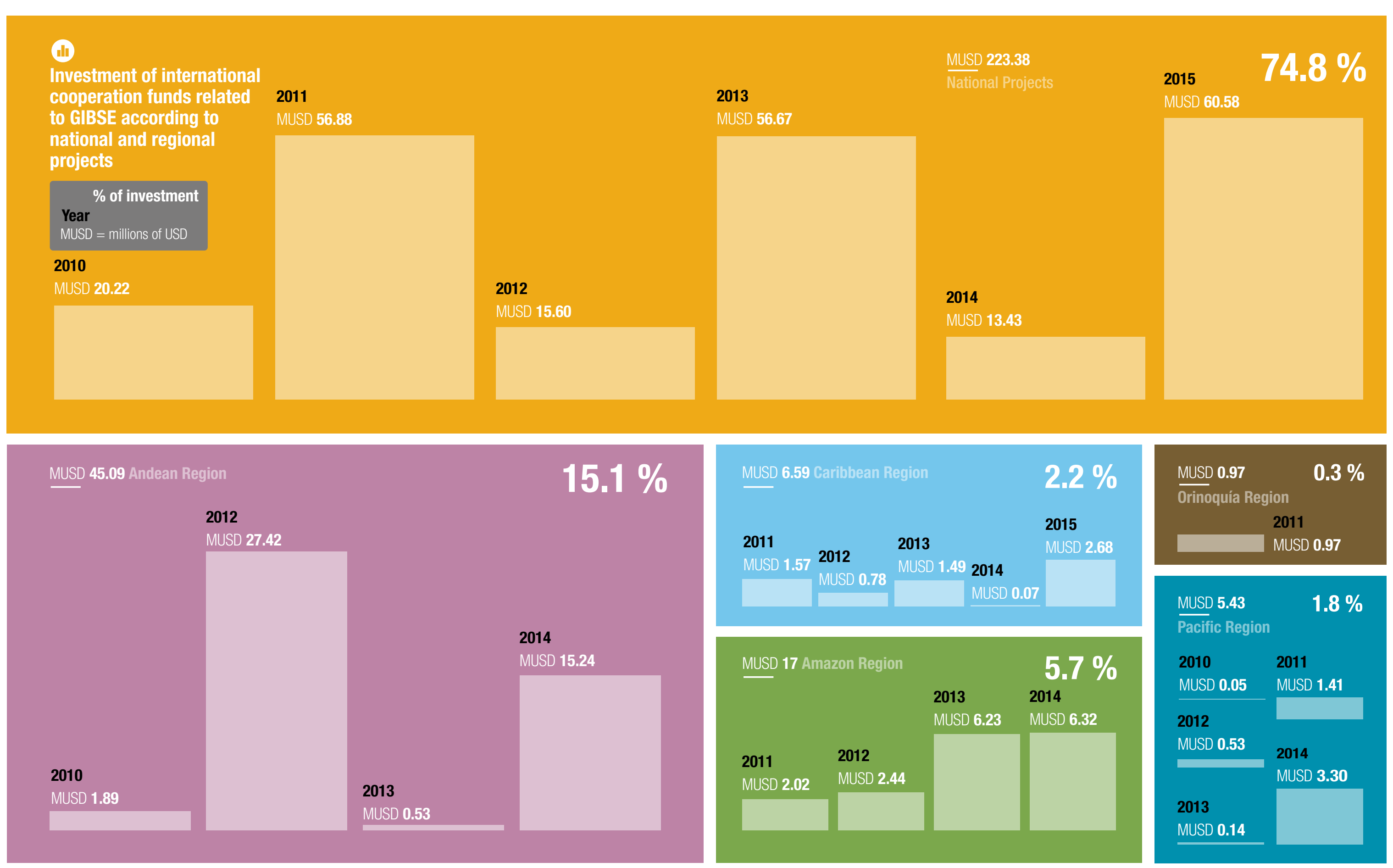
International cooperation related to GIBSE per contributor

MUSD = Millons of USD

- Germany
- World Bank
- Disney's Science, Animal and the Environment
- Spain
- United States
- Finland
- Norway
- France
- Privates
- Tifi, Inc. (USA) project
- Switzerland
- Swift Foundation
- The Walton Family Fountation
- UNESCO
- European Union



Values per contributor available online



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International Cooperation in the Environmental Sector

Challenges and opportunities

Dora Leonor Peña[a], José Leonardo Bocanegra[b], Ana María Hernández[b], and Gabriela Bonilla[c]

OF THE TOTAL RESOURCES RECEIVED FROM INTERNATIONAL COOPERATION BY COLOMBIA BETWEEN 2010 AND 2015, ABOUT 13% WERE DESTINED TO ENVIRONMENTAL TOPICS[1] DESPITE THE PREPONDERANT ROLE THESE RESOURCES HAVE HAD IN THE DEVELOPMENT OF ENVIRONMENTAL POLICIES AND PRIMARY SOURCE OF INCOME FOR THE SECTOR.

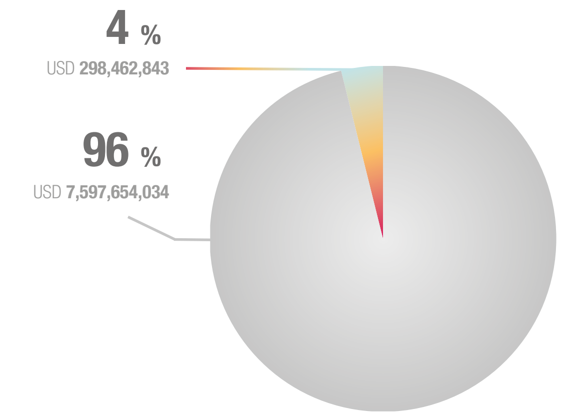
Resources provided by international cooperation are of great importance for Colombia because the *Planes Nacionales de Desarrollo* (National Development Plans-PND for its initials in Spanish) for the years 2010-2014 and 2014-2018 defined international positioning as a strategic pillar for the accomplishment of goals. In this sense, international cooperation has been essential for the *Gestión Integral de la biodiversidad y los servicios ecosistémicos* - GIBSE (Integral Management of Biodiversity and Ecosystemic Services for its initials in Spanish). The Official Development Assistance (ODA) is the major source of resources that have been destined in such topics. Although international cooperation has played an important role in achieving sustainable growth and integrating social and regional development, Colombia was recently classified by the Organisation for Economic Co-operation and Development (OECD) and the World Bank as a country of medium-high rent, making the acquirement of financial resources from international cooperation more difficult. Albeit this situation, Colombia continues to be an important receptor of resources from the ODA due to factors of inequity, environmental degradation[2], and the armed conflict[3], among others.

In Colombia, international cooperation does not represent more than 0.4 % of the total of the Gross Domestic Product (GDP). However, international cooperation in environmental topics equals about 0.5 % of the GDP[4], making international cooperation a structural element in strengthening the management of the environmental sector. It is worth noting that in many cases resources from international cooperation have represented more than 25 % of the budget of the environmental sector[5], evidencing the interest of international cooperation in supporting environmental subjects and the need to increase budget for these areas.

On the other hand, the instructions of the PND in terms of environmental topics have evolved from having a marked perspective of extractivism to adopting a greater affinity with the paradigm of sustainable development. This implies that strategic environmental evaluations to plan and organize productive activities associated with growth turn into essential tools for decision making and land use planning. This new focus entails ambitious goals that need more budget than what is currently invested by the State in the environmental sector and also seek for less dependence on investments of international cooperation. Therefore the challenge is to coherently and strategically plan investments in zones where socio-environmental problems are urgent and where private investments and incentives are limited[6].

Percentage of international cooperation funds in topics related to GIBSE and in agreement with ODA

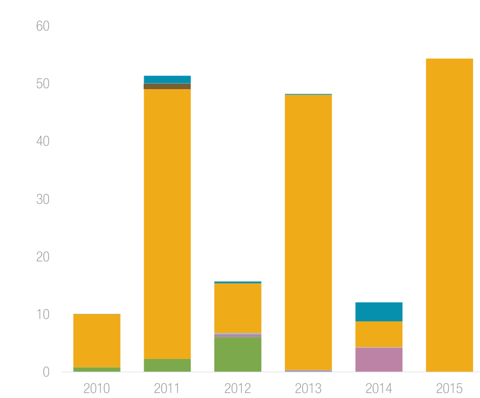
- International cooperation in GIBSE
- International cooperation in other sectors



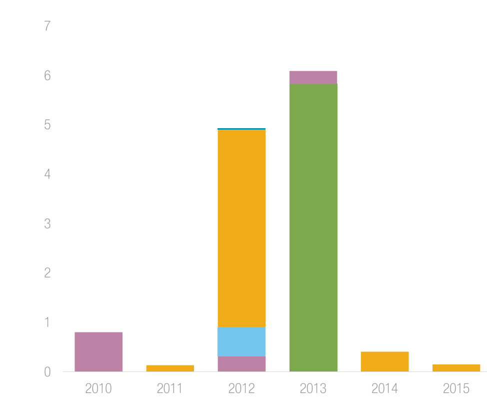
Thematic priorities of international cooperation related to GIBSE according to project approaches [Millions of USD per year]

Amazon Region / Andean Region / Caribbean Region / Orinoquía Region / Pacific Region / National

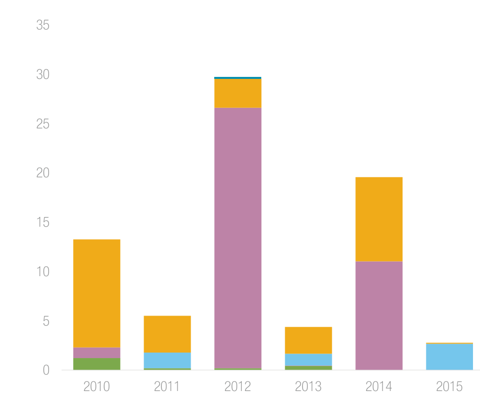
CONSERVATION



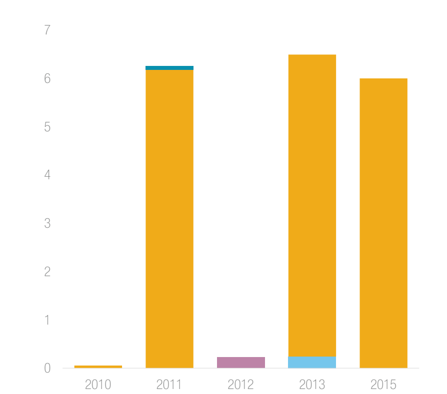
RESTORATION



DECISION MAKING



SUSTAINABLE USE



Institutions: a. *Agencia Presidencial de Cooperación Internacional de Colombia APC-Colombia*; b. *Investigación de Recursos Biológicos Alexander von Humboldt*; c. *Universidad del Rosario.*

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Environmental Compensations for the Loss of Biodiversity

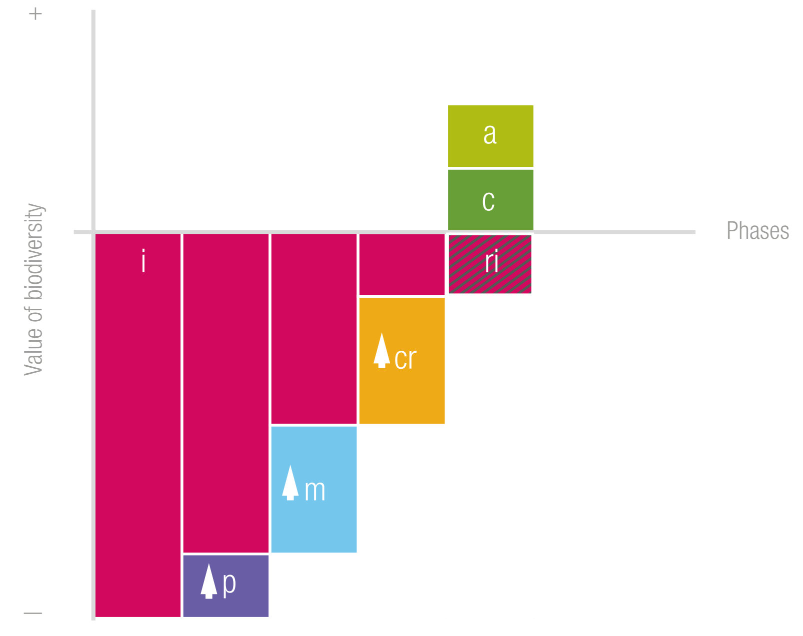
Germán Corzo[a], Marcela Portocarrero[a], and Luz Marina Silva[a]

ALTHOUGH IN COLOMBIA THERE IS A TOOL TO GUIDE LICENSED PROJECTS, THE *MANUAL DE ASIGNACIÓN DE COMPENSACIONES POR PÉRDIDA DE BIODIVERSIDAD* (MANUAL FOR THE ASSIGNMENT OF COMPENSATIONS FOR THE LOSS OF BIODIVERSITY--MACB FOR ITS INITIALS IN SPANISH), MULTIPLE TECHNICAL, LEGAL, AND PROCEDURAL DIFFICULTIES HAVE DELAYED THE FULFILLMENT OF SUCH OBLIGATIONS IN ENVIRONMENTAL LICENSES.

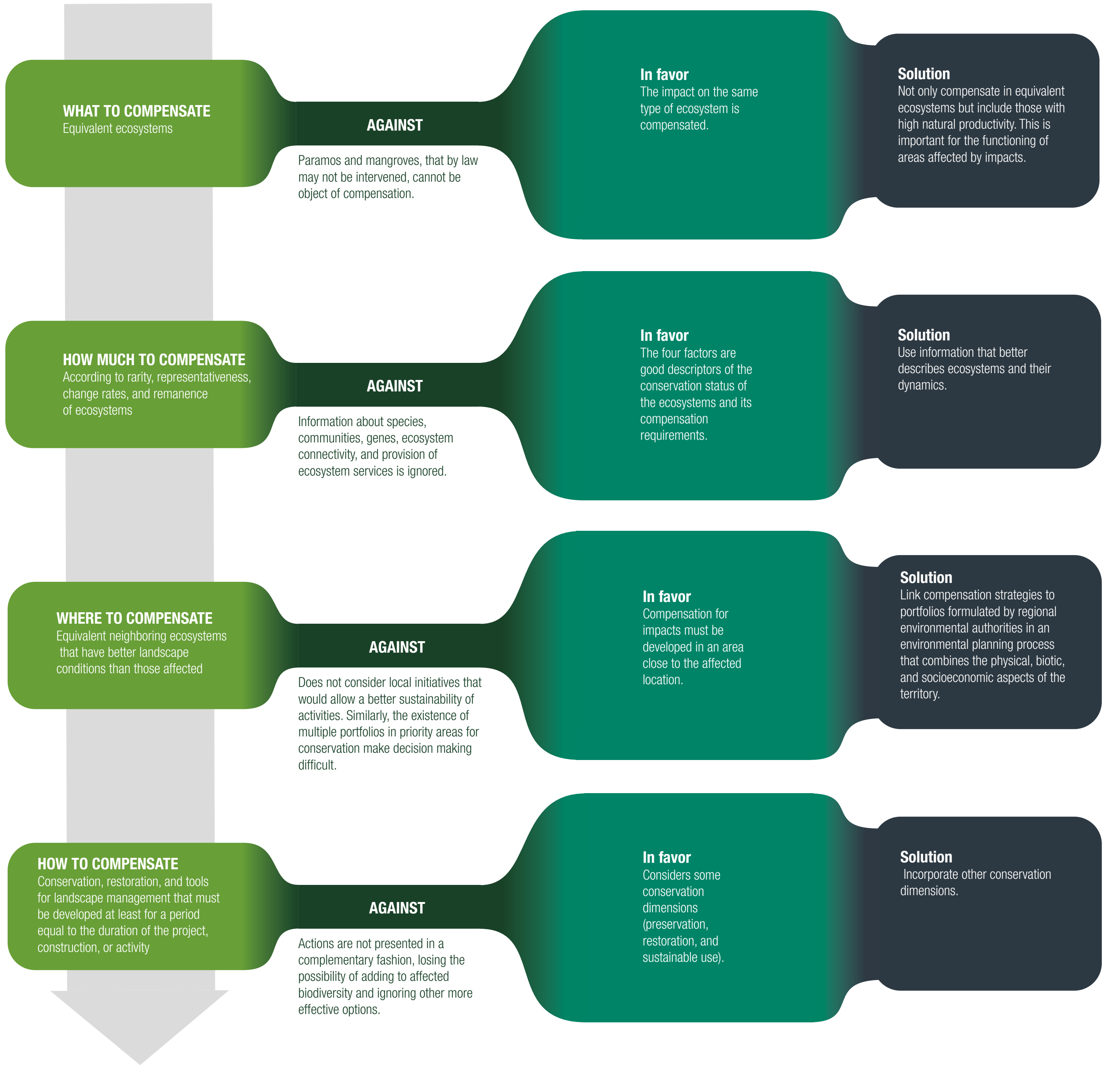
Environmental compensations, formalized in Colombia by the MACB (Resolutions 1517/12), aim to obtain measurable results for the conservation of biodiversity based on actions that compensate for residual impacts generated by development projects. Compensation actions should occur after appropriate preventions and implemented **mitigation** measures (avoid, correct, and mitigate) take place. The overarching goal is to produce zero net less of biodiversity[1].

However, four years after its formalization, neither licensed projects nor environmental authorities have been able to completely implement the actions defined in the MACB: conservation, restoration, and landscape management[2]. The purpose is to sever and update some conceptual paradigms and practices in relation to **reforestation** as a principal compensation mechanism, consolidating a novel and revolutionary methodology that answers the questions of what, where, how, and much to compensate in land ecosystems[3].

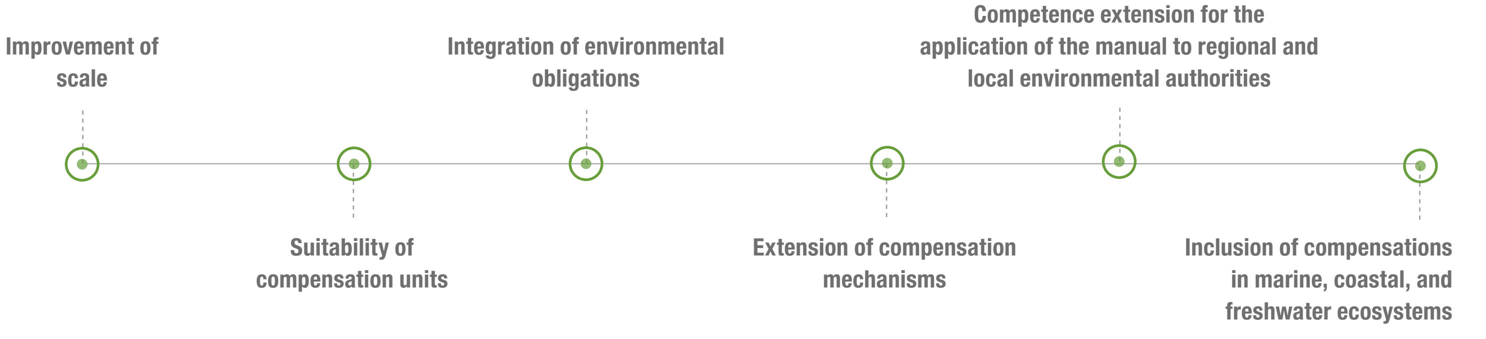
Phases previous to environmental compensation



- **i** **Environmental impact**: Effect of any human activity on the environment
- **p** **Prevention**: Actions to avoid negative impacts and effects on the environment that may be generated by a project, construction, or activity
- **m** **Mitigation**: Actions directed towards minimizing negative impacts and effects on the environment caused by projects, constructions, or activities
- **cr** **Correction**: Actions to recover, restore, or repair environmental conditions that were affected by a project, construction, or activity
- **ir** **Residual impact:** The damage that should be compensated is that which could not be avoided, minimized, repaired, or restored
- **c** **Compensation**: Actions to amend to communities, regions, localities, and the natural environment due to negative impacts and effects generated by a project, construction, or activity that cannot be prevented, corrected, or mitigated
- **a** **Additivity:** actions that add a new contribution to conservation that would not have been created without compensation



Currently the Ministry of Environmental and Sustainable Development is revising the following aspects to update the manual:



Reflections

- Include social components as part of the main axis of local reinforcement and effectiveness in developed mechanisms for biodiversity conservation
- Transition from static portfolios (maps) to spatial models (spatial databases) for decision making
- Ensure the zero net loss of biodiversity through the technical, legal, and administrative adjustments of the MACB, which make it a valuable instrument for this purpose
- Create application protocols for the involved actors to limit interpretations, decrease uncertainty, establish processes, and ensure cost effective compensations
- Emphasize the importance of monitoring as a feedback mechanism and the evaluation of zero net loss of biodiversity

Institutions: a. *Instituto de Investigación de Recursos Biológicos Alexander von Humboldt.*

Experimental design

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From Paramo Delimitation to Zoning and Monitoring the High Mountain

The case of the paramo complex Guantivo-La Rusia

Germán Corzo[a], Diego Córdoba[a], Nicolai Ciontescu[b], Hernando García[a], and Paola Isaacs[a]

It would be necessary to implement zonification and corroborate formulated integrated management guidelines in the field, as well as generate response indicators to monitor biodiversity under the supposition that ecosystem services are generated in a greater amount when there is a flux of matter, energy, and information in comparison to isolated ecosystems.

EVEN AFTER DELIMITING 21 PARAMO COMPLEXES IN COLOMBIA, PARAMO CONSERVATION IS NOT ENSURED. PARAMOS MUST BE INTEGRATED INTO THE SURROUNDING TERRITORY, AND THEY SHOULD BE UNDERSTOOD AS INTERDEPENDENT ECOSYSTEMS THAT ARE NOT SELF-SUSTAINABLE BIOGEOGRAPHICAL ISLANDS.

As part of conserving paramos and their associated ecosystem services, these ecosystems have been delimited in detail. Yet these endeavors are insufficient for the protection of the ecosystems, for processes of integrated biodiversity management in broader contexts that include ecosystem gradients such as the high mountain are yet to be created.

With this purpose, the Humboldt Institute and the Ministry of Environment present a methodological proposal that uses as a case study the paramo complex Guantiva-La Rusia and includes variables of "status" and "pressure" that represent the conservation status and anthropic threats of the ecosystems. Based on this, guidelines for management, such as social and institutional responses, are formulated for evaluation, feedback, and monitoring to determine their effectiveness.

The hypothesis for high mountain integrity at a semi-detailed scale (1:100,000) is generated based on landscape metrics and ecological connectivity. This is how paramos are integrated with surrounding ecosystems and an ecological structure is ensured to guarantee ecosystem functionality and the offer of ecosystem services. At this point more detailed information may be generated based on developed hypotheses.

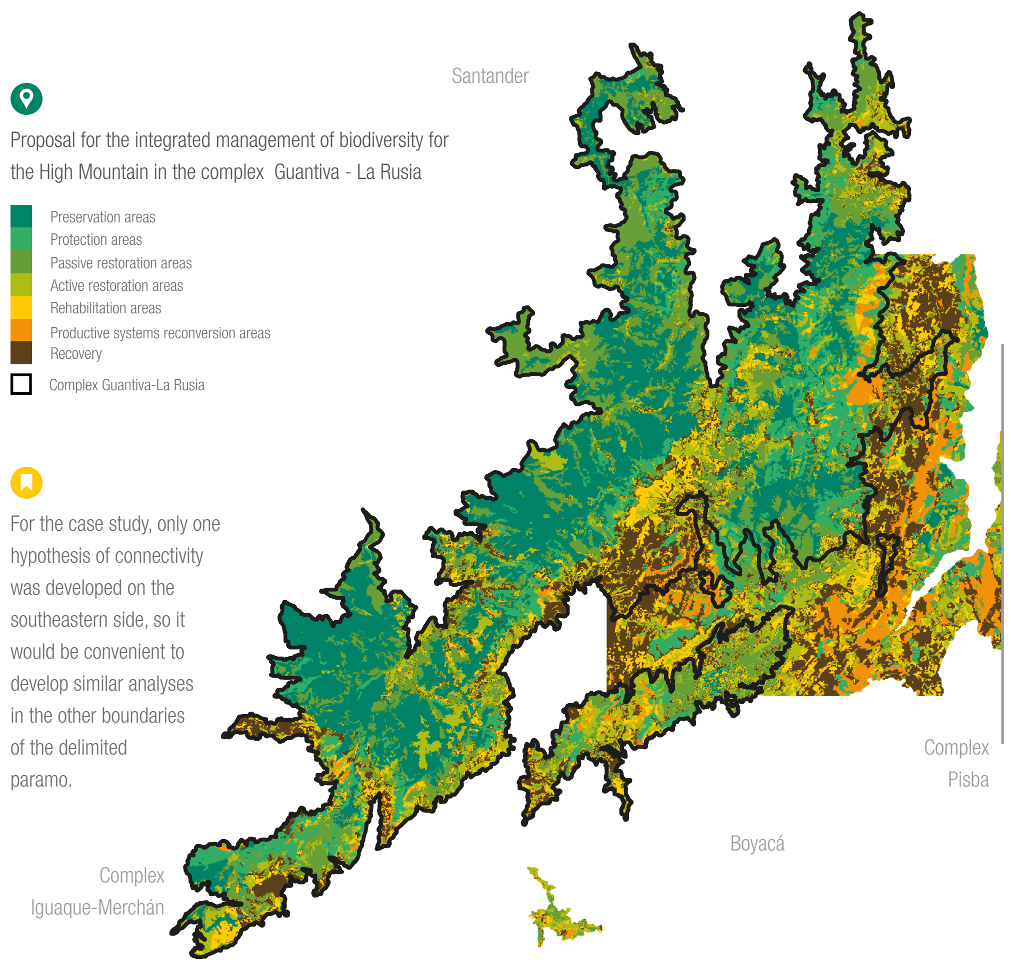
Posteriorly, using a land covers analysis, the conservation status of involved ecosystems is estimated at a 1:25,000 scale. Therefore the status of the paramo complex is determined by indicators of composition (total area of the fragment, area and shape of the nucleus) and configuration (distance between fragments) according to the landscape matrix.

The biophysical conditions of surrounding areas and the access that human populations have to natural remnants represent an opportunity for extracting natural resources and thus altering the natural system. In this sense, variables that allow for the identification of pressures in those areas where threats to ecological processes exist must be incorporated. Consequently, indicators of intensity of use (distance to roads and settlements, land use types, and fragmentation) and biophysical vulnerability (fertility and slope) are included in order to evaluate pressures on the ecosystem.

Finally, ecological integrity is estimated based on the status of the fragment and anthropic pressures or human impact. This result leads to the formulation of management guidelines for the areas assessed, using as a framework the established conservation dimensions proposed by the Convention on Biological Diversity (preservation, restoration, and sustainable use) and the particular governance norms of Colombia.

Proposal for the integrated management of biodiversity for the High Mountain in the complex Guantiva - La Rusia

- Preservation areas
- Protection areas
- Passive restoration areas
- Active restoration areas
- Rehabilitation areas
- Productive systems reconversion areas
- Recovery
- Complex Guantiva-La Rusia



For the case study, only one hypothesis of connectivity was developed on the southeastern side, so it would be convenient to develop similar analyses in the other boundaries of the delimited paramo.

CASE STUDY COMPLEX GUANTIVA - LA RUSIA.
Guantiva - La Rusia was the paramo complex selected due to its multiple social-ecological conflicts (conservation, agricultural uses and mining), the forms in which the territory is used, and the particularity of its spatial configuration of two slopes with climatic differences. With approximately 120,000 ha, this complex was one of the 21 complexes delimited by the Humboldt Institute. In this study, about 130,000 of key surrounding areas were assessed in terms of ecosystem connectivity. It was evidenced that at least a third of the total extension of the complex is under good natural conditions and low anthropic pressure (human footprint low and very low) and additionally counts with guidelines for ecosystem preservation and protection. 21 % of the area is in categories of restoration (medium and high human footprint). In these areas practices should seek the recovery of original ecosystem conditions. The remaining 50 % should be destined for processes of rehabilitation, recovery, conversion of productive systems and landscape management tools so that ecosystem functionality and the supply of ecosystem services may be improved.

Preservation areas, those with high ecological integrity and low levels of threat. Will be used as conservation nodes to ensure the survival of biodiversity and flow of ecosystem services. There may be an "intangible" form that should not be transformed by any activity (inside delimited paramo) and a "primitive" form outside the delimited paramo.

Protection areas, those with high ecological integrity but under growing anthropic threat. In such areas strategies for control of threats will predominate strictly inside paramos and as a proposal outside of the delimited paramo.

Areas of passive restoration, those with intermediate level of ecological integrity but with low or null anthropic footprint. They are near areas of protection and still maintain most ecosystem services, being at a pre-disturbance status inside the paramo and ensuring functionality outside ot these ecosystems through tools such as fragment isolation.

Areas of Active Restoration, those with low levels of ecological integrity and low or medium anthropic footprint. In these areas there are changes in the use of the land, enrichment and intervention of zones inside the paramo through landscape management tools outside the paramo, unsustainable uses are limited, and strategies of payment of ecosystem services are encouraged by conservation agreements. Such areas must be used as biodiversity connectors and ecological and ecosystem services corridors.

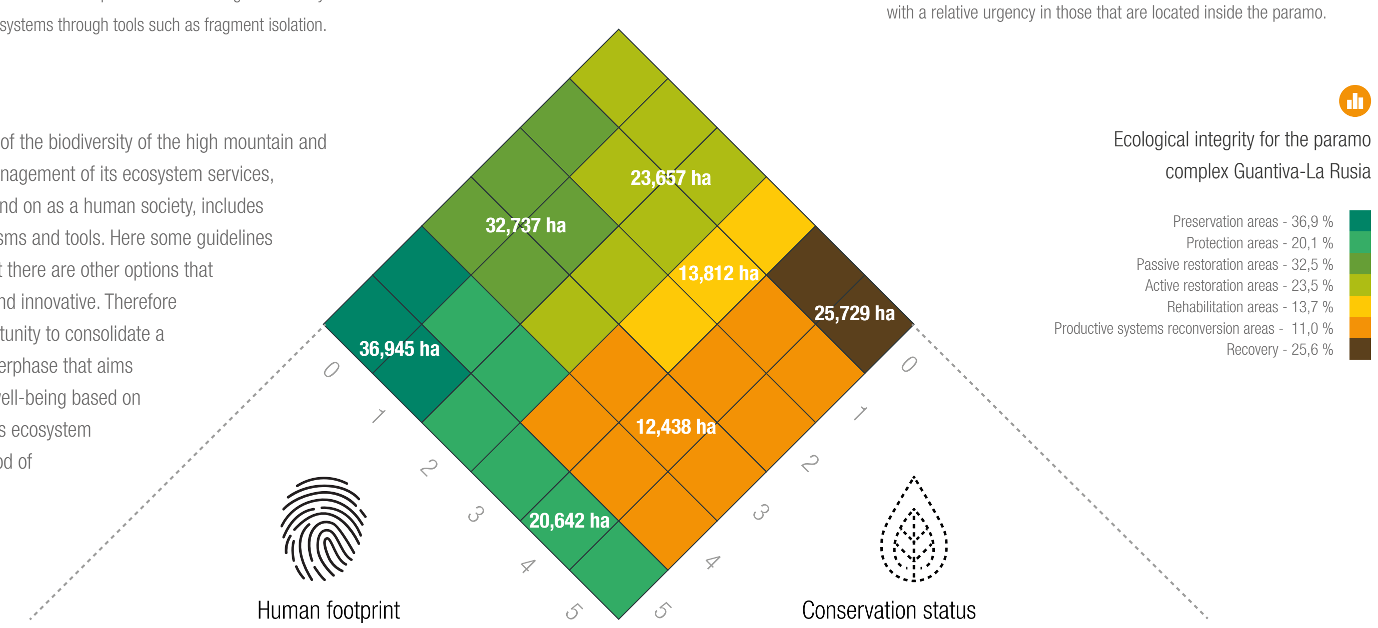
Rehabilitation areas, those with low and medium levels of ecological integrity but with intermediate anthropic footprint. These areas depend on levels of transformation in terms of stresses and disturbances. In these areas the goal is to recover ecosystem. functionality urgently for the zones inside of the delimited paramo and in an opportune manner for those outside.

Productive systems reconversion areas, those with intermediate levels of ecological integrity but high anthropic footprints. These are areas destined to the reconversion of unsustainable productive systems and they suppose processes of ecological planning for connectivity according to levels of transformation. At least those areas inside the paramo are preponderant in the recovery of ecosystem services.

Areas of recovery, those with low levels of ecological integrity and high anthropic footprint. These areas have been submitted to high levels of degradation where some ecosystem services and landscape functionality are sought to be recovered. For the zones both outside and inside paramos, processes need interventions of greater complexity, but with a relative urgency in those that are located inside the paramo.

The conservation of the biodiversity of the high mountain and the integrated management of its ecosystem services, of which we depend on as a human society, includes multiple mechanisms and tools. Here some guidelines are presented, yet there are other options that are more broad and innovative. Therefore there is the opportunity to consolidate a science-policy interphase that aims towards human well-being based on biodiversity and its ecosystem services in a period of reconciliation.

Ecological integrity for the paramo complex Guantiva-La Rusia



Institutions: a. *Instituto de Investigación de Recursos Biológicos Alexander von Humboldt*; b. *Independiente*.

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Ecological Restoration

A political and normative perspective

Mauricio Aguilar-Garavito[a], Sylvia Schlesinger[a], Wilson Ramírez[a], Ana María Hernández[a], and Alejandra Franco Morales[b]

Milestones and events of ecological restoration in Colombia

Normative or political milestone
Politics
Legislation
Academia

Law 23 of 1973

Improve, conserve, and restore

Decree-Law 2811 of 1974

Preservation, restoration, and rational use (Art. 2). Declaration of areas and incentives for restoration.

I. "Restoration for controlling pollution, protecting the environment, and improving, conserving or recovering renewable natural resources".

Political Constitution of Colombia 1991

Art. 80: State planification of conservation, restoration, or substitution

Art. 95: People are responsible for the protection of the ambiental resources

Law 99 of 1993

Number 1 Art.1: General environmental principles

Art. 5 The Ministry of Environment regulates the restoration and recovery of natural resources

Art. 68 Territorial entities must plan and guarantee restoration

Art. 108. National acquisition of territories for restoration

Art. 50: Beneficiaries of environmental licences should prevent, mitigate, correct, compensate, and manage all environmental effects of the authorized activity.

Law 164 of 1994

Land rehabilitation plans

United Nations Framework Convention on Climate Change is acknowledged

Law 165 of 1994

Art. 8, paragraph: Stimulation to ecological rehabilitation and restoration

Adoption about Convention on Biological Diversity

National Biodiversity Policy

Law 357 of 1997

Wetland restoration

Adoption of Ramsar Convention

II. "A healthy environment as a fundamental right for everyone."

Technical and scientific definition of ecological restoration SER 2002

Law 1333 of 2009

Compensatory measures for restoration of affected areas

Decree 2372 of 2010

Art. 2. Point E. Defines ecological restoration in legal system

National Development Plan 2010-2014

Ecological restoration of 90,000 ha

National Policy for the Integrated Management of Biodiversity and its Ecosystem Services

Strategic plan for Diversity Biological 2011-2020

Aichi Targets (14 and 15)

Resolution 1517 of 2012 of the Ministry of Environment

Adopts manual for assignments of compensations for loss of biodiversity based Article 80 of Constitution of 1991

National Development Plan 2014-2018

Ecological restoration of 210,000 ha

CBD 2016

Recommendation 20/12 International political definition for ecological restoration

III. "Ecological restoration is defined in scientific, political, and legal terms, goals are established, and it is defined how and where restoration processes may be implemented. Also, guidelines about how to approach restoration are given and attributes of restored ecosystems are established."

Ecological restoration in sustainable development and green growth

Sustainable Development Goals (SDGs) as a product of the United Nations Conference on Sustainable Development of 2012 (UNCSD) or Río +20

National Policy for the Integrated Management of **Biodiversity and;** its Ecosystem Services **(PNGIBSE)**

National Development Plan 2014-2018

Implementation of **compensation measures** for the loss of biodiversity

Measure of **adaptation to climate change** in the París Agreement of 2015

Restoration goals for Colombia

National Development Plan 2010-2014 restore **90,000** ha

National Development Plan 2014–2018: restore **210,000** ha

BONN challenge, 20 X 20 Iniciative: restore **1,000,000** ha. for the year **2020**

Convention on Biological Diversity-Restoration Program Aichi Target 15: **15 %** of degraded areas for the year **2020**

According to the National plan of restoration, Colombia has **23,339,878** ha in some state of damage, degradation, or destruction[5], Ecological restoration (AICHI target 15) represents approximately **3,500,972 ha.**

ECOLOGICAL RESTORATION IS A WORLDWIDE PRIORITY[1], AND COLOMBIA REPRESENTS AN UNIQUE OPPORTUNITY TO CONTRIBUTE TO THE MITIGATION AND ADAPTATION TO CLIMATE CHANGE. IT MAY ALSO BE APPLIED IN THE POST-CONFLICT TO ATTAIN ECOSYSTEMS THAT ARE BETTER PRESERVED IN DEGRADED OR ABANDONED PRODUCTIVE LANDS AND AREAS OF GREATER DEGRADATION, DAMAGE, OR DESTRUCTION.

In Colombia, the concept of **ecological restoration** has been developed in technical, scientific, political, and normative terms. Ecological restoration has been related to both external and internal dynamics, and, legally, the term of ecological restoration was adopted in the decade of the 70s. In that time, it was related to a conservationist and ruralist philosophy in which actions included **reforestation** and control of environmental pollution. Additionally, the management of conservation, the improvement of the environment, and restoration highly depended on the State. Thanks to the Political Constitution of 1991, ecological restoration was involved in national norms to a greater extent since that time, and norms and jurisprudence gave way to modernized public policies. Under the notion of sustainable development, the right to enjoy a healthy environment as an essential part of human development was recognized. Consequently, it was established that the State must develop conservation actions associated with sustainable use, knowledge of biodiversity, and ecological restoration.

In technical and scientific spheres, the term of ecological restoration is globally known since the second half of the 20th century due to the work of the Society for Ecological Restoration (SER): in 2002[2] a scientific declaration of the principles, definitions, and guidelines was presented. In the political scenario, more than 20 years ago various conventions and multilateral environmental agreements have recognized the crucial role of restoration to accomplish commitments. Some examples are the Convention on Biological Diversity (CBD), United Nations Convention to Combat Desertification (UNCCD), and the Ramsar Convention on Wetlands of International Importance. However, only until 2016 was an unified definition on the term reached at a political global level, marking a difference with other closely related terms such as rehabilitation, creation of new landscapes or ecological features, recovery, substitution, and improvement.

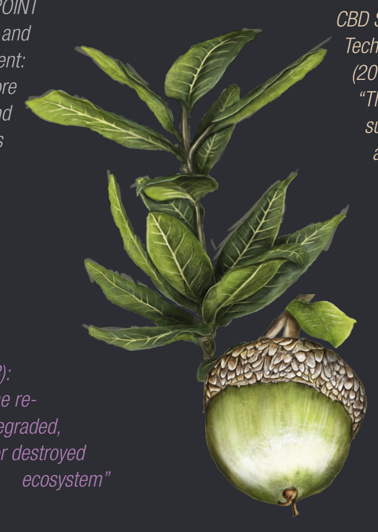
Beginning the 21st century, the definition for ecological restoration had a better political and normative development in Colombia since it was adopted by the Decree 2372 of 2010. This development was also due to the creation of the *Plan Nacional de Restauración* (National Plan for Restoration-PNR for its initials in Spanish). In a parallel fashion, scientific, technical, and technological knowledge in the subject has increased, as have thematic networks that generate spaces for strengthening capacities, having discussions, and exchanging restoration experiences.

Definitions of ecological restoration (ER)

Decree number 2372 of 2010. CHAPTER 1, ARTICLE 2, POINT E. Ministry of Environment and Sustainable Development: "Partially or completely restore the composition, structure, and function of biodiversity that has been altered or degraded"

CBD Scientific, Technical and Technological Subsidiary Body (2016). Recommendation 20/12: "The process of managing or supporting the recovery of an ecosystem that has been degraded, damaged, or destroyed, as a way to support ecosystem resilience and conserve biological diversity"

Society of Ecological Restoration (SER): "Process of aiding the re-establishment of a degraded, damaged, or destroyed ecosystem"



VU
Oak
Quercus humboldtii

Prospects and challenges of ecological restoration

7 A social change: "from the culture of degradation and war to the culture of ecological restoration and peace".

6 Establish Ecological Restoration processes with feasible objectives and goals and a social and ecological base.

5 Attainment and assignment of financial, logistic, and human resources in a efficent and timely manner.

4 Make the National Restoration Plan binding as well as apply and update other normative and sanction instruments.

3 Encourage the exchange of experiences, strengthening of capacities, and dialogue.

2 Develop science and practices of ecological restoration with all the basic phases of a process of ecological restoration: research, diagnosis, implementation, monitoring, and social participation.

1 Understand ecological restoration as a broader concept and at appropriate scales.

More information about prospects and challenges of ecological restoration available online

Instituciones: a. *Instituto de Investigación de Recursos Biológicos Alexander von Humboldt;* b. *Universidad Libre.*

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Freshwater Ecoregions of Colombia

Territorial planning for the Andes region and part of the Amazon and Orinoco

Lina M. Mesa-S[a], Germán Corzo[a], Olga L. Hernández-Manrique[b], Carlos A. Lasso[a], and Germán Galvis[b]

IT IS POSSIBLE TO INTEGRATE A DYNAMIC AND CONTINUOUS PERSPECTIVE ABOUT FRESHWATER ECOSYSTEMS WITH FISH SPECIES COMPOSITION AND GEOMORPHOLOGY IN ORDER TO CONSTRUCT FRESHWATER ECOREGIONS. ALTHOUGH SOME HYDROGRAPHIC LIMITS ARE CHANGED WHEN THE HISTORIC DISTRIBUTION OF SPECIES IS REINTERPRETED, THIS INTEGRATION ENSURES THE EFFECTIVITY OF CONSERVATION.

The folded topography of the Andes makes of Colombia a geographically heterogeneous country and creates a hydrographic network that combines basins of different dimensions, **physiography**, and types of water. It may divided into four water catchments: Caribbean, Pacific, Orinoquia, and Amazon. As the institution in charge of zoning the country's hydrography, the *Instituto de Hidrología, Meteorología y Estudios Ambientales* (Institute of Hydrology, Meteorology, and Environmental Studies-Ideam) classifies and prioritizes units of analysis for the planning and management of water resources based on regional **basin** borders and only in terms of political divisions to manage basins by sections[1].

A regional classification of **freshwater ecosystems** that combines both geographic and biological criteria does not exist for Colombia despite its utility in understanding the territory and defining conservation and management strategies. Within an ecoregion, species, ecological dynamics, and environmental conditions are more similar than surrounding ecological regions; therefore an ecoregion itself is a unit of conservation.

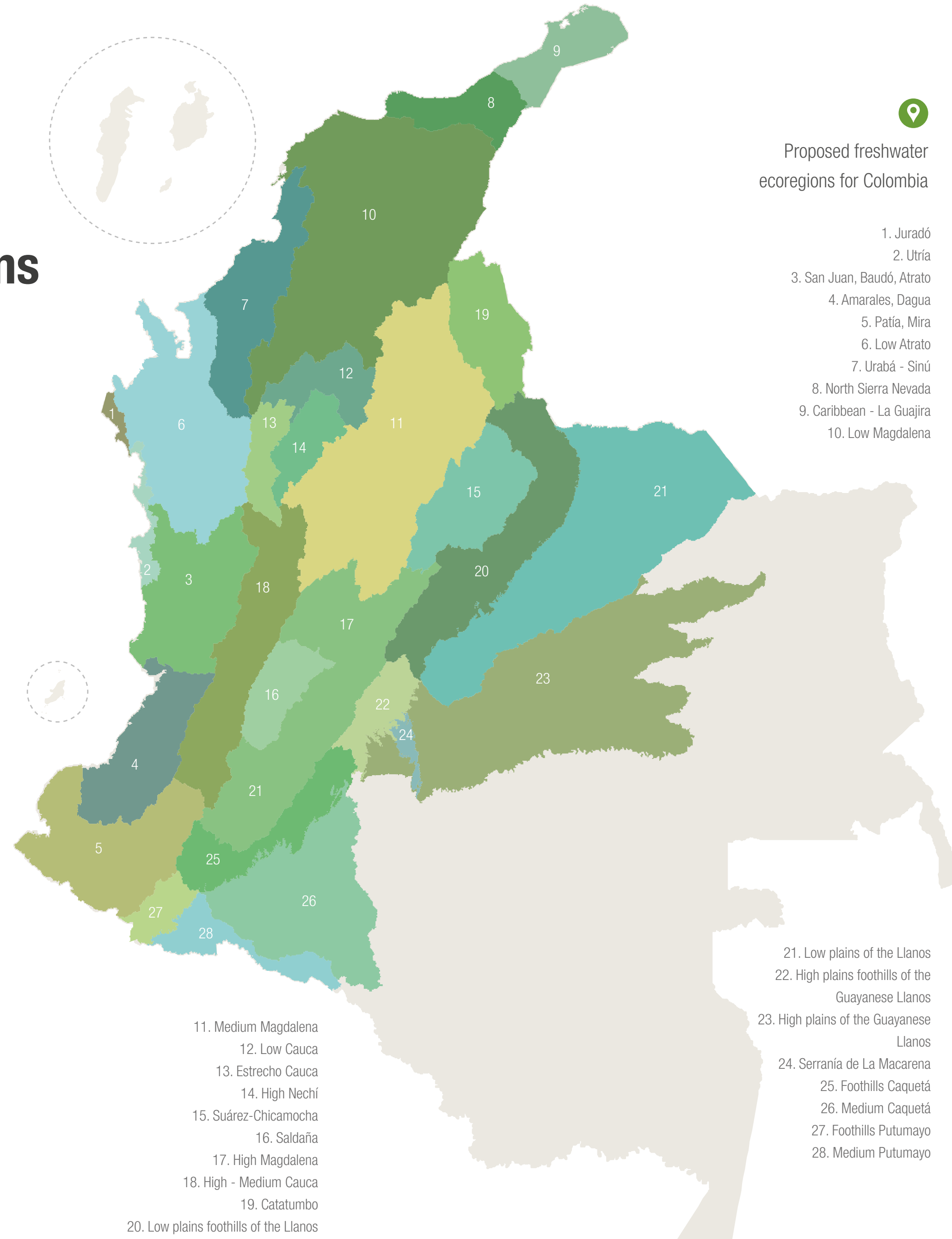
At a global scale, there is a proposal of defining ecoregions in freshwater ecosystems[2]. This proposal makes evident that regionalization exercises are important for establishing freshwater protected zones and highlights the inexistence and precariousness of appropriate models for protection measures. While managing these models globally, practically all **biogeographical** particularities of Northern South America are excluded.

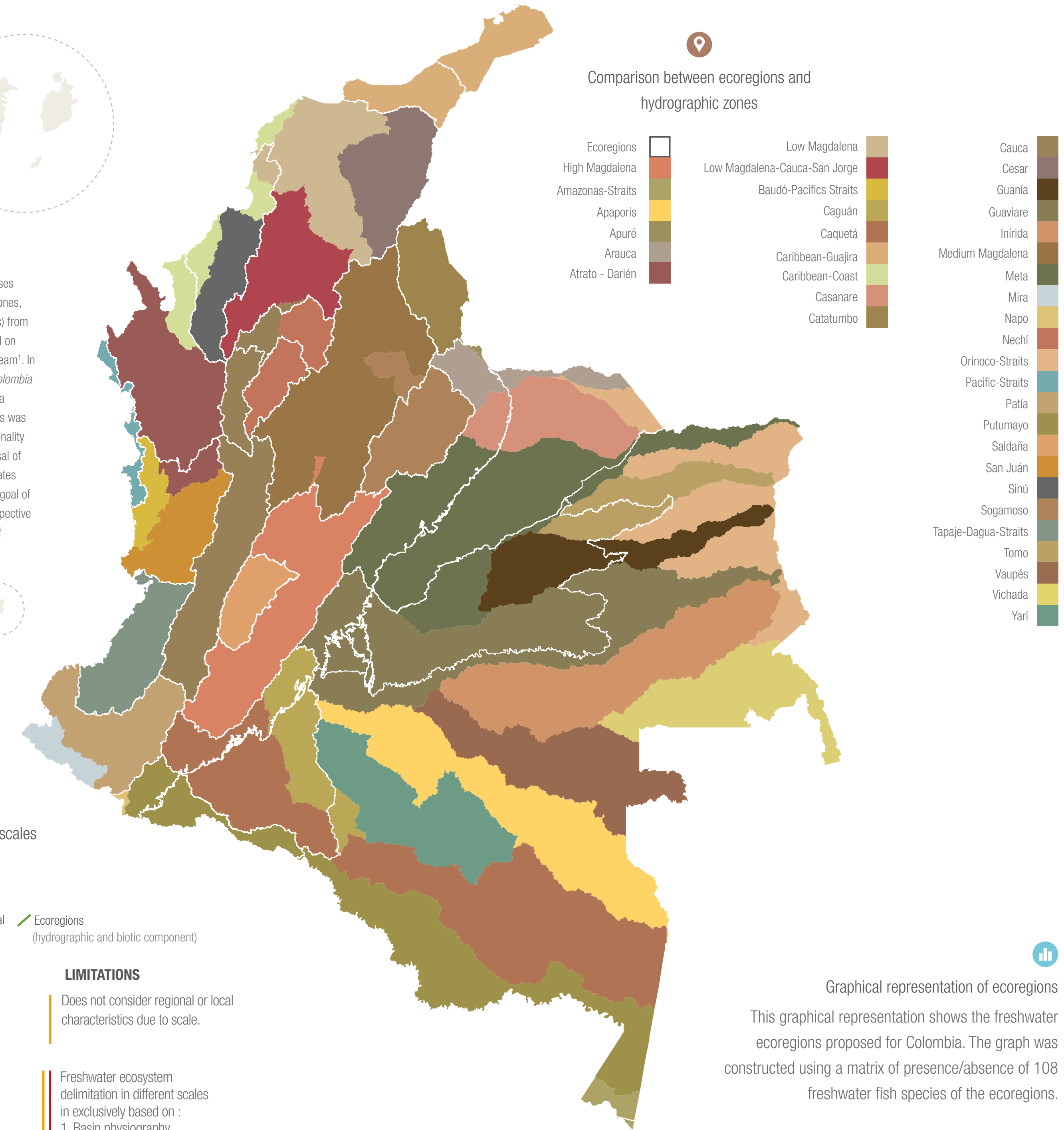
In this proposal, the established hydrographic zones[3] were regrouped according to the composition of fish species, interpreted **drainage network**, and **geomorphological** characteristics of the basins.

In addition, the fish composition and associated geographical attributes were considered as an identity indicator for each ecoregion. 28 freshwater regions are proposed[4], all of which are grouped into two big regions (Trans-Andean and Cis-Andean) and four water catchments. These identified regions may be used in territorial planning, and, according to the proposed conservation goals, may be subdivided altitudinally where there is a differential fish species composition or particular jurisdictions. This tool may be especially useful when defining protected areas or in response to the four levels of territorial planning that link hydrographic basins (large basins and national order plans, hydrographic zones and basins where land use planning and environmental management of hydrographic basins) are developed, small basins, and aquifers)[1].

The greatest differences related to recognized hydrographic zones in Colombia are in species composition and the geomorphology that limits distribution. It is important to recognize the existence of geomorphology, how it shapes the territory, and that it is posterior to the establishment of geoforms in order to understand that fish distribution depends of the relief of the surface and limits of rivers. However, shared distributions and species characteristics are illustrative of historic processes. In conclusion, to create a robust territorial management proposal, geology and hydrology must be integrated in initial phases and biogeography must be verified, complemented, and discussed using as a base the distribution of fish species.

The proposal of ecoregions gives a more complete vision about the territory since it includes an ecological study and the natural histories of some organisms. Approaches such as this one would be greatly useful for territorial planning exercises, conservation plans of aquatic resources, and plans for **environmental compensations** in freshwater ecosystems.





In hydrographic planning exercises 4 levels are combined (areas, zones, subzones, small basins-aquifers) from a national to a local scale based on information generated by the Ideam[1]. In 2015, with the experience of *Colombia Anfibia*[5] (Amphibian Colombia), a dynamic delimitation of wetlands was achieved by including the seasonality of flood fluctuations. The proposal of freshwater ecoregions incorporates biological components with the goal of having an ecosystem-level perspective of the freshwater ecosystems of Colombia in a regional scale.

Ecosystem delimitation scales for their management

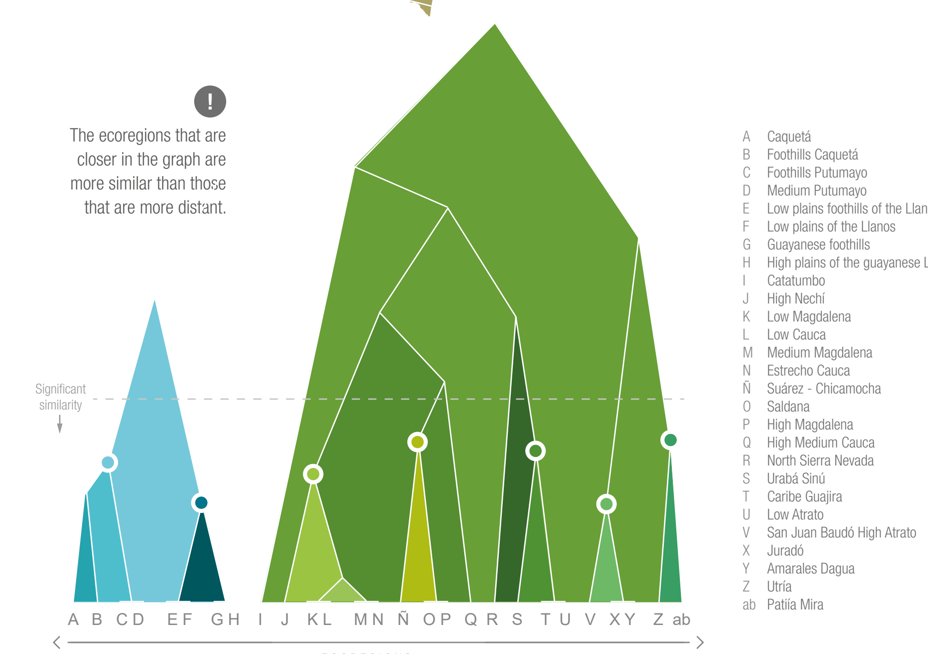
National | Regional-local | Ecoregions (hydrographic and biotic component)

REACHES	LIMITATIONS
Updated cartography of the dynamic and nature of Colombian wetlands.	Does not consider regional or local characteristics due to scale.
Strategic planning with a large basin perspective and national reach.	Freshwater ecosystem delimitation in different scales in exclusively based on : 1. Basin physiography 2. Weak integration of biotic component in territorial units of analysis. 3. Robust information on physical variables but low resolution on biotic data. 4. This causes a bias when interpreting the ecological trends of wetlands. Lack of homogeneous biological information at different scales. This impedes publication of results.
Geopolitical limits that allow for the specific management of the territory through land use planning.	
Descriptive information based on the characterization of different biotic components for particular areas.	Fragmented approach to basins and the hydrological continuum when planning recognizes political and administrative boundaries.
Broadens strictly hydrographic limits to favor a more holistic vision of ecosystems.	The boundaries of proposed ecoregions consists of divisions in the water due to the scale considered (1:100,000), responds to expectations at a regional scale, and the trans-Andean orography made subdivision by altitude difficult.
Through including biological components that contribute with appropriate limits on land use planning and management.	

Graphical representation of ecoregions

This graphical representation shows the freshwater ecoregions proposed for Colombia. The graph was constructed using a matrix of presence/absence of 108 freshwater fish species of the ecoregions.

The ecoregions that are closer in the graph are more similar than those that are more distant.



Institutions: a. *Instituto de Investigación de Recursos Biológicos Alexander von Humbold*; b. *Independiente*.

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Cattle Raising and Floodplains

A production and conservation alternative: The case of Paz de Ariporo, Casanare

Elcy Corrales[a] and Olga Nieto Moreno[b]

IN AN ECOSYSTEM OF HIGH HYDROCLIMATIC AND GEOMORPHOLOGIC VARIABILITY, AS ARE THE FLOODPLAINS OF THE ORINOQUIA, SOCIAL ACTORS HAVE DEVELOPED CATTLE RAISING SYSTEMS BASED ON THE ADAPTIVE EXPLOITATION AND USE OF BIODIVERSITY. THIS TYPE OF CATTLE RAISING ENSURES PRODUCTION PROCESSES THAT MAY SUPPORT COMMUNITIES AND ARE ALSO COMPATIBLE WITH THE CONSERVATION OF BIODIVERSITY.

In the floodplains of the Orinoquia the marked hydroclimatic variability determines resource availability and seasonality, as well as the dynamics of wildlife and human activities[1,2]. The plains, in general, and the floodplains in particular, are ecosystems that have high species richness[3] but are not yet included as areas to be conserved in Colombia[3, 4, 5, 6].

Since a long time ago, the cattle raising system has been established as one of the major economic activities in floodplains. It represents an example of an adaptation process by inhabitants of the area to its natural resources and ecological dynamics[1,7]. Currently, cattle raising in the floodplains of the Casanare represents the most essential part of its economy and is the third largest producer of cattle in the country[8]. Complementary activities in the region that adjust to cattle raising dynamics include crops for basic feeding, fishing, and the exploitation of wild fauna[1,9].

This type of cattle raising is based on an extensive use of the territory in which there is a varied and nutritive natural offer of forage and water management that enables the maintenance of a low animal density[1,10]. The system is supported by a detailed local knowledge about the different parts of the territory and the use of available resources according to ecosystem seasonality and the geomorphological characteristics of the plains.

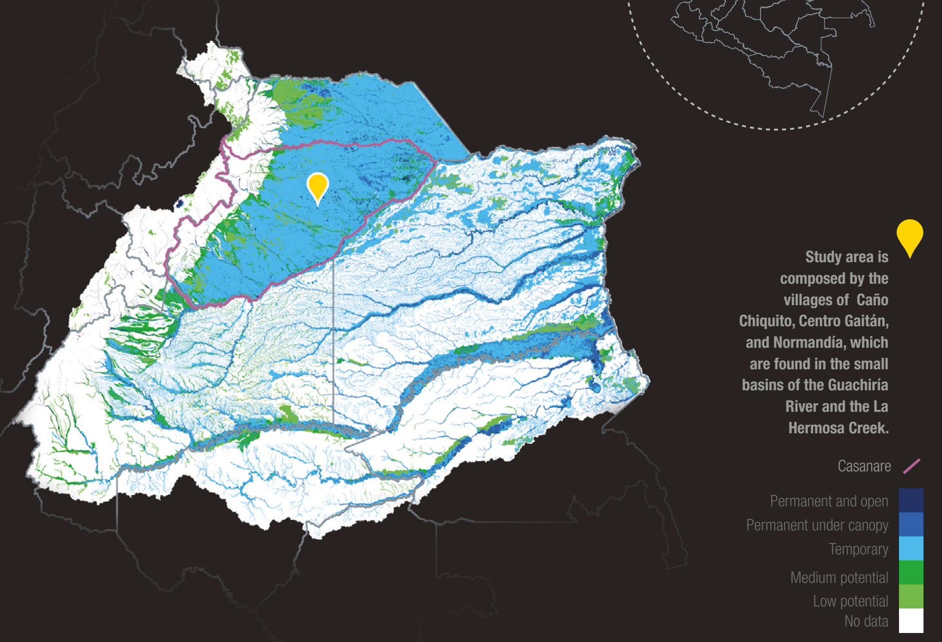
During the last 40 years, economic activities such as the exploration and extraction of hydrocarbons, and more recently the agroindustrial production of flooded rice fields, have become the major drivers of change[1] in floodplains, representing other ways of understanding the territory and forming new socio-economic interactions between existing actors. These drivers of change have significantly transformed the landscape, exerting a greater pressure on resources and generating various environmental issues related to the ecosystems, their services, and the quality of life of the people living there.

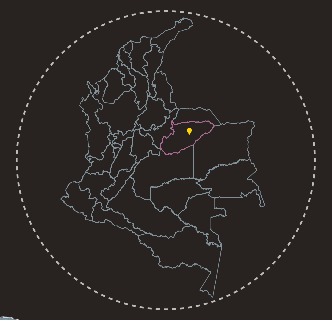
Based on the socio-ecological characterization of floodplains in Paz de Ariporo, developed between the Humboldt Institute and the *Pontificia Universidad Javeriana* (Pontifical Xaverian University) it was determined, among other things, that productive agricultural practices of basic foodstuffs and the form of cattle raising are similar because they are based on the exploitation of floodplains. The forms of use that these ecosystems offer are closely related to intrinsic hydroclimatic and geomorphological conditions.

Two visions regarding the future of floodplains exist: one perceives the ecosystem as a rich shelter for resources that may and should be conserved without excluding their productive use whereas the other seeks to increase productivity on the short run, transforming the ecosystem and ignoring local knowledge, intrinsic characteristics, biodiversity and strategic ecosystem importance[1,3]. That is how tensions around the current and future management of the territory emerge and involve local actors, environmental authorities, and government entities at different scales[1].

In the present, local alternatives to production and conservation have been created. Based on the dialogue between local and scientific knowledge, and using figures such as natural reserves of the civil society, natural corridors, or areas of conservation of wild species, strategies of sustainable cattle raising have been developed. Two examples are water gathering and good practices in rice production[14]. Additionally, many regional and global initiatives exist. An example is the *Alianza para Conservación de Pastizales* (Alliance for the Conservation of Grasslands), which works in the temperate plains of many countries of South America and now also in Colombia[15].

Floodplains of the Colombian Orinoquia





Spaces of use and uses associated to floodplains

The dynamics of uses in space is reflected in the use of a) river banks, which remain dry in winter[6] and cattle is sheltered in time of rain, b) lowlands adjacent to river banks, which are permanently flooded and hold visible grassland in winter[6] and contribute to foraging in that season, and c) tidelands, permanent bodies of water with greater depths that are essential for cattle due to the supply of "natural water" during the summer[6,10].

Diagram of interactions between actors, resources, and spaces of use in the floodplains during the transition between the dry and wet seasons.

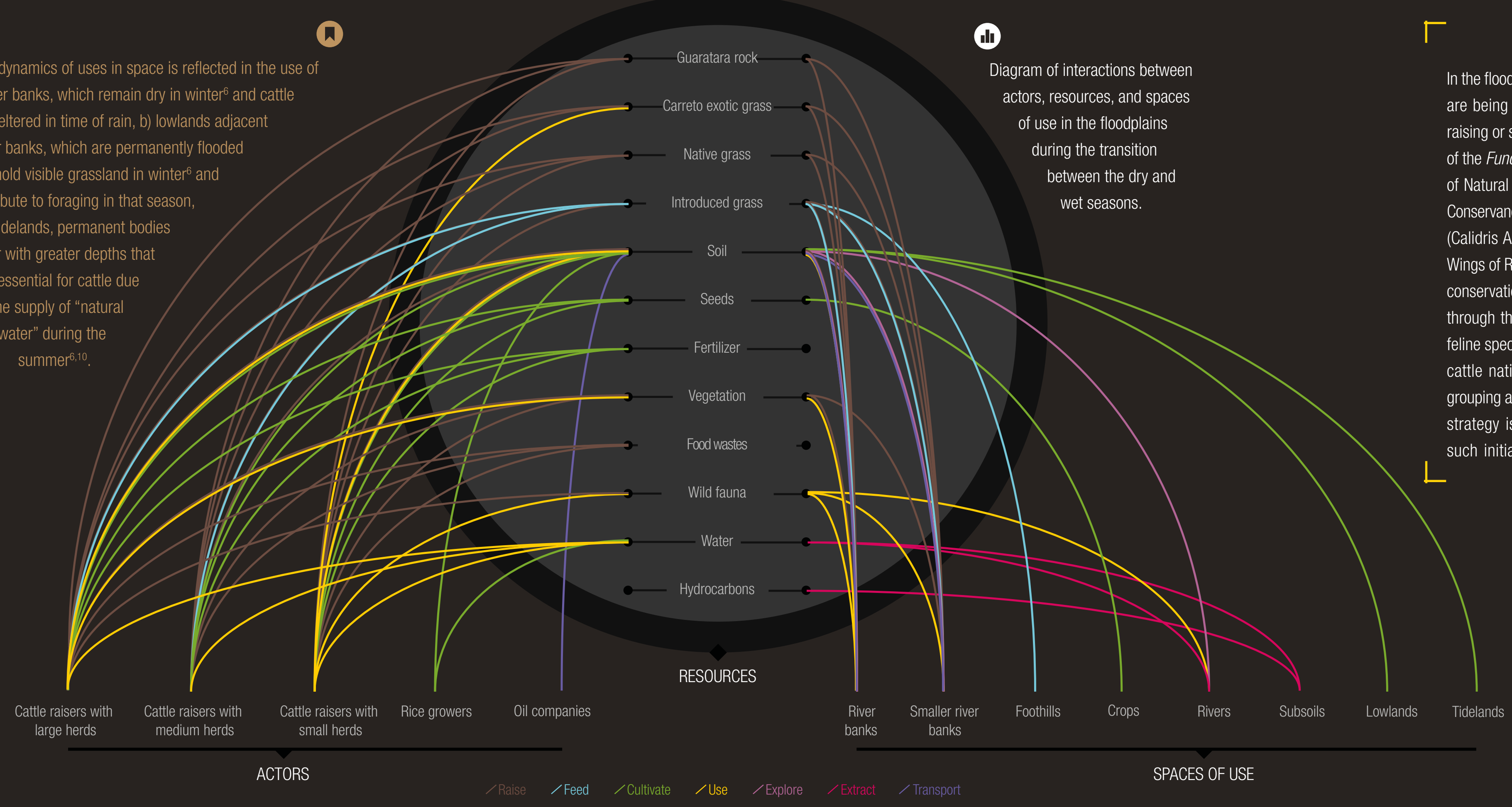
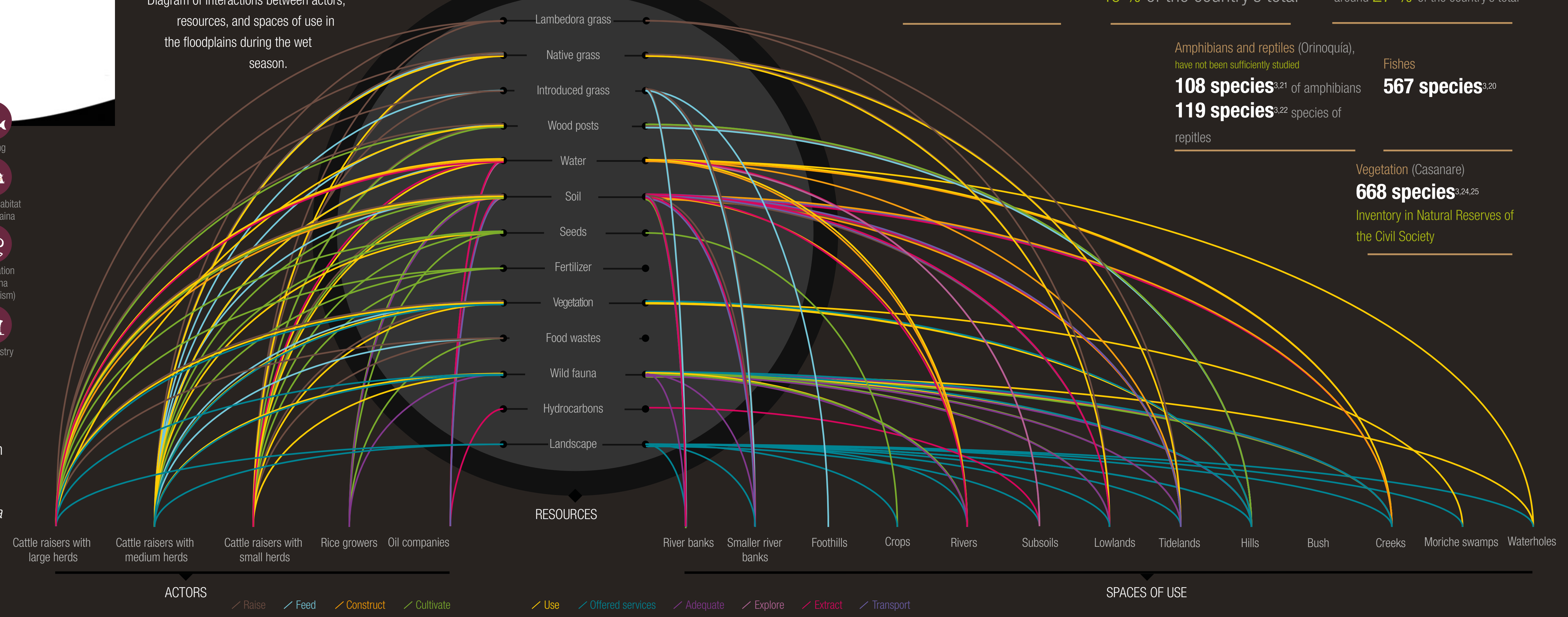
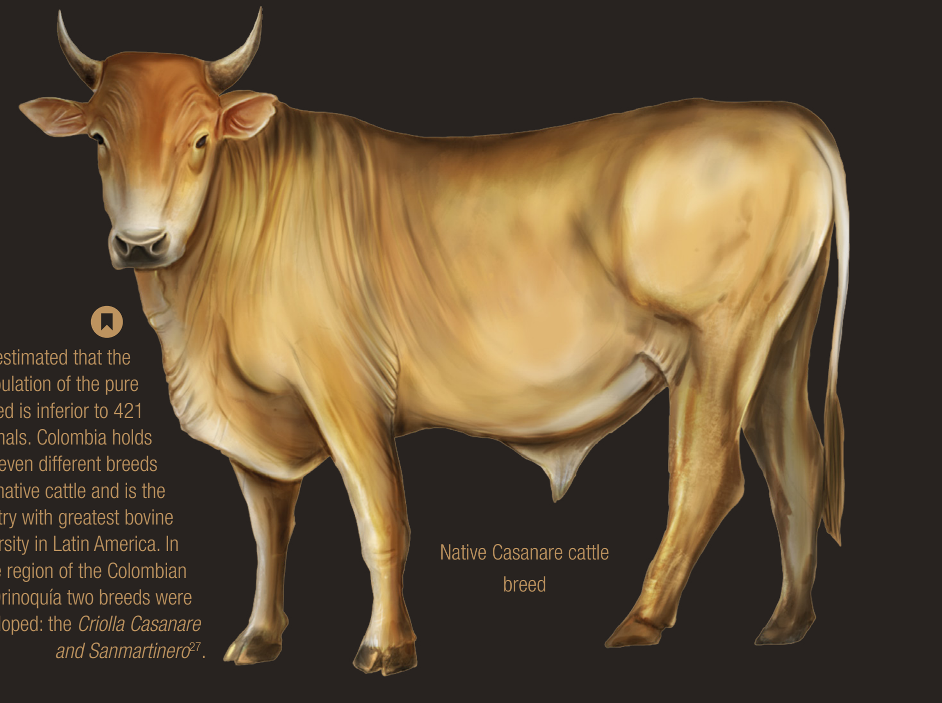


Diagram of interactions between actors, resources, and spaces of use in the floodplains during the wet season.



INITIATIVES

In the floodplains of the Casanare strategies for the conservation of biodiversity are being developed simultaneously to productive systems such as cattle raising or small-scale agriculture. Some initiatives are reported such as those of the *Fundación Horizonte Verde* (Green Horizon Foundation) and the Network of Natural Reserves of the Civil Society with the collaboration of The Nature Conservancy and the *Fundación Natura* (Natura Foundation). *Asociación Calidris* (Calidris Association) is developing the initiative *"Las Alas del Arroz"* ("The Wings of Rice") with the goal of stimulating agricultural practices that are bird-conservation friendly. Panthera Corporation is working on jaguar conservation through the management of ecosystems that provide a food supply for this feline species. Additionally, they are working with cattle raisers to reintroduce cattle native to the Casanare, a breed that has developed a behavior of grouping and defence against jaguar attacks[26]. In both cases, the conservation strategy is part of maintaining biological corridors for these species. In such initiatives, many countries of the American continent are involved.



It is estimated that the population of the pure breed is inferior to 421 animals. Colombia holds seven different breeds of native cattle and is the country with greatest bovine diversity in Latin America. In the region of the Colombian Orinoquía two breeds were developed: the *Criolla Casanare and Sanmartinero*[27].

Native Casanare cattle breed

Savannas from a national perspective

— Highlighted data

Savanna ecosystems occupy **18 million** hectares in Colombia

90 % of savannas in Colombia are found in the *Eastern Llanos*[16]

32 % are floodplains found in Arauca and Casanare[3]

In Casanare, 69 % of floodplains are temporary wetlands that remain flooded between 6 and 8 months during the year[17]

Biodiversity in floodplains has been studied by various authors[3]

Mammals approximately **around 250 species,** 40 % of the country's total

Birds (Casanare) **507 species**[3,20] approximately around 27 % of the country's total

Amphibians and reptiles (Orinoquía), have not been sufficiently studied **108 species**[3,21] of amphibians **119 species**[3,22] species of repitles

Fishes **567 species**[3,20]

Vegetation (Casanare) **668 species**[3,24,25] Inventory in Natural Reserves of the Civil Society

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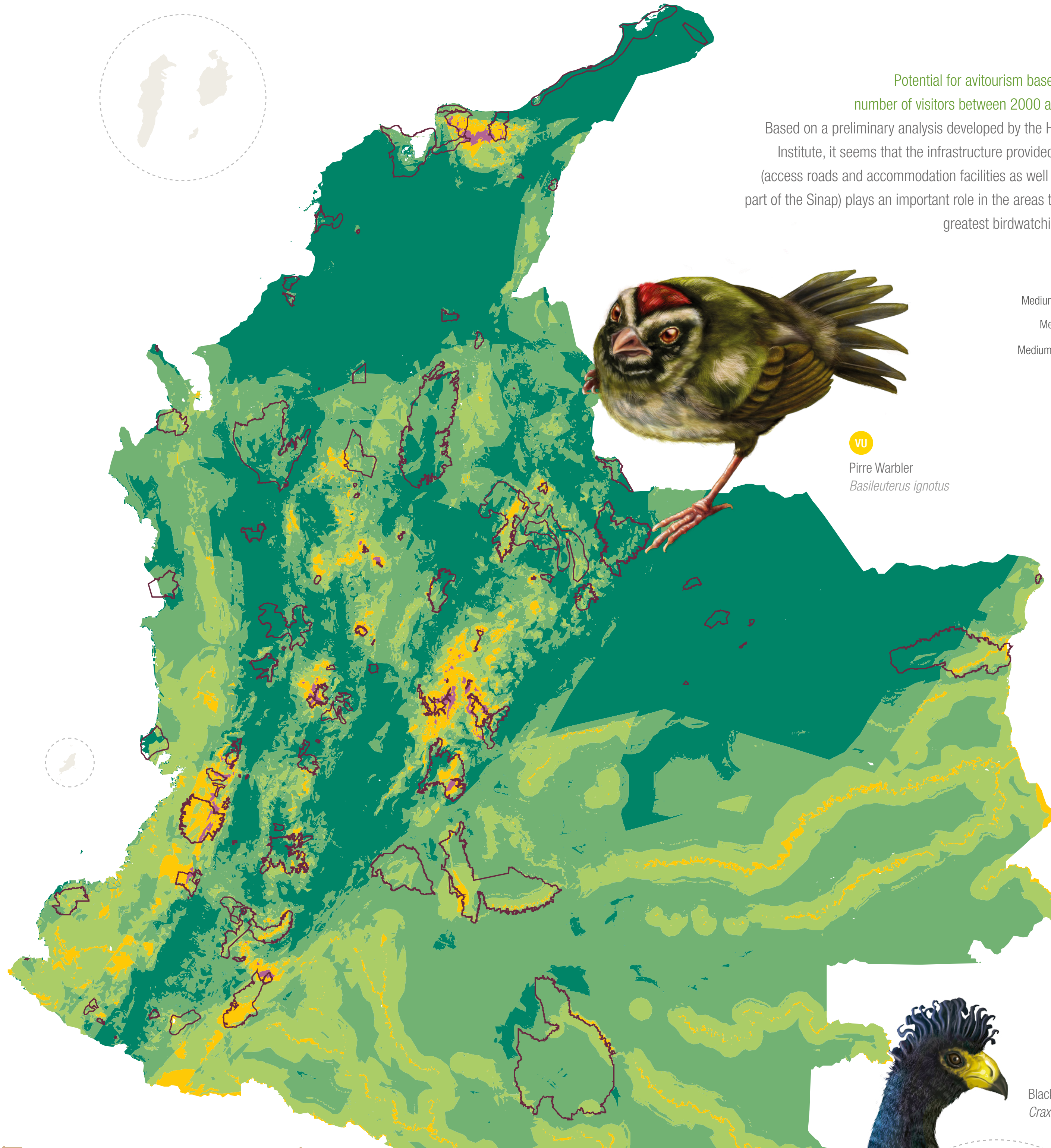
Related searches
BIODIVERSITY 2014: 213,306,307,311 | BIODIVERSITY 2015: 207,306,309,408,409

Topics
Cattle raising | Orinoquía | Conservation | Plains

Institutions: a. *Pontificia Universidad Javeriana*; b. *Instituto de Investigación de Recursos Biológicos Alexander von Humboldt*.



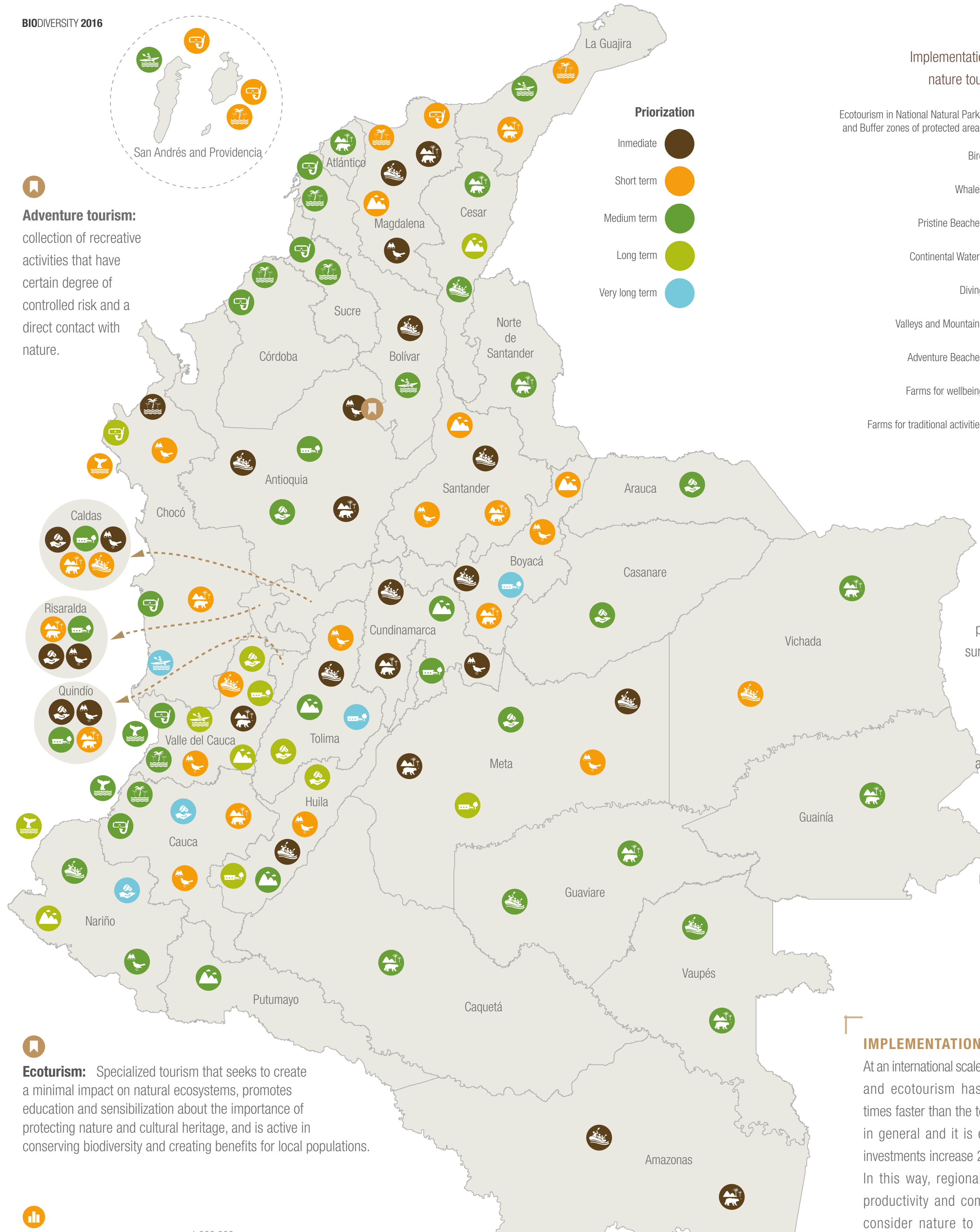
Potential for avitourism based on the number of visitors between 2000 and 2015

Based on a preliminary analysis developed by the Humboldt Institute, it seems that the infrastructure provided by IBAs (access roads and accommodation facilities as well as being part of the Sinap) plays an important role in the areas that have greatest birdwatching visits.

Black Curassow
Crax alector

POTENTIALS OF BIRDWATCHING TOURISM

Colombia is the country with greatest diversity of bird species in the world, with 1,937 recorded species[10]. Of these, 126 are globally threatened[11], while 140 are nationally threatened[12], and 79 are endemic species[13]. Their ornithological importance, in addition to habitat and landscape diversity, stimulate avitourism as a strategic activity with an international market that has 278,850 visitors for the next ten years. These visitors would pay on average 250 USD by person each day in birdwatching tours[14]. In addition to the development of this activity in places where it is already established, a country without an armed conflict would offer the opportunity of visiting new destinations according to the habitats of endemic and threatened species, the two conditions that mostly explain the number of ornithological events between 2000 and 2015. In the period of the post-conflict, these new areas should be stimulated through investing in infrastructure and the training of local communities.



Implementation strategy for nature tourism products

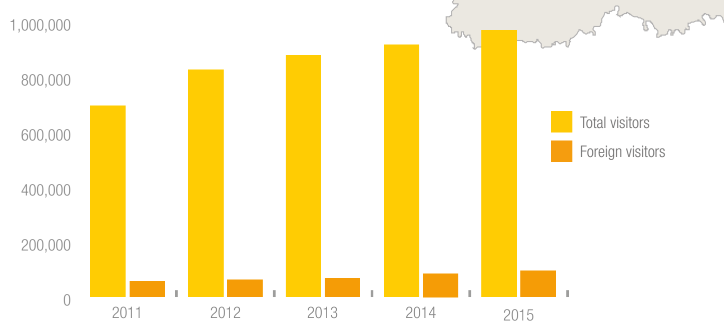
Adventure tourism: collection of recreative activities that have certain degree of controlled risk and a direct contact with nature.

Rural tourism: Relates to the enjoyment of the physical and social surroundings of rural culture, including the personalized supply of direct contact with rural activities, customs, and forms of life.

Ecoturism: Specialized tourism that seeks to create a minimal impact on natural ecosystems, promotes education and sensibilization about the importance of protecting nature and cultural heritage, and is active in conserving biodiversity and creating benefits for local populations.

IMPLEMENTATION STRATEGY. At an international scale, nature tourism and ecotourism has grown three times faster than the tourism industry in general and it is estimated that investments increase 20 % annually[7]. In this way, regional proposals of productivity and competitivity that consider nature to be an axis of development must guarantee areas of conservation and encourage green infrastructure[8]. Examples of this include: the Amazon as a sustainable destination, Chocó as a nature destination, and Guajira and Vichada as areas of ethnic and ecological tourism[9].

Number of visitors to protected areas with ecotourism potential.
There is a growing interest for both national and foreign tourists to visit protected areas with potential for ecotourism[2].



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BIODIVERSITY **2014:** 105,302305,306,307 | **BIO**DIVERSITY **2015:** 303,304,306,309

Topics
Ecosystem services | Integrated management | Economic development | Complementary conservation strategies

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Nature Tourism

Opportunities of development for local communities

Diana Lara[a], César Rojas[b,c], and Jorge Velásquez-Tibatá[a]

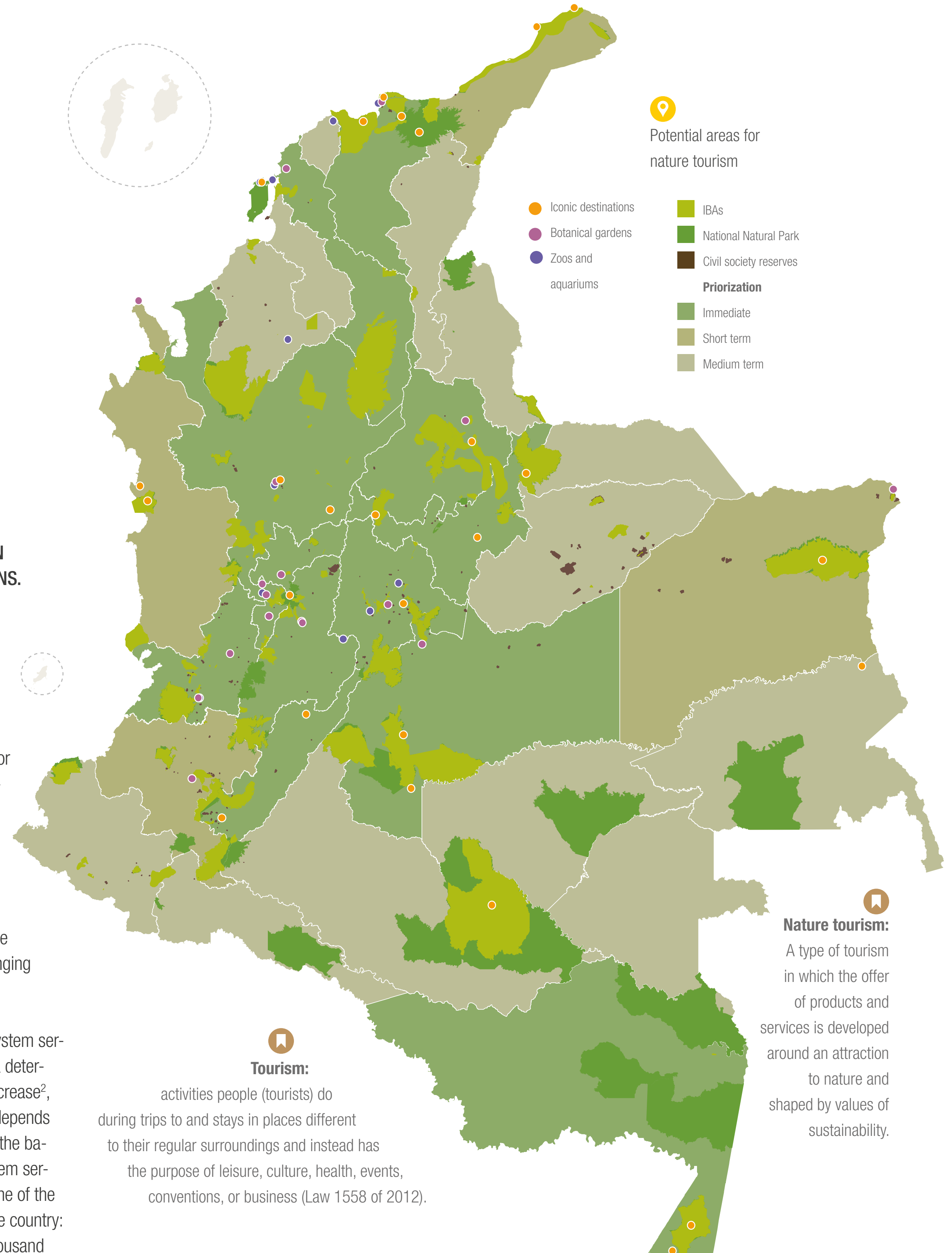
NATURAL AND CULTURAL DIVERSITY IN COLOMBIA FAVORS THE CONSOLIDATION OF NATURE DESTINATIONS, WHICH MAY BRING ECONOMIC DIVERSIFICATION AND AN INTEGRATED DEVELOPMENT OF THE REGIONS.

Colombia's natural heritage offers benefits for the positioning of **nature tourism** as a key strategy in local and regional development[1]. At a national scale, both plans of state development and public policy have identified nature tourism as a potential for creating employment and attracting international currency, thus representing an essential industry for the economic development of the country[1] in a changing scenario such as that of the post-conflict.

Nature tourism is a product of cultural ecosystem services. However, when the **loading capacity** of a determined area is surpassed, such services may decrease[2], so the continuous growth of the sector directly depends on the maintenance of healthy ecosystems and the balance between the offer and demand of ecosystem services[3]. In this context, ecosystem services are one of the main assets in the development of tourism in the country: annual profits fluctuate between 2.3 and 6.9 thousand million Colombian pesos[4] for the case of the national natural parks.

In Colombia, the construction of territories that guarantee the conservation of biodiversity and include the active participation of local communities must be reinforced[5]. Also, improving institutional capacities in relation to land use planning, along with planning and monitoring of ecosystem services balance, should be made a priority. To reach such goal, the following actions should take place: 1. Consolidate research about green markets and design ecotourism products, 2. Develop quality standards based on loading capacities of destinations according to ecosystem services balance, 3. Implement restoration and conservation actions that are associated with communities, 4. Promote and commercialize local services, 5. Improve processes of education, generation of information, and knowledge about biodiversity, among others.

A strategy for sustainably managing nature tourism implies that the multiple interested actors participate to maximize social and economic benefits, serve as a medium to create cultural conscience, preserve traditions and forms of life, and, finally, ensure the protection of the environment as the major guarantee of long term success in tourism[1]. This has been proposed in different strategies such as the one that is currently being developed to position Colombia as an international avitourism destination.



Potential areas for nature tourism

Tourism: activities people (tourists) do during trips to and stays in places different to their regular surroundings and instead has the purpose of leisure, culture, health, events, conventions, or business (Law 1558 of 2012).

Nature tourism: A type of tourism in which the offer of products and services is developed around an attraction to nature and shaped by values of sustainability.

NATURE TOURISM AS AN INSTRUMENT TO REACH PEACE. Peaceful territories increase the trust both foreign and national visitors may have while going to nature destinations in the country[6]. By making tourism activities closely related to local economies, an equitable distribution of derived benefits and a tourism culture that avoids conflicts and also offers community incentives for preserving natural and cultural heritages may be achieved[7]. Examples of this include: Camino a Teyuna (Ciudad Perdida) of the Sierra Nevada de Santa Marta (Magdalena), the hills of the Macarena (Meta), the Valle del Sibundoy and Mocoa (Putumayo), and Urabá-El Darién (Antioquia-Chocó)[7].

Institutions: a. *Instituto de Investigación de Recursos Biológicos Alexander von Humboldt;* b. *The Nature Conservancy;* c. *Instituto de Hidrología, Meteorología y Estudios Ambientales de Colombia -IDEAM.*

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Socio-ecological Systems of the Orotoy River Basin

Bases to identify territorial management strategies

Viviana Guzmán[a] and Luis G. Castro[a]

TO PROPOSE INTEGRATED MANAGEMENT STRATEGIES, IT IS ESSENTIAL TO CONCEIVE THE TERRITORY AS A SPACE WHERE DIFFERENT SOCIAL AND ECOLOGICAL SYSTEMS CONVERGE.

Timeline with beginning of conflict and responses

| In a specific year | Between many years

ACTOR

- Ecopetrol S.A funds project for the Universidad de los Llanos.
- International Development Research Center (IDRC) Canada funds project for Humboldt Institute.
- Alliance between the Humboldt Institute and the Instituto de Ciencias Ambientales de la Orinoquia Colombiana de la Universidad de los Llanos (Environmental Sciences Institute for the Colombian Orinoquía of the Universidad de los Llanos).

2009 — 2012 — 2013 — 2015 — 2017

ACTION

- Incidental spilling of organic cleanser used in petroleum activities causes the death of 340 kg of fish and the contamination of 20 km of downstream water in the Orotoy River, consequently restricting water consumption.
- Determination and creation of measures for the social and environmental management for the recovery of the Orotoy River in the area of influence of the central operations of Ecopetrol (municipalities of Acacias and Castilla la Nueva).
- Strengthening of capacities for social and ecological adaptation to climate change in the hydrographic basin of the Orotoy River, Meta.
- Combine efforts to advance in the development of activities for academic formation and strengthening of capacities of the actors of the Orotoy River basin.
- Strengthened local leaders and communities in terms of social and ecological knowledge.

Some initiatives of integrated management of biodiversity and **ecosystem services** in Colombia have been developed based on planning units of biophysical (p.e. basins) or political (p.e. municipalities) aspects, assuming that these are appropriate units for such purpose[1,2]. On the contrary, these planning units have proven to be a limiting factor when describing territorial dynamics in a holistic sense.

The Humboldt Institute has been implementing a methodology of territorial management that is based on the **integrated valuation** of ecosystem services[3]. The methodology originates in the perception of the territory as a **socio-ecological system** in which the relationships and interdependence of ecosystems and human societies is identified[2]. Such socio-ecological focus is converted into a conceptual and methodological tool for analyzing interrelations of systems. Due to its versatility, it may be implemented in different areas and contexts. This is a key and necessary aspect for integrated territorial management and the prevention of environmental conflicts.

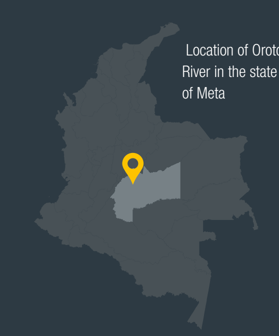
An example is the basin of the Orotoy River, which is located in the Orinoquía. In the basin three different socio-ecological systems exist: 1. A system in the higher part, with high mountain ecological functions where the greatest amount of forests and areas of water provision are found. This part is inhabited by small landowners and peasants dedicated to small-scale cattle raising, fishing, and recreation and tourism in the river. 2. The system of the middle zone, where petroleum extraction and palm and cattle agricultural systems in the foothills are predominant. There are dynamics of urban and industrial expansion where communities resemble urban centers, and workers associated with the hydrocarbons sector have settled. 3. A system in the lower part of the basin where there is a landscape characteristic to the Llanos Orientales. It is dominated by the expansion of palm and cattle agricultural systems and contains a rural population dedicated to traditional activities of cattle raising and rice crops, even if there is a large and new floating population that arrives with surges in the palm oil industry.

It is evident that the characteristics of socio-ecological systems inside the basin are not homogeneous. Nevertheless, the ecological connection between the systems, and especially the links between ecosystem services of water regulation or quality and the cultural similarities between the zones, must not be ignored. As a result of such connections, there currently is a growing demand for ecosystem services that has caused environmental conflicts between local and regional actors, chiefly those linked to productive activities and the use of **water resources**[5]. Conflicts may be addressed from a socio-ecological systems perspective to develop actions of conflict resolution, increase the adaptive capacity[6] of each system, and reduce the risk of degradation or collapse of ecosystems and their associated services[7].

Using such socio-ecological perspective may function as a response to address or prevent environmental conflicts because it considers a broad set of variables in planning that allow for greater detail of the territory.

Potential areas for nature tourism

- Agricultural ecosystem of rice
- Basal flooded gallery forest
- Humid Sub-Andean forest
- Fragmented forest with secondary vegetation
- Agricultural ecosystem mosaic of crops and grasses
- Agricultural ecosystem mosaic of crops, grasses, and natural spaces
- Agricultural ecosystem mosaic of grasses and natural spaces
- Agricultural ecosystem of palm
- Agricultural ecosystem of cattle raising
- White water river
- Secondary vegetation



SOCIO-ECOLOGICAL SYSTEMS OF THE BASIN OF THE OROTOY RIVER. The identified socio-ecological systems of the basin are divided in three zones: high, medium, and low. These zones are differentiated by ecological and social characteristics as well as economic activities. In the map the differences in land covers for each one may be visualized, making evident the decreasing presence of forests in all of the basin. Additionally, in terms of ecological aspects differences were identified for landscapes of high mountain, urban foothills, and the plains (high, medium, and low zones, respectively).

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Analysis of Scenarios

Instruments for territorial management in the context of socio-environmental conflicts

Alexander Rincón[a,b], Diana Lara[a], and Lorena Tique[a]

THE ANALYSIS OF SCENARIOS IN CONTEXTS OF SOCIO-ENVIRONMENTAL CONFLICTS MAY BE A KEY ELEMENT WHEN SUPPORTING TERRITORIAL MANAGEMENT. SUCH IS THE CASE OF THE BASIN OF THE OROTOY RIVER, WHERE THERE ARE POWER INEQUITIES AND AN INTRICATE VARIETY OF ACTORS INVOLVED.

One important function of the analysis of scenarios in the context of socio-ecological systems (SES) evaluation is that it offers a focus in which the possible implications of different decisions that are taken in a territory may be reflected upon in a structured manner[1,2]. Such analysis is particularly useful to evaluate the future development of complex and uncertain systems[3] such as SES. In this way this tool allows for decision making in the long term for the tuning of socio-economic and environmental objectives[4,5], human welfare, and environmental sustainability.

Different scenarios may be constructed based on participation of the actors, scientific information, or a combination of both[6] (qualitative, quantitative, mixed). Qualitative scenarios incorporate information from social actors as narratives or visual symbols. Quantitative scenarios use models based on social, economic, and environmental information to create trends that determine future scenarios[3]. Finally, mixed scenarios combine quantitative and qualitative information by minimizing deficiencies of quantitative and scientific information and the absence or low participation of actors. Thus mixed scenarios are a methodological challenge[7,8] and their application is ideal in the context of environmental conflicts.

A SES for which analysis scenarios have been developed is the basin of the Orotoy River, where multiple ecological, economic, and social interests converge. Additionally, there is a variety of actors that have complex relations with the ecosystem services of the region. The differentiated dynamics along the basin[9] foster the existence of environmental conflicts, thereby increasing social and ecological vulnerability in a context of climate change.

Under this context, in the scenario analysis technical elements and the participation of the different actors associated to the basin were integrated. Consequently, an ideal scenario of collective construction was found. Since it is a participative tool, the analysis of scenarios allowed for a dialogue between scientific, traditional, and local knowledge in which a diverse group of actors (community, sectors, and government) discussed environmental subjects that affect them and the decisions that relate to the model of development that is planned for their territories.

The context analyzed in the Orotoy River basin is similar to that of other territories in Colombia, where multiple parts are in conflict, there are few spaces of participation and inclusion, and the visions about development and the territory are polarized. In these circumstances, the analysis of scenarios may be an essential instrument for territorial management. In fact, the scenarios found in Orotoy may be applied to other territories to favor the construction of ideal scenarios that may hold diverse interests in harmony.

Definition of scenarios

Ideal

The scenario in which ecosystems maintain an adequate capacity for offering benefits to everyone (water, food, entertainment, tourism, agriculture, etc.) and productive systems based on local economy achieve the appropriate management of ecosystems without affecting other actors in the area. Additionally, a participative and including governance, in which all decisions that affect the territory are discussed in committees and groups that are representative of the community (ranchers, peasant farmers, palmers, etc.), is developed.

Green growth without social inclusion

A scenario in which the major productive sectors (palm, petroleum, and cattle raising) achieve an equilibrium between activities and environmental impact. However, an inclusive governance is not attained because other actors (peasant farmers, local population, etc.) are not taken into account. Therefore social inequities may increase, as well as conflicts with actors that hold different views about the territories and consider their activities and environment to be at risk.

Usual

The scenario in which a productive development that is unsustainable nor socially inclusive is developed. In it, productive sectors impact basic ecosystem services that affect other actors. There is an expansion of environmental conflicts, that have at their center the exclusion of communities when making decisions that affect the territory, corruption, and environmental degradation. Also, environmental problems linked to water resources (access and quality) increase.

Pessimistic

The scenario in which the offer of ecosystem services and benefits for everyone (water, agriculture, etc), even productive sectors, are lost due to high levels of ecosystem degradation. Economical activities are impaired and there is a social problematic that is evidenced in unemployment and serious environmental problems related to the access to water. There is an expansion of social conflicts that is not only related to environmental issues but also economic problems.

Scenarios selected for the basin of the Orotoy River. Each scenario is constructed based on determined characteristics and factors in contexts of socio-environmental conflicts.

In the obtained results, a fundamental difference between the usual and ideal scenarios stands out. It is important to include all actors in territorial decisions to accomplish a governance that results in healthy and resilient ecosystems.

Scenario
Characteristics
Factors

	IDEAL	GREEN GROWTH WITHOUT SOCIAL INCLUSION	USUAL	PESSIMISTIC
Healthy ecosystems	Good offer of ecosystem services	Good supply of ecosystem services, but does not include needs and impacts of other actors	Environmental degradation and loss of biodiversity and ecosystem services	Environmental degradation loss of biodiversity and ecosystem services
	Balance between productive systems and ecosystem management			
Social inclusion and governance	Participative and inclusive governance	Existence of socio-environmental conflicts	Existence of socio-environmental conflicts	Existence of socio-environmental conflicts
	Participation of sectors	Existence of social inequities	Existence of social inequities	Existence of social inequities
Economic sustainability	Balance between productive systems and ecosystem management	Balance between productive systems and management of ecosystems, but does not include needs and impacts of other actors	Unsustainable productive development	Environmental and economics problems
				Detriment of economic activities

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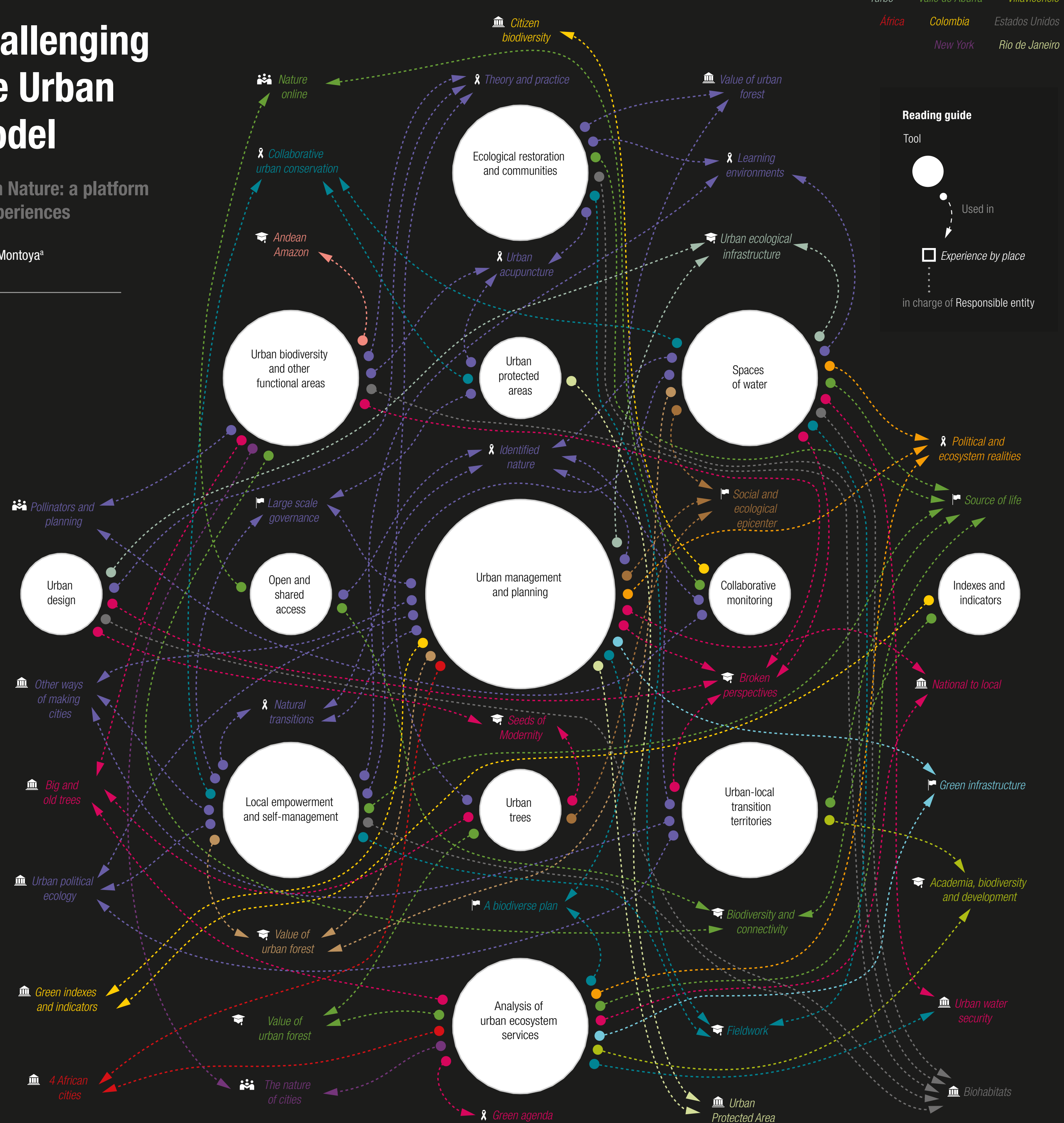
Challenging the Urban Model

Urban Nature: a platform of experiences

Juliana Montoya[a]

Urban biodiversity management tools in Colombian cities



AS EVIDENCED IN THE COLLECTIVE EXPERIMENT CALLED *NATURALEZA URBANA* (URBAN NATURE), THE CONSTRUCTION OF A MODEL OF ENVIRONMENTALLY SUSTAINABLE CITIES THAT MANAGE THEIR BIODIVERSITY FROM DIFFERENT SCALES, SECTORS, AND APPROACHES IS POSSIBLE.

In cities, the conservation of biodiversity faces a duality between challenges and opportunities. The Colombian context is one of an increasing number of people living in urban landscapes, where profound transformations and impacts on nature are being generated and the rupture between inhabitants and ecological processes that support life is augmenting. Consequently, the approach of research about **urban biodiversity**, which covers not only the descriptive analysis of related issues but also its incorporation of urban biodiversity as a strategic element in planning and environmental management in multiple cities around the world, has changed.

In 2016, the Humboldt Institute developed a collective experiment. It evidenced that cities are willing to improve their relations with nature, and local abilities may exchange ideas and inspire solutions based on biodiversity at different scales and from varied perspectives. In *Naturaleza Urbana: Plataforma de experiencias*[1] (Urban Nature: A Platform of Experiences), 30 cases present initiatives that aim to comprehend, protect, and restore urban nature through subjects such as citizen science, biodiversity inventories, evaluation of ecosystem services, mapping of wetlands, environmental quality, ecological corridors, environmental governance and education, ecological restoration, protected urban areas, ecological conflicts, and environmental justice, among others.

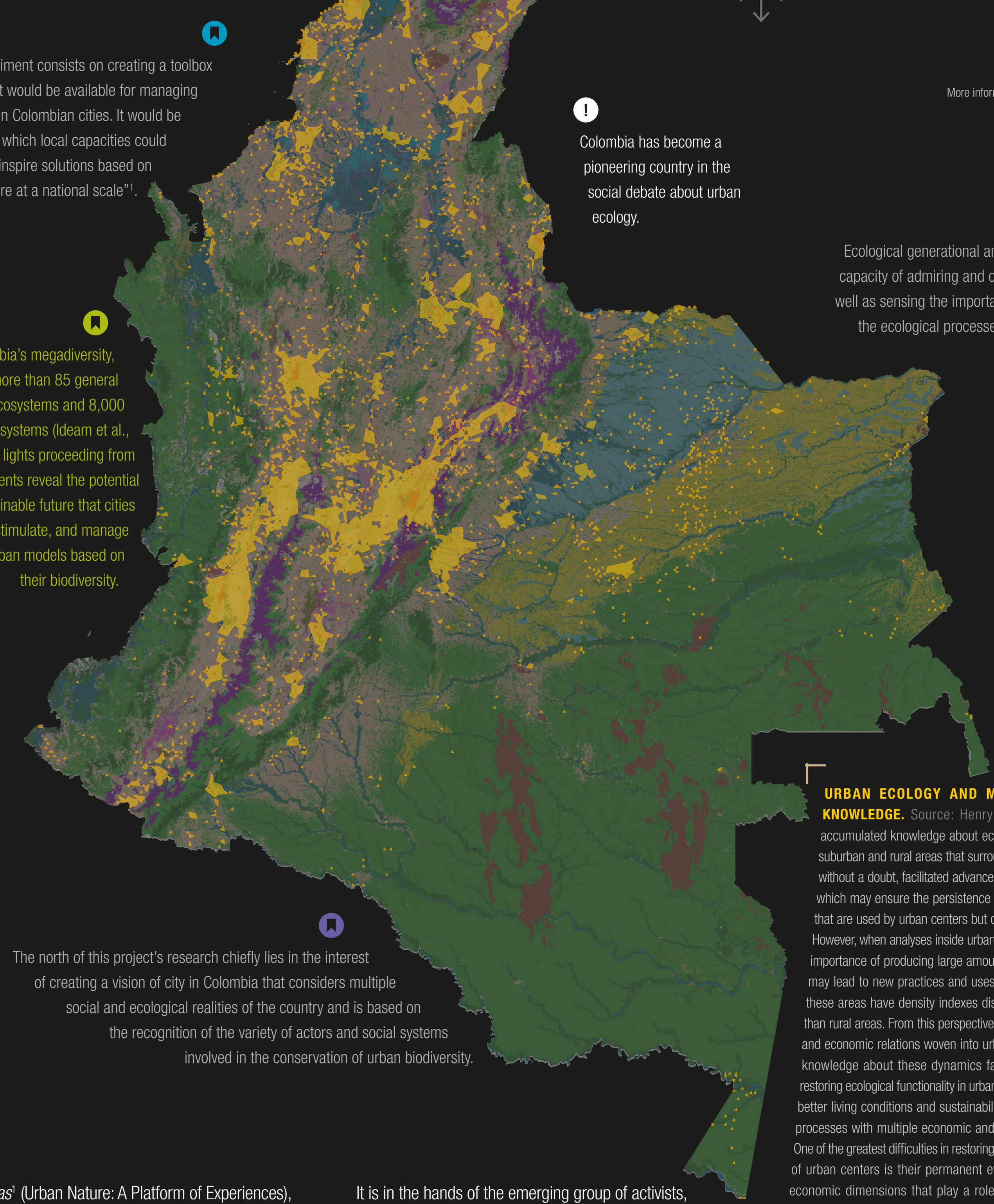
It is in the hands of the emerging group of activists, investigators, urbanists, and decision makers to stimulate an urban model that is distanced from speculation and instead serves collective interest[2]. There must be a change of paradigm in urban decisions in such a way that biodiversity becomes a principal element in the processes of urban planning and environmental management, creating a scenario in which citizens live in closer contact with biodiversity.

Projections of total population (urban and rural) of Colombia

"The experiment consists on creating a toolbox that would be available for managing biodiversity in Colombian cities. It would be a platform on which local capacities could dialogue and inspire solutions based on nature at a national scale"[1].

Colombia's megadiversity, reflected in more than 85 general types of ecosystems and 8,000 specific ecosystems (Ideam et al., 2008), and the lights proceeding from human settlements reveal the potential of a sustainable future that cities must lead, stimulate, and manage through urban models based on their biodiversity.

Colombian biodiverse cities



Type of ecosystems: IDEAM et al., 2008. Map of continental, coastal, and marine ecosystems of Colombia. Scale 1:500,000.
Albedo: Adaptation of the Humboldt Institute to NASA image (www.nasa.gov).

More information about each type of ecosystem in Colombia

Colombia has become a pioneering country in the social debate about urban ecology.

Ecological generational amnesia reduces our capacity of admiring and caring for nature, as well as sensing the importance of species and the ecological processes that support life[2].

The north of this project's research chiefly lies in the interest of creating a vision of city in Colombia that considers multiple social and ecological realities of the country and is based on the recognition of the variety of actors and social systems involved in the conservation of urban biodiversity.

URBAN ECOLOGY AND MANAGEMENT OF KNOWLEDGE. Source: Henry Garay-EcoNat. The accumulated knowledge about ecological functioning in suburban and rural areas that surround urban centers has, without a doubt, facilitated advances in territorial planning, which may ensure the persistence of ecosystem services that are used by urban centers but originate in rural zones. However, when analyses inside urban centers are made, the importance of producing large amounts of information that may lead to new practices and uses is even greater since these areas have density indexes disproportionately larger than rural areas. From this perspective, there are many social and economic relations woven into urban surroundings. The knowledge about these dynamics faces the challenge of restoring ecological functionality in urban centers to accomplish better living conditions and sustainability of those productive processes with multiple economic and social repercussions. One of the greatest difficulties in restoring ecological functionality of urban centers is their permanent evolution in social and economic dimensions that play a role in determining their identity. In other words, between the inhabitants of a city, there are different visions about the future. So the social context plays a major role in coordinating basic aspects to reorient the continuous construction of cities. In this complex situation, the role of applied scientific knowledge is to provide elements for different social parties to make judgements and finally reach basic agreements. In this sense, Colombia has become a pioneering country concerning the social debate of urban ecology[1] by integrating various systems of knowledge for the management of urban biodiversity.

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Wetlands to the Rescue of Society

Fundamental ecosystems for the management of risk

Úrsula Jaramillo[a] and Lina M. Estupiñán Suarez[a]

ONE OF THE MOST EFFECTIVE STRATEGIES TO MINIMIZE THE IMPACT OF FLOODS AND DROUGHTS IS THE INCORPORATION OF UPDATED INFORMATION ABOUT WETLANDS IN THEIR TERRITORIAL MANAGEMENT, WHICH SHOULD ACKNOWLEDGE THE COMPLEXITY AND DYNAMIC NATURE OF THESE ECOSYSTEMS.

Wetlands are ecosystems that are formed where water is temporally or permanently accumulated in response to geomorphological and hydrological conditions, which imply particular characteristics of the soil, fauna, and flora[1]. In Colombia, there are wetlands in all the regions of the country[2], and they may be found from sea level all the way to the high mountains. The area of wetland does not only include the body of water but also those parts that periodically dessicate, even those that are never flooded but have characteristics of high humidity and soil processes.

In 2010-2011 the phenomenon of La Niña brought floods that resulted in the death of 1,100 people and economic costs of 11.2 billion pesos[3]. Such catastrophe initiated unprecedented research at a national level that allowed for a greater understanding of the wetlands of Colombia. As part of the obtained results, the **cartography** of wetlands shows that more than 26 % of the national territory is composed of wetlands. The map identifies the fluctuating nature of wetlands in three categories: permanent, temporal, and potential[4,5]. Each type must be understood and used in a differentiated manner. In permanent wetlands, it is necessary to guarantee that no reduction in the flow of water occurs through deviations or actions that result in **desiccation**. The fluctuation of flooding in temporal wetlands generally has an interannual cycle that corresponds to the expansion of rivers and other bodies of water in periods of heavy rain. Areas of potential wetlands are also susceptible to flooding but in a lower interannual frequency.

Based on the previous information, an analysis about the transformation of wetlands evidenced that 24 % of wetlands have suffered some change in land covers, between 2007 and 2012, due to anthropogenic activities. The regions of the Urabá, Orinoquía foothills, and the Sinú and Mojana basins[9] are the most affected by such transformations.

Wetland categories

Permanent and open
Water is constantly present and trees are absent.

2,529,117 Total hectares | 9,645 Transformed | 59 Types of wetlands | 19,370 Inventory records

Permanent under canopy
Water is constantly present and covered by woody vegetation.

1,625,407 Total hectares | 109,361 Transformed | 54 Types of wetlands | 2089 Inventory records

Recommended uses: Exclusion of economic activities with high impact. Should preferably be areas of conservation, research, and sustainable tourism.

Ecosystem services: Fundamental for water supply.

Temporary
Water varies periodically in response to hydrological cycles. Water disappears in periods within years.

17,861,536 Total hectares | 2,095,535 Transformed | 64 Types of wetlands | 13,706 Inventory records

Recommended uses: Activities that allow for the contraction and expansion of body of water. Protected areas for the conservation of biodiversity. Seasonal cattle raising and agriculture could be present. If infrastructure is built, it should not alter expansion and contraction dynamics. **Ecosystem services:** Fundamental for water regulation.

Seasonality
In all types of wetlands there are seasonal variations that imply the contraction and expansion of the wetland area, in agreement with the hydrological cycle of the region.

Medium potential
No body of water present, but existence of periodic flooding within years. Edaphological and geomorphological characteristics evidence periodic humidity in the soil.

5,031,592 Total hectares | 2,206,797 Transformed | 51 Types of wetlands | 1833 Inventory records

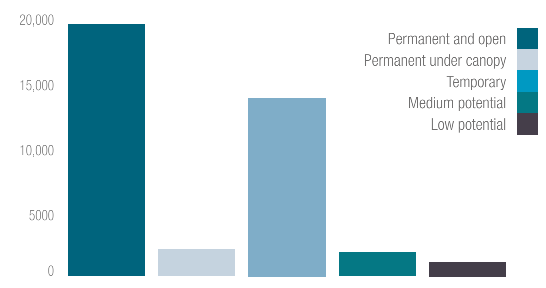
Low potential
No body of water present, but existence of periodic flooding between years. Edaphological and geomorphological characteristics evidence periodic humidity in the soil.

3,733,497 Total hectares | 2,931,317 Transformed | This category was not included in the analysis of wetland classification | 1123 Inventory records

Recommended uses: All economic activities should consider possibility of flooding in extreme events. Economic activities developed in these areas should guarantee longitudinal and transversal connectivity with temporary and permanent wetlands, as well as vertical connectivity with groundwater. **Ecosystem services:** Fundamental for risk management.

2017, YEAR OF WETLANDS TO REDUCE RISK OF DISASTERS. Wetlands are the only ecosystem protected by an international convention, the RAMSAR Convention on Wetlands[5]. 2017 was declared the year of wetlands to sensibilize the public about the benefits healthy wetlands bring in terms of reducing the impact of extreme weather events such as floods, droughts, and cyclones, in addition to increasing community resilience.

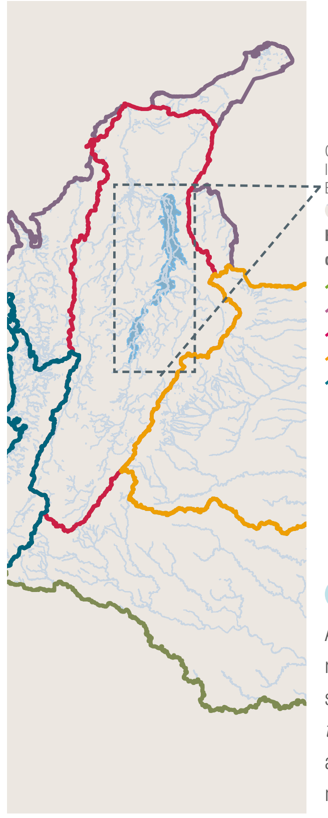
Number of records in wetland inventory for each category



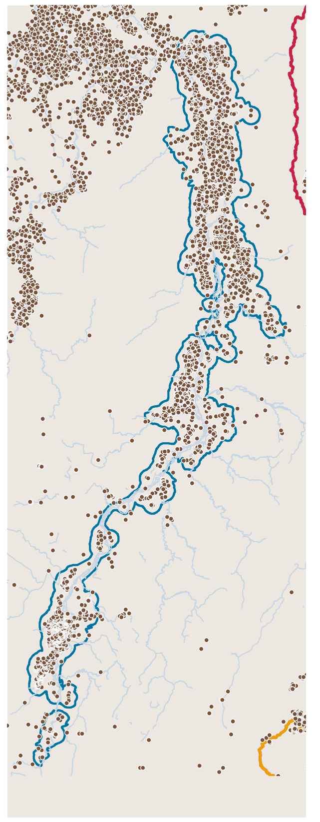
Additionally, a classification system categorized the 30 million hectares that have been identified according to the type of wetland, reaching more than 88 categories for all of the country[2,10]. Based on the updated information found by participating institutions, the records were organized and collected to form a national inventory with more than 48,000 records[11] grouped into 134 complexes.

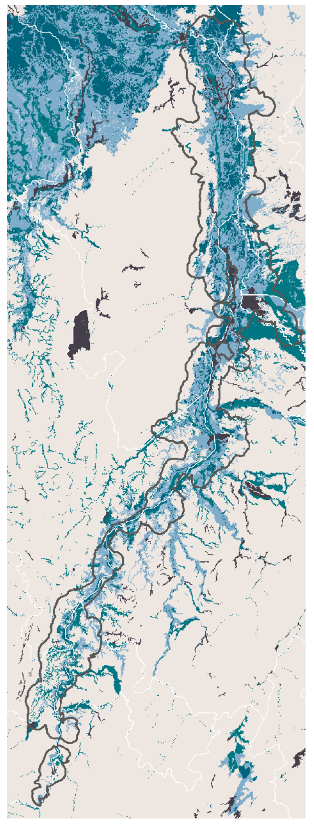
Colombia is clearly a territory dominated by water, so it is necessary to highlight the opportunities and benefits this condition brings. A total of 1,100 municipalities have wetlands, of which 284 are covered with more than 30% by water. Some of these, like Mompox (99.98 %), Cravo Norte (99.91 %), Sitio Nuevo (99.76 %), Pinillos (99.41 %), and Orocué (99.21 %)[12,13] are almost totally covered by water. Ignoring such reality in territory planning and the adaptive development of populations has caused consequences such as the increase of catastrophes related to drought and flooding.

The only way of implementing an effective risk management is by acknowledging the territorial as amphibian (periodic flooding and drought) and encouraging the recovery of ways of life adapted to these conditions in the populations that inhabit the territory. A first step to accomplish such goal is to incorporate generated information to tools of territorial management such as the *Planes de ordenación y manejo ambiental de cuenca hidrográfica* (Land Use Planning and Environmental Management Plans of Hydrographic Basins) and *Planes de Ordenamiento Territorial* (Land Use Planning) to reach a different

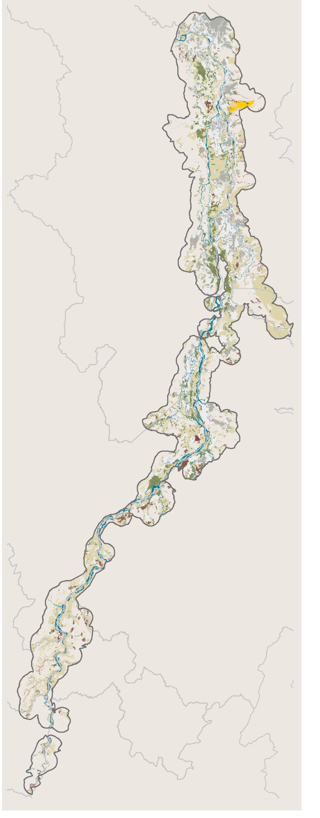


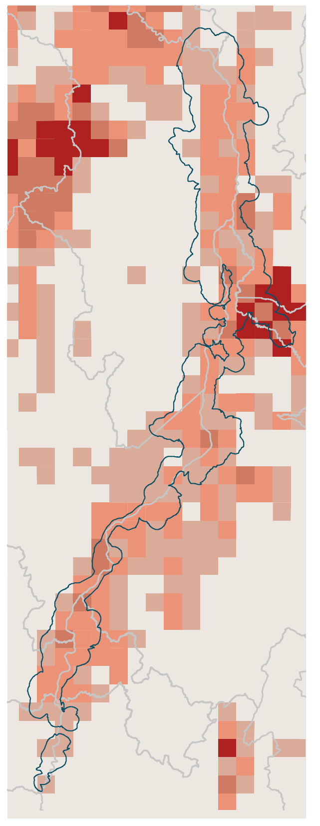
Across regions wetlands receive different names such as *manglar, sajal, tremedal, zapal, bijagual,* and *morichal*, among many others[15].





30 million hectares in the country are wetlands





MANAGEMENT OF WETLANDS IN THE LOWER AND MIDDLE MAGDALENA BASIN. The complex of wetlands in the lower and middle Magdalena Basin, which is found under the jurisdiction of nine different autonomous regional corporations, was one of the most affected in the floods of 2010-2011. Responses to this catastrophe are a great challenge in terms of management since a high degree of coordination between entities is required. The number of records for this complex in the inventory is 2,825, making an individual management plan for each one impossible. A less local and more regional perspective is needed to evidence the high connectivity of the system and interrelated processes within the basin. Similarly, it must also be understood that what takes place in the lower and middle Magdalena Basin may also impact adjacent complexes such as La Mojana. Thus the diversity of wetlands must be seen in a complementary fashion. It is estimated that the complex of wetlands in the lower and middle Magdalena Basin comprises 700,000 ha, of which 24 % correspond to permanent and open wetlands, 3 % permanent under canopy, 49 % temporary, 18 % medium potential, and 6 % low potential. Recognizing each of these categories and their related dynamics will allow for a proper risk management[14].

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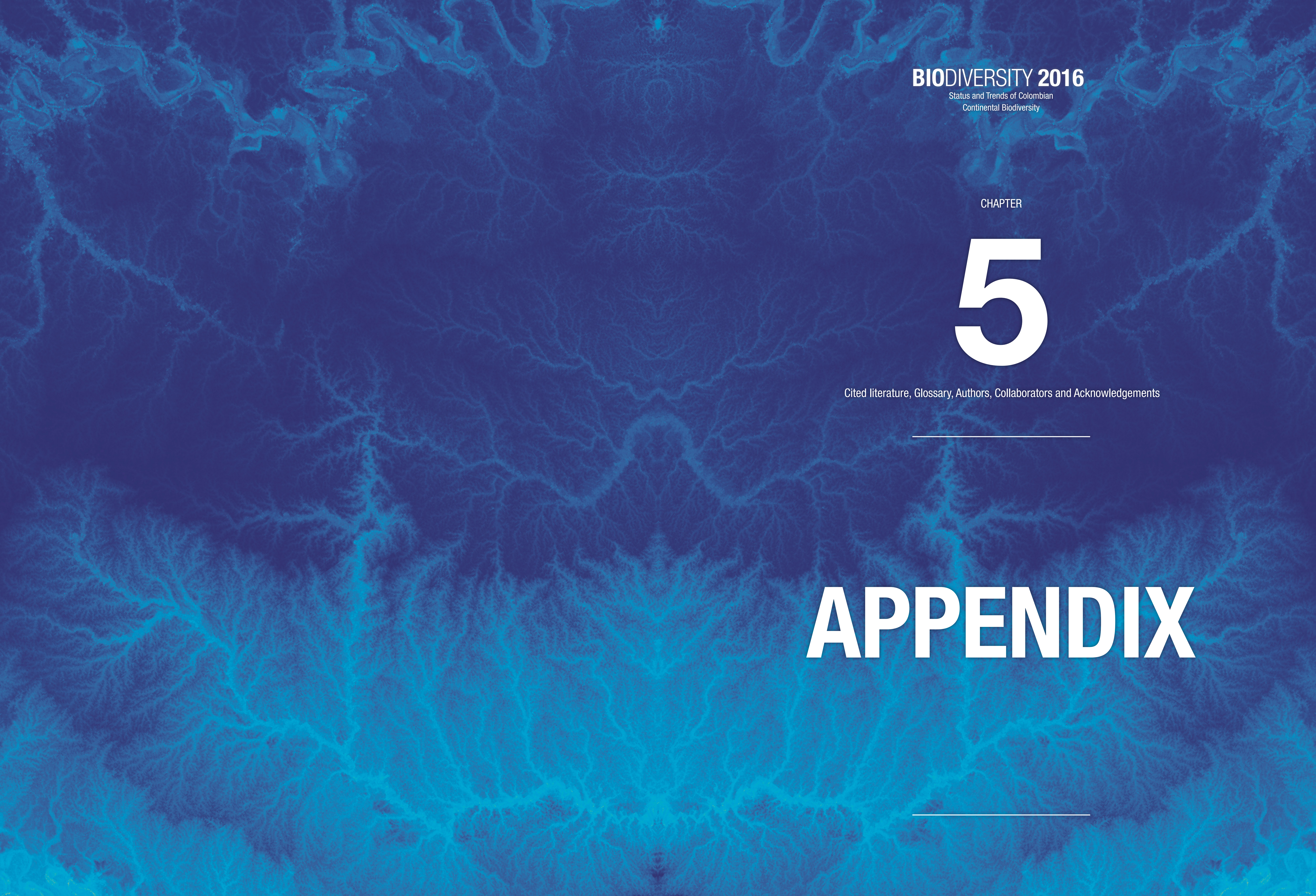

CHAPTER

5

Cited literature, Glossary, Authors, Collaborators and Acknowledgements

APPENDIX

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Glossary

A

ABUNDANCE. The abundance of a species in a determined habitat is the number of individuals of that species living in that habitat. Abundance varies in time and space.

ADAPTATION. Process by which an organism adjusts to the environment and its changes.

ADAPTIVE GOVERNANCE. The way in which the structure of the rules, norms, and mechanisms of application adapt and evolve through time as a result of changes in information or characteristics of the environment of common goods.

ASSEMBLAGE. A group of similar populations or species that simultaneously occur in a determined area.

ATTRIBUTES. Characteristics of populations that may have a numeric representation. Some examples of population attributes are density, natality, age groups, biotic potentials, dispersion, and growth forms.

B

BASINS. Areas of superficial or subterranean water that are part of a natural hydrographic network or water catchments, have a continuous or interrupted flow, and converge into larger bodies of water that may lead to major rivers, natural water deposits, swamps, or directly into the sea.

BIOGEOGRAPHIC. A division of parts of the planet that considers relations between its organisms and the environment, under an evolutionary perspective.

BIOLOGICAL RECORDS (OCCURRENCE RECORDS). Information based on evidence (existence, fact, or instance) of a living organism. This event may be recorded chiefly in a natural medium (*in situ*) by human or machine observations or the revision of specimens in a biological collections.

BIOMASS. Total quantity of living matter that exists in a community or an ecosystem.

BYCATCH. Part of the captures of fishing that are incidental because they are not the species towards which the fishing effort is directed.

C

CAMERA TRAPPING. Use of a diversity of techniques in automatized photographic equipment. An example are movement sensors that obtain images that allow for not only knowing about the presence of some species but also obtaining estimations of frequency and density and identifying individuals by designs on fur, identification spots, etc.

CARTILAGINOUS. The class of Chondrichthyes, which includes more than 600 marine species such as sharks, rays, and manta rays.

CARTOGRAPHY. Design and production of maps.

CHARGE CAPACITY. Represents the maximum level of use an area may maintain.

CLIMATE CHANGE. The United Nations Framework Convention on Climate Change (UNFCCC) defines climate change in its Article 1 as the "change in climate caused directly or indirectly by human activity that alters the composition of the global atmosphere and adds to the natural variability of the climate observed in comparable time periods".

COMPOSITION. In the structure of a biological community three fundamental aspects are distinguished: composition, stratification, and limits. Composition is comprised by abundance, diversity, dominance, habitat, ecological niche, and ecological indicator.

COMPLEMENTARY CONSERVATION MEASURE OR STRATEGY. Defined geographical area in which an action or a group of actions is implemented by a social actor (communitary or institutional) where different scales, figures, interests, and management schemes converge to ensure the preservation, restoration, and sustainable use of the biological and cultural diversity in the territory. Such actions contribute to the complementarity and functional and structural connectivity of protected areas, be it in a continental (urban or rural), coastal, or oceanic scenarios.

CONSERVATION PLANS. Action plans for the conservation of species and ecosystems are indispensable tools for the conservation of biodiversity. An action plan for conservation proposes guidelines for actions that are critical to achieve conservation goals and monitor their progress to adequately adjust practices.

CONSERVATION STATUS. The conservation status of plants and animals is one of the mostly used indicators to evaluate the condition and biodiversity of an ecosystem. The categories and criteria used by the IUCN Red List constitute a global system used to measure the extinction risk of species.

CREDITS. Ecological credits finance "green" activities and investments that contribute to sustainable development through "green" financing services for small and medium enterprises.

D

DEFORESTATION. According to the UNEP, deforestation is the total or partial destruction of trees to use the resulting space with activities of agriculture, cattle raising, or others.

DESICCATION. A continuous loss of humidity in soils located above phreatic levels.

DOMINANCE. Influence or organisms in a community in function of the abundance of their species..

DRAINAGE NETWORK. System of channels through which superficial, sub-superficial, and subterranean water flows temporally or permanently.

E

ECOLOGICAL CONNECTIVITY. Also referred to as landscape connectivity, it is the movement of species (exchange of individuals and genes) in the territory between different habitat areas.

ECOLOGICAL INTEGRITY. Level of conservation of ecosystems. The concept supposes the recognition of an original condition with a basic nature.

ECOLOGICAL RESTORATION. Assisted recovery of a degraded or destroyed ecosystem with the goal of recuperating natural composition and function.

ECOLOGICAL STRUCTURE. Collection of biotic and abiotic elements that support essential ecological processes of the territory. The purpose of their use is that of preserving, conserving, restoring, and sustainably using and managing natural renewable resources, which support the socio-economic development of populations.

ECOSYSTEM SERVICES. Benefits that society obtains from ecosystems. They may be direct (food, water, or timber) or indirect (nutrient cycling, formation of organic matter).

ECOTOURISM. Specialized tourism that seeks to create a minimal impact on natural ecosystems, promotes education and sensibilization about the importance of protecting nature and cultural heritage, and is active in conserving biodiversity and creating benefits for local populations.

ENDEMIC. Belonging to only one place.

ENVIRONMENT-BASED ADAPTATION. EbA integrates sustainable management, conservation, and ecosystem restoration to provide services that allow humans to adapt to the impacts of climate change. Its purpose is to maintain and increase resilience and reduce vulnerability of people and ecosystems.

ENVIRONMENTAL COMPENSATION. Actions that aim to compensate biodiversity for the negative impacts or effects that may not be avoided, corrected, mitigated or substituted and cause the loss of biodiversity in natural terrestrial ecosystems and secondary vegetation so that the effective conservation of an ecological equivalent area is guaranteed. A strategy of permanent conservation or ecological restoration must be developed in order to achieve zero net loss of biodiversity.

EXOTIC SPECIES. Species, subspecies or inferior taxon that is found outside its natural area (past or present) and potential dispersal (outside of the area that it occupies naturally without the direct or indirect intervention of humans) and includes any part, gamete, or propagule of the species that may survive and reproduce.

EX SITU. Ex situ conservation is the protection of genetic material outside of the area of distribution of the source population.

EXTINCTION. Disappearance of all the individuals of a species.

F

FECUNDITY. Physiological potential of reproduction of one individual throughout its lifetime.

FLORAL COMPOSITION. The list of plant species in a determined place, usually considering density, distribution, and biomass.

FLOODED RICE FIELDS. Productive systems in which the availability of rainfall is used. Most of the parts of production are mechanized and do not demand much labor force.

FLOODPLAIN. Ecosystems that are located chiefly in the states of Casanare and Arauca and have a tropical humid climate that in some areas may be more dry. They have a flat-concave relief with high points or banks that represent 40% of the territory and are the foraging areas in the winter.

FOREST EXPLOITATION. Sum of operations related to cutting of trees and extraction of trunks or other parts for their posterior transformation into industrial products.

FORESTRY PLANNING. Multiple use of the forest so that its total capacity of providing goods and services does not decrease.

FRAGMENT. The structural pattern of a landscape is composed by three elements: fragments, corridors, and matrix. Fragments are delimited and differentiated by their biotic and abiotic composition and structure, and may be large or small, round or elongated, scarce or numerous, and scattered or grouped.

FRESHWATER ECOSYSTEMS. Ecosystems where water is a fundamental component and concentration of salts does not surpass 10% or there is no influence of tides, in comparison to other aquatic ecosystems such as the ocean and coasts.

FUNCTIONAL DIVERSITY. Value, range, and abundance of functional attributes of a community or an ecosystem. It has been proposed as a tool to understand the relations between community structures, diversity, and ecosystem functioning.

FUNCTIONAL TRAITS. Biological traits that influence the performance of organisms that may be related with ecosystem processes (flux of matter and energy), ecosystem stability (resistance and resilience), biological interactions (intra and interspecific) or habitat change.

G

GEOMORPHOLOGY. Branch of geology and geography that studies the forms of the terrestrial surface and the processes that create them.

GREENHOUSE EFFECT GASES. Compounds that despite being present in the atmosphere (trace gases), significantly increase temperature in the lower atmosphere due to their capacity of absorbing and reflecting infrared radiation.

GROSS DOMESTIC PRODUCT. Total goods and services produced in a country during a given time period. Includes the production generated by residents in the country and excludes the production of national that reside in the exterior.

GOVERNANCE. Completion of political relations between varied actors involved in the process of deciding, executing, and evaluating decisions about topics of public interest. The form of interaction between the actors reflects the quality of the system and affects each of its components and the system in its totality.

H

HIGH MOUNTAIN. Altitudinal summits of the Andean mountain ranges or areas of higher orogenic rises that result in higher potential energy and thus transfer materials to lower, medium or peripheric areas.

I

IN SITU. *In situ* conservation is the continuous maintenance of a population in the community to which it belongs and in the environment to which it is adapted. It permits the protection of complete ecosystems in which there is a continuity of evolutionary and ecological processes.

INTEGRATED MANAGEMENT. The integrated management of biodiversity and its ecosystem services is defined as a process in which actions for conserving biodiversity and its ecosystem services are planned, executed, and monitored in a given social and territorial scenario that may have different conservation statuses.

INTEGRATED VALUATION. The *Valoración Integral de la Biodiversidad y los Servicios Ecosistémicos* (Integrated Valuation of Biodiversity and Ecosystem Services) is an opportunity to create tools and data for managing the territory. It is a proposal that by following the guidelines of the PNGIBSE seeks to recognize the value of ecosystem services and biodiversity to support decision making without the implication of focusing on only one dimension of valuation.

INTERNATIONAL COOPERATION. A tool of collaboration that supports processes of development through the transfer of technical and financial resources between different parties of the international system (governments, territorial agents, civil society organizations, NGO's).

INVASIVE SPECIES. Species that prosper outside of their natural area of distribution without the help of human beings and threaten natural or semi-natural habitats.

ISOCLINES. A line on a map or diagram that joins points of equal gradient or inclination .

M

MANAGEMENT PRACTICES. Standardized or uniform forestry practices that must be followed or considered with the purpose of avoiding or minimizing negative environmental impacts and risks.

MITIGATION. Policies, technologies, and trending measures to limit and reduce emissions of greenhouse effect gases and improve their sinks, according to the United Nations Framework Convention on Climate Change.

MONITORING. Environmental monitoring is a process of continuous observation that implies the systematic recollection of data through standardized equipment and methods.

MULTILATERAL COOPERATION. A type of cooperation in which governments give funds to multilateral organizations so that they may finance their own activities. In this way, management is in the hands of public international institutions and not donor governments.

N

NATIVE SPECIES. Species that is found inside the area of its original (historic or current) or natural distribution according to its potential of natural dispersal without the help or intervention of human beings.

NATURE TOURISM. A type of tourism in which the offer of products and services is developed around an attraction to nature and shaped by values of sustainability.

O

ORNITHOLOGY. Branch of zoology that studies birds in different research topics such as natural history, ecology, distribution, and conservation mechanisms, among others.

P

PARAMIZATION. Phenomenon that occurs when paramo species that are highly competitive and restricted to higher elevations occupy lower altitudinal levels.

PHYLOGENIES. Collection of data associated to the analysis and synthesis of phylogenetic, systematic, and evolutionary information for a given species.

PHYSIOGRAPHY. Study of the relationships between climate, geology, morphology, origin, and age of rocks, hydrology, and biotic aspects in the area where the latter impact the soil and its characteristics for potential use and management.

POPULATION BIOLOGY. Branch of biology in which the patterns and causes of diversity in and within populations is studied, including distribution, size and change over time. This research area appeared when studies of ecology and genetic diversity were combined.

PRIMARY VEGETATION. Vegetation in places where there has not been transformation or it has been mild, so the soil remains covered by natural vegetation.

PROTECTED AREAS. A geographically defined area that has been designated, regulated, and managed with the goal of reaching specific conservation objectives.

R

RATE OF CHANGE. A rate of population growth that is caused by the number of births, deaths, emigrations and immigrations. It is one of the most important population parameters that is used.

REFORESTATION. Silvicultural process used to re-establish forest cover, thus initiating the restoration of forest functions.

RELATIVE COVERAGE. Relative coverage is obtained by the following formula: Relative coverage= Absolute coverage of each species/ Absolute coverage of all species x 100, where Absolute coverage= Coverage of a species/ Sampled area.

RICHNESS. Species richness is defined as the number of species present in a given geographical area.

RISK MANAGEMENT. Identification, analysis, and quantification of probabilities of loss and secondary effects that are caused by disasters, as well as preventive, corrective, and reductive actions that must be developed. Risk is a function of two variables: threat and vulnerability.

S

SECONDARY VEGETATION. Vegetation cover originated by the process of succession from natural vegetation to the one that is formed after intervention or destruction of primary vegetation.

SINAP. The combination of protected areas, social actors, and management strategies and instruments that contribute as a whole to the accomplishment of the country's conservation objectives. It includes all protected areas of public, private, or community governance and may be at a national, regional, or local scale.

SINERGY. Action composed by two or more causes that has an effect that is superior to the sum of the individual effects.

SOCIO-ECOLOGICAL SYSTEM. A system in which cultural, political, social, economic, ecological, and technological components, among others, interact. The concept emphasizes on human perspectives about nature.

SOCIO-ENVIRONMENTAL CONFLICTS. Processes in which different social actors interact due to the shared interest in natural resources.

SOUND LANDSCAPES. Analyzes all sounds heard in a location. Sounds may be biological, geological, or anthropic.

SPECIES LIST. List of scientific names with taxonomic, geographic, or thematic information. They rapidly provide a baseline of the species in a given context.

SPECIMEN. An individual that serves as a sample of its species.

U

URBAN BIODIVERSITY. The variety of living organisms in both terrestrial and aquatic habitats that are found inside and around human settlements that are considered as urban areas.

V

VIVIPAROUS. Animals in which the embryo develops inside the maternal body.

VULNERABILITY:. Animals in which the embryo develops inside the maternal body

W

WATER RESOURCES. Sources of water, usually fresh water, that are useful or potentially useful for society.

The references supporting this glossary are available online

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LC

Three-toed Sloth

Bradypus variegatus

To weave knowledge about biodiversity into a social fabric is a challenge that implies a continuous recognition and creation of varied forms of representation. Under this premise, the editorial and infographic work–developed with and almost artisanal dedication–of *Biodiversity 2016* aims to seduce the reader through compositions that play with space, geometry, illustrator, and color. It also seeks to facilitate the comprehension of the presented information, encourage the discovery of our biodiversity, and foster a more adequate management of biological resources in favor of social welfare.

David Fernando González T.

Design and layout

"THE ONLY WAY OF OVERCOMING THE RISK OF EXTINCTION IS THROUGH THE ACTIVE PROCESS OF SOCIAL LEARNING IN WHICH ALL SECTORS ASSUME A PART OF THE COMPLEX RESPONSIBILITY IN PROTECTING THE FORMS OF LIFE OF THE COUNTRY, A ROUGHLY COUNTED TENTH OF ALL CREATURES ON EARTH. "

Brigitte L. G. Baptiste
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