



# Conservation Planning for Tropical Dry Ecosystems of Cucuta, Colombia



**Fundación Caipora  
&  
Grupo de Investigación en Ecología y Biogeografía – Universidad de Pamplona**

**Report prepared by  
Silvia J. Alvarez & Diego R. Gutierrez**

**Colombia, 2012**

## Conservation Planning for Tropical Dry Ecosystems of Cucuta, Colombia

Aim: Priorization for conservation of tropical dry forest fauna

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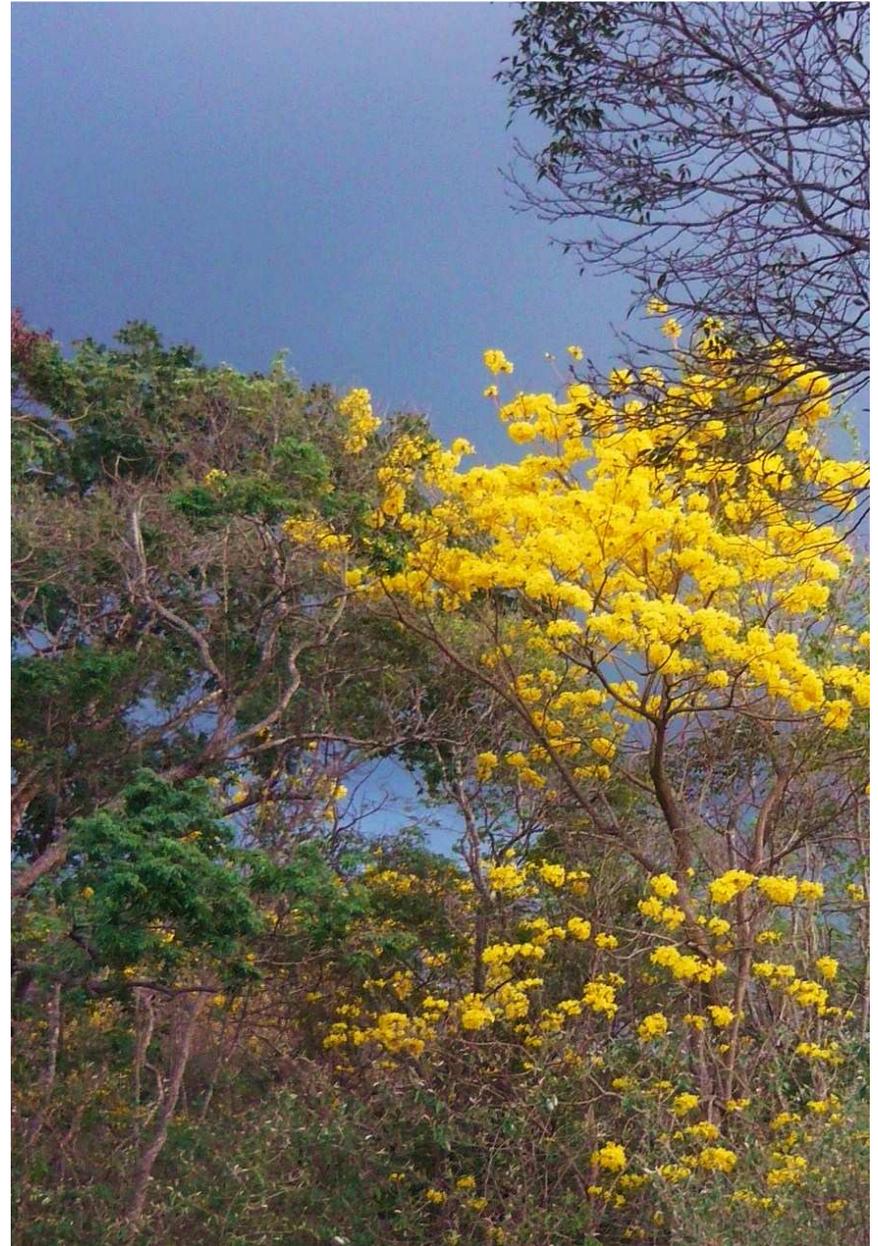
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### Fieldsite

Colombia, Norte de Santander, Metropolitan Area of Cucuta  
2009-2010

Guayacán Amarillo (*Tabebuia ochracea*) flowering in the tropical dry forest of Cucuta, Colombia (opposite site).



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The tamandua (*Tamandua mexicana*)



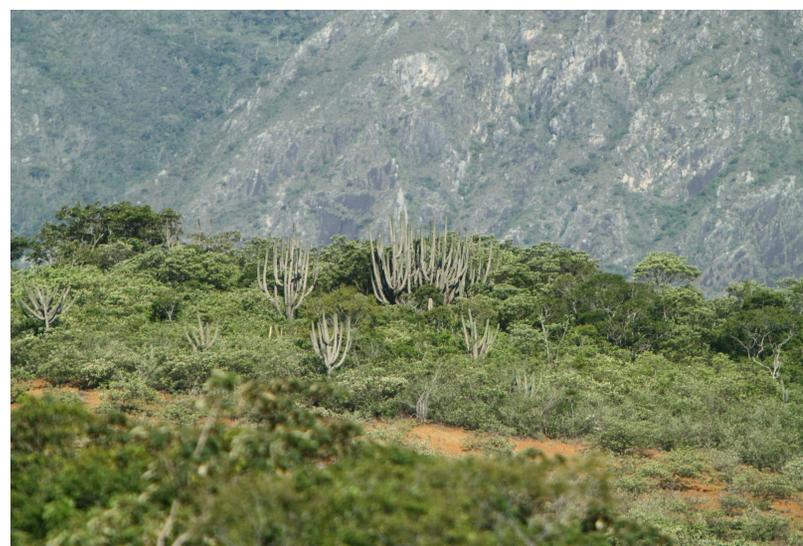
The red siskin (*Carduelis cucullata*)

## Summary

Tropical dry forests are amongst the most threatened ecosystems globally. To identify priority areas for the conservation of tropical dry forests around the city of Cucuta in northeastern Colombia, we followed a systematic planning approach. Field data on biodiversity was gathered in eight localities and was complemented with data from the bibliography and scientific collections. The number of species in the area included 93 butterflies, 18 amphibians, 140 birds, 31 bats and 21 mid-sized to large mammals. Species distribution ranges of butterflies and birds were estimated. According to the interviews with local people, mining is perceived as the main cause of forest loss and degradation. Priority areas were identified considering each animal group separately and altogether, setting conservation targets for threatened, endemic and dry forest-specialists. Selected areas varied between 8450 ha. and 9430 ha. The results of the project have been shared with the local authorities and were considered for the regional plan of land management.



Sight of the Pamplonita valley



Spiny shrub vegetation with columnar cacti

## Introduction

Tropical dry forests (TDF) are amongst the less studied and protected ecosystems. In Colombia, TDF have been identified as a priority ecosystem for conservation due to its low representativity within the national network of protected areas (Forero-Medina & Joppa 2010; Galindo et al. 2009). In comparison to tropical rainforests, TDF present lower species richness but higher endemism levels, with some species showing adaptations to low precipitation levels during long time periods (Murphy & Lugo 1986). Despite the low precipitation rate, soils covered by TDF are highly productive resulting in high human occupation and agricultural development, among other activities that threatened the maintenance of this ecosystem (Miles et al. 2006).

Some of the last and largest fragments of less disturbed TDF in Colombia occur around the city of Cucuta (Fig. 1). It is an important development centre in north-eastern Colombia with ca. 1 million people, high rates of urbanization and a highly active mining industry, which altogether threaten the persistence of TDF. The biodiversity of the area and the impacts of rapid development have been poorly assessed, making it difficult to plan and prioritize for conservation of this ecosystem. In order to safeguard a representation of TDF and its biodiversity, a system of protected areas that takes into account both development and conservation interests, needs to be established in this region.

Before starting the project, we knew about the presence of three threatened species in the TDF of Cucuta. One of these is the red siskin (*Carduelis cucullata*), a specialist of tropical dry

ecosystems, which is mainly threatened by habitat loss and illegal trade ((BirdLifeInternational 2008). The last register of red siskin in Cucuta was made in the year 2000 (López-Lanús 2000). A second threatened species in the area is the owl monkey (*Aotus griseimembra*), which is threatened by habitat loss and its use as medical research model in the 1960s and 1970s (Morales-Jiménez & Link 2008). Finally, tropical dry forests and shrubs in Cucuta make part of the visiting sites of the migratory bat (*Leptonycteris curasoae*). This nectarivorous-pollinivorous bat has a mutualistic relationship with columnar cacti and agavacean plants, which makes it a keystone species of tropical dry ecosystems (Soriano & Molinari 2008). Our surveys expanded the list to include another bat species globally threatened, the Tiny Yellow Bat (*Rhogeessa minutilla*), which is a specialist of dry ecosystems.

TDF in Cucuta face a very difficult challenge: poor knowledge and lack of interest on this ecosystem and its biodiversity among citizens and decision makers. The perception of these forests as spiny, dense and valueless vegetation cover among landowners increases their vulnerability to be trimmed down and replaced by pastures, crops or clay mines all over the area.

This project aimed to identify the fragments of tropical dry forest and shrubs that represent a conservation priority in the region of Cucuta based on the presence of populations of threatened, endemic and dry forest specialists. Priorization was also made taking into consideration the distribution of human processes that could be challenging for conservation (e.g. mining or urbanization plans). The protection of the areas identified in this project would be a starting point for the conservation of this threatened ecosystem in Colombia.

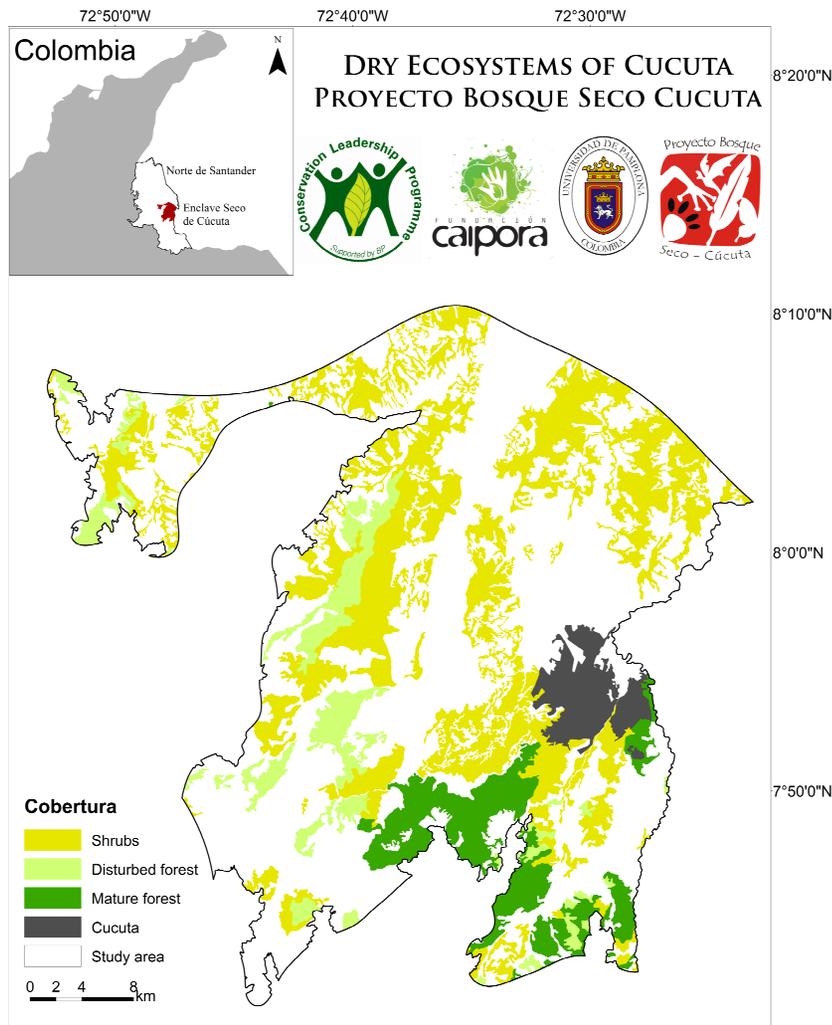


Figure 1. Study area of the project. Delimitation of the study area was made based on precipitation and temperature maps, so that it includes all the areas with mean annual precipitation under 1200 mm and mean annual temperature above 24 °C.

## Project Members

**Silvia J. Alvarez** – Biologist with a Master of Science in Biodiversity and Ecology. She has carried out research on the ecology of different mammalian species and is a cofounder of Fundación Caipora, where she’s been leading the project “PROYECTO BOSQUE SECO CUCUTA”. Silvia has also worked as researcher and instructor of conservation biology at the University of Pamplona in Colombia for three years. Currently, she is pursuing a PhD in Biological Sciences at the University of Maryland working on animal movement and grouping dynamics of spider monkeys. Silvia was in charge of the project coordination and data analyses.

**Diego R. Gutierrez** – Biologist with research experience in mammal ecology. He worked as researcher in the Group of Ecology and Biodiversity at the University of Pamplona, Colombia. He is currently pursuing a Master’s degree in Wildlife Conservation and Management at Universidad Nacional of Costa Rica. Diego was the field coordinator of the project and surveyed large to mid-sized mammals. He also developed part of the educational material.

**Arley O. Gallardo** – Biologist with research experience in bat ecology, birds and snakes. He is currently working as biologist at Acuameunier Ltda in Cucuta. During the field phase of the project, he surveyed bats and collected information on perception and attitudes of local people towards the dry forest.

**Orlando Armesto** – Biologist with research experience in amphibians. He is currently finishing his masters in Ecology at the Instituto Venezolano de Investigaciones Científicas in Venezuela. Orlando led the surveys of amphibians and helped with the development of educational and outreach material.

### **Students and volunteers**

Rubén D. Pacheco

Sara N. Poveda

Yarlenis Mercado

Lesly Peña

Sandra Milena Alvarez



### **Aim and Objectives**

Considering the threats to the maintenance of tropical dry forests in Cucuta, the project aimed to identify priority areas for the conservation of this ecosystem relying on animal diversity information.

Objective 1. Determination of spatial patterns in diversity of butterflies, frogs, birds, bats and mid to large mammals in the tropical dry ecosystems of Cucuta.

Objective 2. Identification of distribution ranges of the threatened species (*Carduelis cucullata*, *Aotus griseimembra* and *Leptonycteris curasoae*) and of landscape species (*Pecari tajacu* and *Puma concolor*) in the area of Cucuta. This objective was modified to include modelling the distribution ranges of all threatened species found during the surveys, endemic species and dry forest specialists. This change was made based on suggestions made by the reviewers and advisors of the project.

Objective 3. Determination of spatial patterns in main threats to biodiversity in the area (i.e. mining, agriculture, urbanization, hunting and climate change). Climate change was excluded since we lack climatic, environmental and spatial data to make this analysis. We added goats as another threat, since it is an invasive foreign species that ranges freely in the area and might have an impact on vegetation cover.

Objective 4. Identification of potential areas for implementing biodiversity conservation actions in Cucuta.

## Methodology

### Animal diversity in the tropical dry ecosystems of Cucuta

Seven localities were surveyed to determine species composition of butterfly, amphibian, bird, bats and mammal communities. For butterfly assessment four transects (500 m each) were surveyed using a hand net. Additionally, Van Someren Rydon traps were randomly distributed at 5 m height and left exposed for 10 hours/day in each locality, using fermented banana and decomposing fish as bait. All adult individuals found within a distance of 2.5 m from the transect and belonging to the superfamily Papilionoidea were collected.

For amphibians, six survey sites were selected in each locality, covering different habitats (e.g. creeks, rivers, artificial ponds, forests, and shrubs). Each site was visited twice to carry out a free search through visual inspection to count and collect samples of adult individuals and tadpoles. Collected specimens were conserved in alcohol (70%) and identified through taxonomic keys and expert consultation.

Bird surveys were carried out by visual/vocal detection on four transects (1 km each). Mist nets were also used from 5:30 to 9:30 am and in the afternoon (16:00 to 18:00). One field day was used to survey the red siskin based on play-back. Vocalizations were played 15 minutes in points distributed every 100 m along transects.

Mammals were surveyed outside fixed trails. Tracks, faeces and burrows were registered and negatives of tracks were



obtained to keep a register of species in the area. Surveys were carried out between 18:00 and 24:00 hours for four days, between 4:00 and 10:00 for two days, and between 14:00 and 19:00 for other four days. Hunters and local people were interviewed in each locality to complement the list.

Bats were surveyed from 18:00 to 24:00 hours using mist nets. Caves, old bridges, and other artificial roosts were also explored. Individuals were collected whenever species identification was not possible in the field. Given that *Leptonycteris curasoae* is a migratory bat, we used the presence and abundance of columnar cacti and agavacean plants in each locality as a surrogate of the species presence. Four transects (500 m each) were surveyed counting and registering the phenological status of all individuals of these plants. Plant samples were collected for taxonomic identification. All collected specimens of all groups were included in the Zoology collection of the Museo de Historia Natural José Celestino Mutis at the University of Pamplona in Colombia.

### Distribution patterns of species

Distribution patterns of species were obtained by means of two different approaches: 1) for species with six or more records, Maxent models (Phillips et al. 2006) were developed to predict distribution ranges in the area, and 2) for species

with less than 6 records, its distribution was defined by the habitat patches where they were found and no predictive models were developed. For predictive modeling, environmental variables including precipitation, altitude, aspect, slope, landcover type, distance to water, distance to urban centers were used.

### Distribution patterns of threats

Main threats were identified based on direct observation, structured interviews to local people on their perceptions of tropical dry forests, and information from local authorities and institutions, such as Corponor and Parques Nacionales de Colombia. Distributions of main threats to biodiversity in the area were determined based on land use and land cover maps as well as maps on mining areas and developmental plans of



Cucuta. The presence of goats, an introduced species that now ranges freely all over the area, was also considered a threat. Therefore, models of goat distribution were obtained based on Maxent models.

### Identification of priority areas for conservation

Distribution models of species were used for conservation planning (Sarkar et al. 2006), for which threatened, endemic and TDF specialists were given higher conservation targets. Scenarios were developed based on conservation goals for species occurrence and costs derived from human activities in

the area. A scenario considering goals for disturbed forest, primary forest and shrub covers was also developed. Marxan 2.1.1. (Ball & Possingham 2000) was used to create the models and identify alternative systems of protected areas. Scenarios were compared in terms of spatial distribution, species representativity and costs.

## Outputs and Results

### Spatial patterns in animal diversity

The TDF of Cucuta harbor at least 94 species of butterflies, 18 of amphibians, 140 of birds, 30 of bats, and 21 of mid- to large sized mammals (Table 1). From these, 62 correspond to first time records for the area. Complete lists of recorded species and first records are included in the Appendix 2.

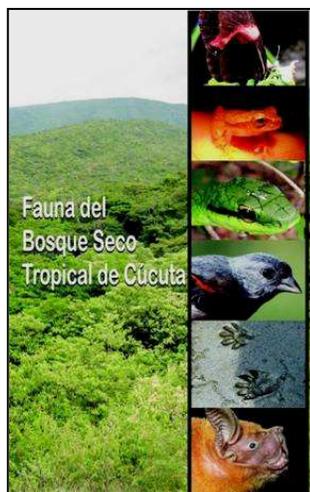
*Leptonycteris curasoae* and *Aotus griseimembra* were not registered in the area. The former is a migratory species that visits the area and it is probable that the surveys didn't match its visits to the area, given the low production of flowers and fruits by columnar cacti and *Agave* plants during the surveys. *A. griseimembra* was never recorded and only one



local person reported to having seen it recently. It was found in captivity at a wildlife rescue center in the area. It is possible that the population has been dramatically reduced or disappeared from this area.

Table 1. Species richness and conservation status of animal groups sampled in the Tropical Dry Forests of Cucuta.

	Butterflies	Amphibians	Birds	Bats	Mammals
Species richness	94	18	140	30	21
Threatened species	0	0	1	2	2
Endemic species	1	0	1	0	0
TDF specialists	6	0	56	4	0



Species richness of butterflies varied between 2 and 33 species in surveyed patches. A forest patch of only 23 ha included the highest number of butterfly species (Fig. 2). The number of bird species varied between 22 and 51 among surveyed patches, with the highest richness in two forest patches in the south of the study area (Fig. 2). Amphibians, bats and mammals also presented the highest richness in the south, following a similar spatial pattern to that of butterflies and birds.

A field guide of the Fauna of Cucuta (“Fauna del Bosque Seco Tropical de Cúcuta”) was designed, published and shared with local people and school students (5 schools, 150 students, 3<sup>rd</sup> and 6<sup>th</sup> grade students) during informative workshops.

### Distribution patterns of species

A distribution model was obtained for each species. Here, we include the maps of threatened species given global and national red lists (Fig. 3), which had a higher weight in the definition of priority areas, together with endemic and TDF specialists. We also included distribution maps of the columnar cacti (*Stenocereus griseus*), (*Subpylocereus repandus*) and agave (*Agave* sp.), which represent potential foraging areas for *Leptonycteris curasoae*.

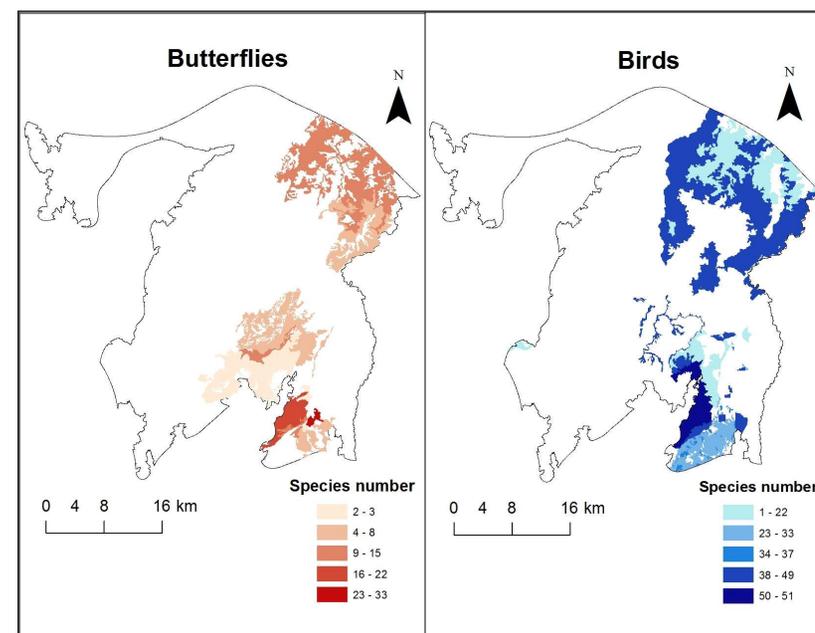


Figure 2. Distribution of bird and butterfly species richness in the tropical dry ecosystems of Cúcuta.

*Carduelis cucullata* was only registered in three out of the seven survey sites, while there were no reports of *Aotus griseimembra* in any of the sites. *Rhogeessa minutilla* was collected in two of the seven sites.

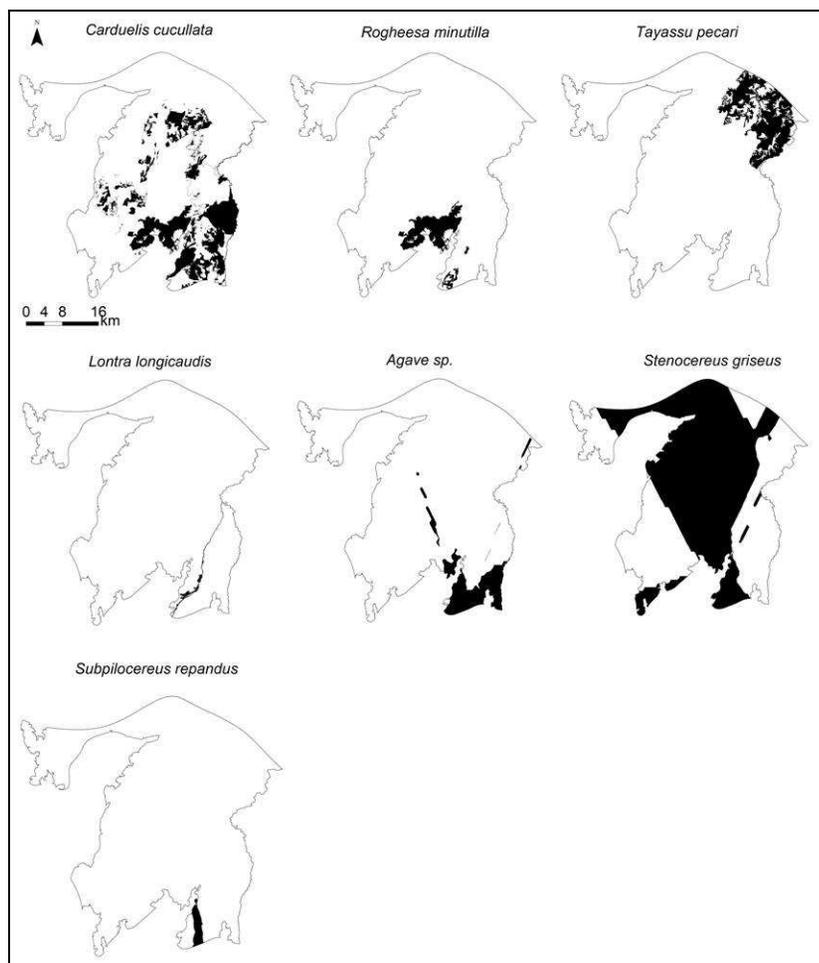


Figure 3. Potential distribution ranges of threatened and data deficient species in the tropical dry forests of Cucuta.

### Distribution patterns of threats

Main threats to forest conservation in Cucuta included mining, urbanization, hunting, goats, and agriculture (crops and cattle). Based on interviews (n=50), almost 50% of the local people considered mining the main threat to conservation of tropical dry forests (Fig. 4), while goats and urbanization were not recognized as threats or problematic for forest conservation by any person. Model of the distribution patterns of crops, pastures, goats, urbanization and mining can be found in Appendix 3.

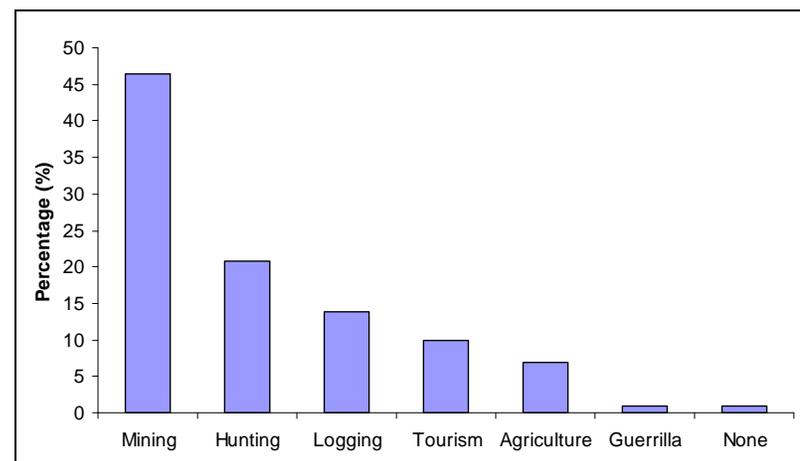


Figure 4. Percentage of local people identifying different human activities as main threat to dry forest conservation.

In general, people seemed to be aware of forest and species loss in the area without considering it a problem. Only few people interviewed recognized themselves as part of the

solution and were willing to do something about it, including two land owners.



We carried out workshops with the communities close to each of the survey sites (5 workshops, 90 people), to share the results of the study and to raise awareness towards the importance of protecting the tropical dry forests of Cucuta. T-shirts, leaflets and guides were

shared with the community.

To reach people in the city of Cucuta and those interested in tropical dry forest conservation, we developed a website for the project ([proyectobosqueseco.weebly.com](http://proyectobosqueseco.weebly.com)) and a facebook site (<http://www.facebook.com/pages/Proyecto-Bosque-Seco-Cucuta-PBSC/156095679079>), which already counts with 902 fans. They have helped us to call the attention of Cucuta citizens towards tropical dry forest conservation and to contact other people working on other environmental issues in the area.

### Priority areas for conservation

Priority areas were identified for each one of the groups, except for amphibians due to the lack of threatened, endemic or dry-forest specialists found during the survey (Fig. 5). Selected areas ranged between 8450 ha and 9430 ha among different scenarios and differed spatially, with correlation coefficients ( $r$ ) ranging between 0.18 and 0.48. The less

similar scenarios correspond to butterflies and birds, while the most similar ones were those of mammals and bats. When related to the scenario where all animal groups were included, the highest correlation corresponded to mammals. Correlation with the cover-only scenario was low, with the highest coefficient corresponding to butterflies ( $r=0.51$ ).

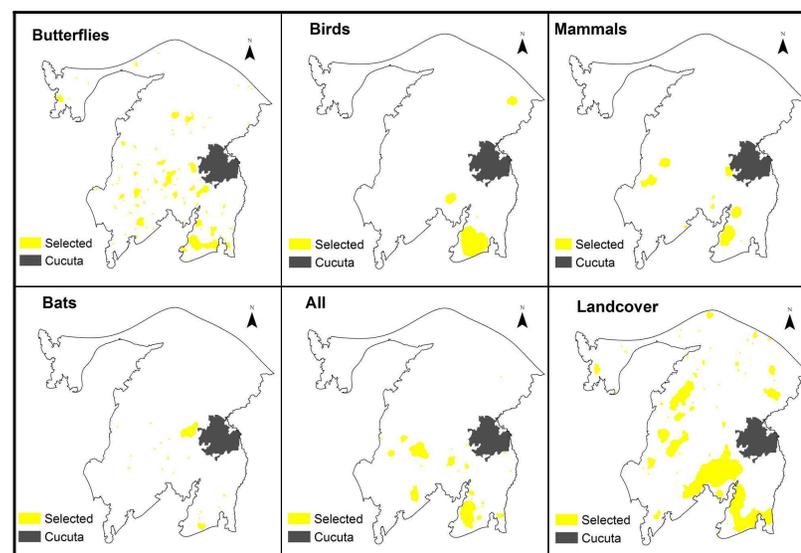


Figure 5. Priority areas for conservation of tropical forests of Cucuta using different animal groups as surrogates.

Representativity was high in all scenarios, varying between 89% for the bats scenario and 100% for mammals, butterflies and the all-groups scenarios. When cover only was considered representativity was 100%. The type of ecosystems selected varied between models (Fig. 6). Priority areas for butterflies, birds and mammals corresponded mostly to undisturbed forest, while bats and all-groups resulted in the selection of a higher percentage of disturbed forests. Shrubs were poorly

represented in all models. Costs were higher for butterflies than for any other group and were higher for cover-only than for the scenarios based on species presence.

These results were shared with the local government and CORPONOR (environmental authority) for consideration in the new land management plan of 2011. Two meetings were prepared together with CORPONOR staff, and hold with local stakeholders, including representatives of the mayor's office, the Metropolitan Area of Cucuta, CORPONOR, two NGO's, miners (Asocarbón) and universities (U. Pamplona and U. Francisco de Paula Santander). In this meeting, the need for a definition of a system of protected areas in Cucuta was discussed. Results were also shared with local land owners and communication has been maintained with two land owners who have considered the possibility of declaring a private reserve. The declaration of a national park in the area was stopped due to mining conflicts in most of the area covered by tropical dry forest in Cucuta.

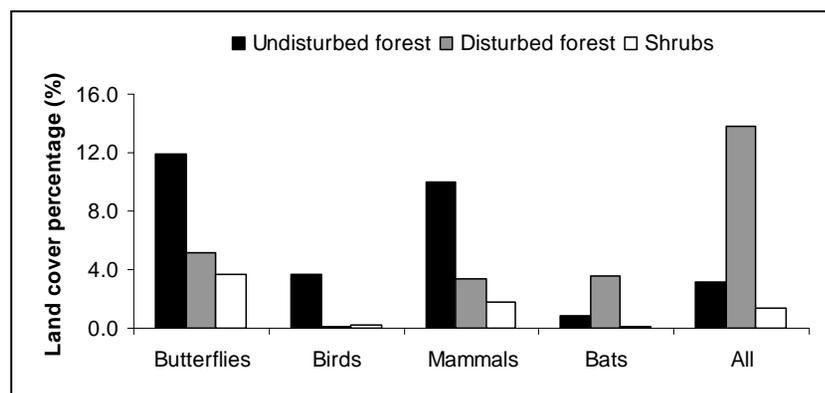


Figure 6. Representativity of main tropical dry ecosystems in each priority scenario.

## Achievements and Impacts

Regarding species inventories, this project is the most complete inventory of animals ever carried out in the area. It presents basic information on terrestrial vertebrate and butterfly species in the tropical dry forest of Cucuta, complementing the biodiversity inventory of Colombia. The first registry of several species was obtained, amplifying their distributional ranges. This project also resulted in the first report of the red siskin since the year 2000. The founding of another threatened bat *Rhogeessa minutilla* (VU), which is a tropical dry forest specialists reflects the need for further studies of the fauna associated to this ecosystem, including population status and other ecological aspects. These results have not only been shared with the local communities but with other researchers and scientists during the II National Conference of Zoology (2010) and the I National Conference of Mammalogy (2011) in Colombia. In the latter, one of our team members (Diego R. Gutierrez) obtained the award for Best work in Mammal Conservation.



Children learning about the tropical dry forest fauna.

The lack of reports of the two threatened species *Aotus griseimembra* and *Leptonycteris curasoae* might be an indication of local extinction of the former, while for the latter further studies are needed to confirm its visits to the area are still occurring. The absence of *L. curasoae* might have an impact on the populations of columnar cacti (Sosa & Soriano 1993), further deteriorating dry ecosystems in the area.

Identification of the main threats to biodiversity in the area, as well as the perceptions of local people towards deforestation and tropical dry forest disturbance is an asset for the definition of strategies to protect these forests and the identification of important stakeholders.



Coal mining and brick fabrication threaten the conservation of tropical dry forests in Cucuta.

Through participation of 8 undergraduate students from the Universidad de Pamplona in the project, the region counts now with people prepared to engage and support further activities directed to protect tropical dry forests in the area.

These students not only gained field experience but training to approach conservation issues in this and other regions of Colombia.

The project provides a proposal of the areas that need to be protected in order to maintain a representation of the biodiversity of these tropical dry forests. Most important, it considers the costs associated to their conservation, giving further elements to add on decision making processes in the region. The establishment and management of these areas will need the support of local people as well as environmental authorities, since the most viable option in the area at this moment is the creation of private reserves.



Mammals have a larger influence on the identification of priority areas than other groups and are recommended as surrogate for further priority exercises in the region or other tropical dry forest regions. Mammals are a relatively well-known group, so that its use as surrogate can rely on biodiversity and species distributions databases, avoiding the need for further field surveys, thus reducing costs and time investments.

## Conclusions

- Species richness in the tropical dry forest corresponded to 93 butterflies, 18 amphibians, 140 birds, 31 bats and 21 mid-sized to large mammals.
- There are five threatened species in the area, three of them at a global scale and two at the national scale.
- Mining is the main threat to the conservation of tropical dry forests in Cucuta.
- Conservation of more than 90% of the threatened, endemic and dry-forest-specialist species would require the protection of at least 8450 ha.
- Mammals have a larger influence on the identification of priority areas than other groups and are recommended as surrogate for further priority exercises in the region.

## Problems and lessons

Although the survey scheme was changed, field-work was very productive and led us to learn from people and the environment about the challenges for conservation in the area. It was effective and allowed us to identify priorities for conservation. The importance of team work during this part was evident and added to the formation of a camaraderie spirit within the group (team members and students).

The identification of priority areas was a very enriching and gratifying part of the project. Not only due to the technical lessons learnt during the analysis but because it actually produced information that was lacking before and was/will be needed to support management plans in the region, local management decisions by mining companies, and research opportunities for further understanding of tropical dry forests.

The survey scheme was changed to ensure more complete inventories in each area, which resulted in a reduction of areas surveyed. Presence of armed groups in some areas around Cucuta also limited access to survey interesting sites.

Desertion of two team members due to economic needs and career development interests, lead us to reorganize the team and reassign activities. Students were involved and became very active in some activities, especially during field work. Involving undergraduate students in this project was important because it helped us to turn their universities into partners of the project, students were highly enthusiastic about learning and doing anything related to biodiversity conservation, and they were trained in the field of biodiversity survey and conservation.

Lack of interest for conservation by top managers of the environmental authority CORPONOR was a barrier that slowed any plan to discuss the possibility of a protected area system of tropical dry forests. It also hold back the development of the project, since organization of meetings with them or other stakeholder were frequently rescheduled.

Poor knowledge and awareness about tropical dry forests and biodiversity in general among the community, limited involving some of the stakeholders since the beginning of the project. Therefore, field guide, leaflets and t-shirts were distributed among local people. The website and facebook pages are intended share information on tropical dry forest among people in the city in an attempt to change attitudes towards this ecosystem.

## In the future

1. A conservation plan for the red siskin *Carduelis cucullata* is needed. The species is rare in the area, and ecological studies covering habitat use and population dynamics are needed to generate basic information for further decision making on the species conservation.

2. A conservation plan of the *Rhogeessa minutilla* should be developed in collaboration with researchers from other dry forest areas in its distribution range. A system to collect and exchange information on the distribution and ecology of the species should be designed, to evaluate knowledge gaps and prioritize actions for its conservation.

3. Columnar cacti, agave and dry forest plants depend on pollinators and frugivores for the maintenance of their populations and viceversa. A strategy to protect these interactions should be designed and implemented, focusing on pollinating bats and birds. The role of the tropical dry forests of Cucuta as foraging site for the migratory pollinator

*Leptonycteris curasoae* should be secured since it might have an impact on its population.

4. Mining impact on biodiversity and tropical dry forests, considering both coal and clay mining should be analyzed. Illegal mining poses a challenge. A collaboration with authorities and legal miners should be seek to define strategies to control illegal mining but also to reduce the impact of legal mining on tropical dry forests.

5. Encourage and support land owners in the creation of private reserves. In collaboration with local environmental authorities deliver information to land owners on economical benefits and legal processes needed for the creation of private reserves.

6. An education program to modify perception and generate changes in the society of Cucuta towards the conservation of tropical dry forests. A general lack of information on the environmental services offered by these forests challenges the implementation and effectiveness of conservation plans in the area.

Therefore a media campaign showing the importance of tropical dry forest conservation for Cucuta and the insertion of the topic in schools curricula need to be implemented.



## Appendixes

### Appendix 1. The project in the media and outreach activities



- On the 13<sup>th</sup> February 2010 the most important newspaper in the region (La Opinión) published a whole paper report about the project. [http://www.laopinion.com.co/noticias/index.php?option=com\\_content&task=view&id=345323&Itemid=91](http://www.laopinion.com.co/noticias/index.php?option=com_content&task=view&id=345323&Itemid=91)
- The Universidad de Pamplona made a film about the project which can be seen on YouTube (<http://www.youtube.com/watch?v=Vp3ax4ptBrE>) and was emitted in the Channel TRO, the regional channel of Northeastern Colombia.
- A brief note on the regional section of La Opinión. [http://www.laopinion.com.co/noticias/index.php?option=com\\_content&task=view&id=345575&Itemid=28](http://www.laopinion.com.co/noticias/index.php?option=com_content&task=view&id=345575&Itemid=28)

## Appendix 2. Species lists

Appendix 2.1. List of butterfly species registered in the tropical dry forests of Cucuta.

Family	Subfamily	Species
Ithomiidae	Ithomiinae	<i>Dircenna jemina</i> (Geyer, 1837)
Lycaenidae	Polyommatainae	<i>Leptotes cassius</i> (Cramer, 1775)
	Theclinae	<i>Strephonota sphinx</i> (Fabricius, 1775)
	Theclinae	<i>Strymon</i> sp.
	Theclinae	<i>Strymon albata</i> (Felder, 1865)
Nymphalidae	Apaturinae Biblidinae	<i>Arawacus leucogyna</i> (Kaye 1904)
		<i>Calycopis beon</i> (Cramer 1780)
		<i>Hemihargus hanno</i> (Butler & Druce, 1872)
		<i>Pseudolycaena marsyas</i> (Linnaeus, 1758)
		<i>Doxocopa</i> sp.
		<i>Dynamine tithia</i> (Hübner, 1823)
		<i>Dynamine agacles</i> (Dalman, 1823)
		<i>Dynamine artemisia</i> (Bates, 1865)
		<i>Dynamine postverta</i> (Cramer, 1780)
		<i>Dynamine</i> sp. 1
<i>Dynamine</i> sp. 2		
<i>Dynamine theseus</i> (C. Felder & R. Felder, 1861)		
<i>Ectima</i> sp.		
<i>Haematera pyrame</i> (Hübner, 1819)		
<i>Hamadryas amphichloe</i> (Boisduval, 1870)		
<i>Hamadryas amphinome</i> (Linnaeus, 1767)		
<i>Hamadryas</i> sp.		
<i>Mestra hypermestra</i> (Hubner 1825)		

Family	Subfamily	Species
		<i>Myscelias leucocyana</i> (Doubleday, 1848)
		<i>Pyrrha</i> sp.
		<i>Pyrrhogyra neaerea</i> (Linnaeus, 1758)
	Charaxinae	<i>Temenis laothoe</i> (Cramer, 1777)
		<i>Archaeoprepona demophon</i> (Linnaeus, 1758)
		<i>Fountainea martinezi</i> ( Maza & Díaz, 1978)
		<i>Hypna rufescens</i> (Butler)
	Danainae	<i>Memphis pithyusa</i> (R. Felder, 1869)
		<i>Aeria elara</i> (Hewitson, 1855)
		<i>Danaus gilippus</i> (Cramer, 1775)
		<i>Danaus plexippus</i> (Linnaeus, 1758)
		<i>Ithomia iphianassa</i> (Doubleday, 1847)
		<i>Lycorea cleobacea</i> (Doubleday, 1847)
	Heliconiinae	<i>Pteronymia aletta</i> (Hewitson, 1855)
		<i>Agraulis vanillae</i> (Linnaeus, 1758)
		<i>Dryas iulia</i> (Fabricius, 1775)
		<i>Euptoieta hegesia</i> (Cramer, 1779)
		<i>Heliconius erato</i> (Linnaeus, 1758)
		<i>Heliconius ethilla</i> (Godart, 1819)
	Ithomiinae	Unidentified
		<i>Athesis clearista</i>
		<i>Mechanitis lysimnia</i> (Fabricius, 1793)
		<i>Mechanitis menapis caribensis</i>
		<i>Mechanitis polymnia</i> (Linnaeus, 1758)
		<i>Mechanitis</i> sp. 1
		<i>Mechanitis</i> sp. 2
		<i>Mechanitis</i> sp. 3
		<i>Tithorea harmonia</i>

Family	Subfamily	Species
	Libytheinae	Unidentified
	Limenitidinae	<i>Libytheana carinenta</i> (Cramer, 1777)
	Morphinae	<i>Marpesia chiron</i> (Fabricius, 1775)
	Nymphalinae	<i>Morpho helenor</i> (Cramer, 1776)
		<i>Anartia amathea</i> (Linnaeus, 1758)
		<i>Anartia jatrophae</i> (Linnaeus, 1763)
		<i>Anthanassa drusilla</i> (C. Felder & R. Felder 1861)
		<i>Junonia genoveva</i> (C. & R. Felder, 1867)
		<i>Siproeta stelenes</i> (Linnaeus, 1758)
	Satyrinae	<i>Tegossa anieta</i> (Hewitson, 1864)
		<i>Euptichia</i> sp.
		<i>Hermeuptychia hermes</i> (Fabricius, 1775)
		<i>Pharnaueptychia hermes</i>
		<i>Taygetis virgilia</i> (Cramer, 1776)
		Unidentified 1
		Unidentified 2
		<i>Hypothyris</i> sp.
		<i>Hypothyris lycaste</i> (Fabricius, 1793)
		<i>Pteronymia lisa</i>
Papilionidae	Papilioninae	Unidentified (Nymphalidae)
		<i>Battus polydamas</i> (Linnaeus, 1758)
		<i>Mimoides phaeon</i> (Boisduval, 1836)
		<i>Parides erithalion</i> (Boisduval, 1836)
		<i>Parides eurimedes</i> (Bates, 1861)
Pieridae	Coliadinae	<i>Papilio lycophron</i>
		<i>Aphrisa boisduvalii</i> (C. Felder & R. Felder, 1861)
		<i>Ascia</i> sp. 2
		<i>Eurema xanthochlora</i> (Kollar, 1850)

Family	Subfamily	Species
		<i>Eurema albula</i> (Cramer, 1775)
		<i>Eurema daira</i> (Wallengren, 1860)
		<i>Eurema elathea</i> (Cramer, 1775)
		<i>Eurema gratiosa</i> (Doubleday, 1847)
		<i>Eurema proterpia</i> (Fabricius, 1775)
		<i>Eurema</i> sp. 1
		<i>Eurema</i> sp. 2
		<i>Melete lycimnia</i> (Cramer, 1777)
		<i>Phoebis philea</i>
		<i>Phoebis sennae</i>
	Pierinae	<i>Pyrisitia nise</i> (Cramer, 1775)
		<i>Ascia monuste</i> (Linnaeus, 1764)
Riodinidae	Riodininae	<i>Ascia</i> sp. 1
		<i>Melanis iarbass</i> (Fabricius, 1787)
		<i>Rhetus arcus</i> (Linnaeus, 1763)

Appendix 2.2. List of amphibian species registered in the tropical dry forests of Cucuta.

Order	Family	Species
Anura	Bufonidae	<i>Rhinella granulosa</i>
		<i>Rhinella marina</i>
	Hylidae	<i>Dendropsophus microcephalus</i>
		<i>Scarthyla vigilans</i>
		<i>Hypsiboas crepitans</i>
		<i>Hypsiboas boans</i>
		<i>Scinax rostratus</i>
		<i>Scinax ruber</i>
	Leptodactylidae	<i>Phyllomedusa cf. tarsi</i>
		<i>Leptodactylus insularum</i>
		<i>Leptodactylus poecilochilus</i>
		<i>Leptodactylus lineatus</i>
		<i>Physalemus pustulosus</i>
		Microhylidae
	Ranidae	<i>Lithobates palmipes</i>
	Strabomantidae	<i>Pristimantis</i> sp.
	Pipidae	<i>Pipa parva</i>
Gymnophiona	Caeciliidae	<i>Typhlonectes natans</i>

Appendix 2.3. List of bird species registered in the tropical dry forests of Cucuta.

Family	Genus	Species
Accipitridae	<i>Chondrohierax</i>	<i>uncinatus</i>
Alcedinidae	<i>Chloroceryle</i>	<i>amazona</i>
	<i>Chloroceryle</i>	<i>americana</i>
Apodidae	<i>Streptoprocne</i>	<i>zonaris</i>
Ardeidae	<i>Bulbucus</i>	<i>ibis</i>
	<i>Casmerodius</i>	<i>albus</i>
	Ibis	unidentified
	<i>Phimosus</i>	<i>infuscatus</i>
	<i>Pilherodius</i>	<i>pileatus</i>
	<i>Syrigma</i>	<i>sibilatrix</i>
Bucconidae	<i>Hypnelus</i>	<i>ruficollis</i>
Caprimulgidae	<i>Caprimulgus</i>	<i>cayanensis</i>
	<i>Caprimulgus</i>	<i>rufus</i>
Cathartidae	<i>Cathartes</i>	<i>aura</i>
	<i>Coragyps</i>	<i>atratus</i>
	<i>Vanellus</i>	<i>chilensis</i>
Coerebidae	<i>Coereba</i>	<i>flaveola</i>
Columbidae	<i>Claravis</i>	<i>pretiosa</i>
	<i>Columbina</i>	<i>minuta</i>
	<i>Columbina</i>	<i>passerina</i>
	<i>Columbina</i>	<i>talpacoti</i>
	<i>Leptotila</i>	<i>verreauxi</i>
	<i>Zenaida</i>	<i>auriculata</i>
Corvidae	<i>Cyanocorax</i>	<i>affinis</i>
Cotingidae	<i>Tityra</i>	<i>inquisitor</i>
Cracidae	<i>Ortalis</i>	<i>ruficauda</i>
	<i>Penelope</i>	<i>purpurascens</i>
Cuculidae	<i>Crotophaga</i>	<i>ani</i>

Family	Genus	Species
	<i>Crotophaga</i>	<i>sulcirostris</i>
	<i>Piaya</i>	<i>cayana</i>
	<i>Piaya</i>	<i>minuta</i>
	<i>Tapera</i>	<i>naevia</i>
Dendrocolaptidae	<i>Campylorhamphus</i>	<i>pusillus</i>
	<i>Lepidocolaptes</i>	<i>souleyetii</i>
	<i>Xiphorhynchus</i>	<i>guttatus</i>
	<i>Xiphorhynchus</i>	<i>picus</i>
Ebmerizidae	<i>Arremonops</i>	<i>conirostris</i>
	<i>Tiaris</i>	<i>olivaceus</i>
Falconidae	<i>Buteo</i>	<i>albicaudatus</i>
	<i>Buteo</i>	<i>magnirostris</i>
	<i>Buteo</i>	<i>nitidius</i>
	<i>Buteogallus</i>	<i>meridionalis</i>
	<i>Falco</i>	<i>femoralis</i>
	<i>Falco</i>	<i>rufigularis</i>
	<i>Falco</i>	<i>sparverius</i>
	<i>Herpetotheres</i>	<i>cachinans</i>
<i>Milvago</i>	<i>chimachima</i>	
Formicariidae	<i>Polyborus</i>	<i>plancus</i>
	<i>Cercomacra</i>	<i>nigricans</i>
	<i>Formicivora</i>	<i>grisea</i>
	<i>Myrmeciza</i>	<i>longipes</i>
	<i>Myrmotherula</i>	<i>axilaris</i>
	<i>Thamnophilus</i>	<i>doliatus</i>
	<i>Thamnophilus</i>	<i>melanonotus</i>
	<i>Thamnophilus</i>	<i>multistriatus</i>
Fringilidae	<i>Ammodramos</i>	<i>aurifrons</i>
	<i>Carduelis</i>	<i>cucullata</i>
	<i>Carduelis</i>	<i>psaltria</i>

Family	Genus	Species
	<i>Phrygilus</i>	<i>unicolor</i>
	<i>Saltator</i>	<i>albicollis</i>
	<i>Saltator</i>	<i>coerulensis</i>
	<i>Sicalis</i>	<i>flaveola</i>
	<i>Sporophila</i>	<i>nigricollis</i>
	<i>Sporophila</i>	<i>schistacea</i>
	<i>Volantina</i>	<i>jacarina</i>
Furnariidae	<i>Xenerpestes</i>	<i>minlosi</i>
Galbulidae	<i>Galbula</i>	<i>ruficauda</i>
Hirudinidae	<i>Notiochelidon</i>	<i>cyanoleuca</i>
	<i>Phaeoprogne</i>	<i>tapea tapea</i>
Icteridae	<i>Icterus</i>	<i>mesomelas</i>
Mimidae	<i>Mimus</i>	<i>gilvus</i>
Parulidae	<i>Basileuterus</i>	<i>flaveolus</i>
Picidae	<i>Chrysoptilus</i>	<i>punctigula</i>
	<i>Dryocopus</i>	<i>lineatus</i>
	<i>Melanerpes</i>	<i>rubricapillus</i>
	<i>Picumnus</i>	<i>olivaceus</i>
	<i>Picumnus</i>	<i>squamulatus</i>
	<i>Vernilionis</i>	<i>kirkii</i>
Pipridae	<i>Machaeropterus</i>	<i>regulus</i>
Psittacidae	<i>Brotojenis</i>	<i>jugularis</i>
	<i>Forpus</i>	<i>conspicillatus</i>
Rallidae	<i>Aramides</i>	<i>cajanea</i>
Scolopacidae	<i>Actitis</i>	<i>macularia</i>
Stringidae	<i>Otus</i>	<i>choliba</i>
Sylviidae	<i>Polioptila</i>	<i>plumbea</i>
Thraupidae	<i>Conirostrum</i>	<i>leucogenys</i>
	<i>Eucometis</i>	<i>penicillata</i>

Family	Genus	Species
	<i>Euphonia</i>	<i>laniirostris</i>
	<i>Euphonia</i>	<i>trinitratis</i>
	<i>Habia</i>	<i>rubica</i>
	<i>Nemosia</i>	<i>pileata</i>
	<i>Piranga</i>	<i>flava</i>
	<i>Piranga</i>	<i>rubra</i>
	<i>Ramphocelus</i>	<i>dimidiatus</i>
	<i>Tachiphonus</i>	<i>luctuosus</i>
	<i>Tachiphonus</i>	<i>rufus</i>
	<i>Tangara</i>	<i>cayana</i>
	<i>Tangara</i>	<i>cyanicollis</i>
	<i>Tangara</i>	<i>vitriolina</i>
	<i>Thraupis</i>	<i>episcopus</i>
Trochilidae	<i>Amazilia</i>	<i>tzacatl</i>
	<i>Chlorostilbon</i>	<i>mellisugus</i>
	<i>Chrysolampis</i>	<i>mosquitus</i>
	<i>Colibri</i>	<i>delphinae</i>
	<i>Glaucis</i>	<i>hirsuta</i>
	<i>Phaethornis</i>	<i>augusti</i>
	<i>Phaethornis</i>	<i>griseogularis</i>
	<i>Phaethornis</i>	<i>guy</i>
	Unidentified 1	
Troglodytidae	<i>Campylorhynchus</i>	<i>nuchalis</i>
	<i>Campylorhynchus</i>	<i>zonatus</i>
	<i>Thryothorus</i>	<i>leucotis</i>
	<i>Thryothorus</i>	<i>rufalbus</i>
	<i>Troglodytes</i>	<i>aedon</i>
Turdidae	<i>Turdus</i>	<i>nudigenis</i>
Tyrannidae	<i>Atalotriccus</i>	<i>pilaris</i>
	<i>Camptostoma</i>	<i>obsoletum</i>

Family	Genus	Species
	<i>Chiroxiphia</i>	<i>lanceolata</i>
	<i>Cnemotriccus</i>	<i>fuscatus</i>
	<i>Contopus</i>	<i>cinereus</i>
	<i>Elaenia</i>	<i>chiriquensis</i>
	<i>Elaenia</i>	<i>flavogaster</i>
	<i>Empidonax</i>	<i>euleri</i>
	<i>Legatus</i>	<i>leucophaeus</i>
	<i>Leptopogon</i>	<i>supersiliaris</i>
	<i>Machetornis</i>	<i>rixosus</i>
	<i>Megarhynchus</i>	<i>pitangua</i>
	<i>Myiodynastes</i>	<i>maculatus</i>
	<i>Myozetetes</i>	<i>similis</i>
	<i>Pachyramphus</i>	<i>cinnamomeus</i>
	<i>Phaeomyias</i>	<i>murina</i>
	<i>Pitangus</i>	<i>sulphuratus</i>
	<i>Pyrocephalus</i>	<i>rubinus</i>
	<i>Sayornis</i>	<i>nigricans</i>
	<i>Todirostrum</i>	<i>cinereum</i>
	<i>Tolmomyas</i>	<i>flaviventris</i>
	<i>Tyrannus</i>	<i>melancholicus</i>
Tytonidae	<i>Tyto</i>	<i>alba</i>
Vireonidae	<i>Cyclarhis</i>	<i>gujanensis</i>
	<i>Hylophilus</i>	<i>flavipes</i>

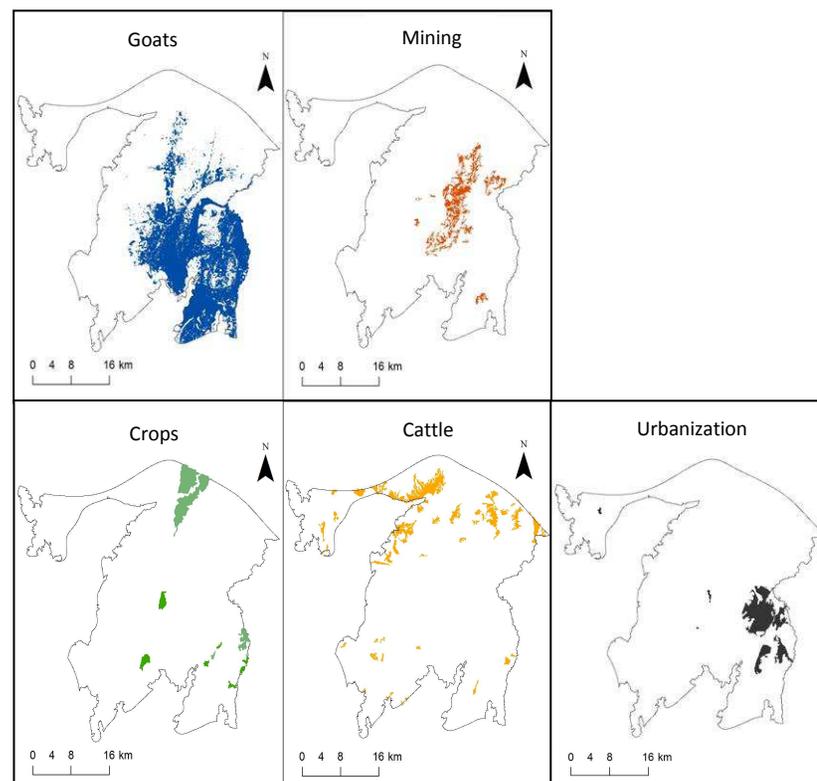
Appendix 2.4. List of bat species registered in the tropical dry forests of Cucuta.

Family	Subfamily	Species
Molossidae	Molossinae	<i>Cynomops greenhalli</i> <i>Eumops</i> sp. <i>Molossus currentium</i> <i>Molossus molossus</i> <i>Molossus pretiosus</i>
Moormopidae		<i>Pteronotus parnelli</i> <i>Pteronotus davyi</i>
Noctilionidae		<i>Noctilio albiventris</i>
Phyllostomidae	Carollinae	<i>Carollia perspicillata</i>
	Glossophaginae	<i>Glossophaga longirostris</i> <i>Glossophaga soricina</i>
	Phyllostominae	<i>Micronycteris microtis</i> <i>Phyllostomus discolor</i> <i>Lonchorrhina aurita</i> <i>Lophostoma silvicolium</i> <i>Micronycteris schmidtorum</i> <i>Lampronnycteris brachyotis</i>
	Stenodermatinae	<i>Artibeus jamaicensis</i> <i>Artibeus lituratus</i> <i>Artibeus obscurus</i> <i>Platyrhinus helleri</i> <i>Uroderma bilobatum</i> <i>Uroderma magnirostrum</i> <i>Sturnira lilium</i> <i>Sturnira cf. luisi</i>
Vespertilionidae		<i>Lasiurus blossevillii</i> <i>Eptesicus brasiliensis</i> <i>Myotis nigricans</i> <i>Rhogeessa io</i> <i>Rhogeessa minutilla</i>
Emballonouridae		<i>Peropteryx macrotis</i>

Appendix 2.5. List of mid to large sized mammal species registered in the tropical dry forests of Cucuta.

Order	Family	Scientific Name
Carnivora	Canidae	<i>Cerdocyon thous</i>
		<i>Leopardus pardalis</i>
	Felidae	<i>Leopardus wiedi</i>
		<i>Panthera onca</i>
		<i>Puma concolor</i>
	Mustelidae	<i>Eira barbara</i>
		<i>Lontra longicaudis</i>
Procyonidae	<i>Procyon cancrivorus</i>	
Cingulata	Dasypodidae	<i>Dasypus novemcinctus</i>
Pilosa	Bradypodidae	<i>Bradypus variegatus</i>
	Myrmecophagidae	<i>Tamandua mexicana</i>
Primates	Cebidae	<i>Alouatta seniculus</i>
		<i>Cebus albifrons</i>
Rodentia	Caviidae	<i>Hydrochoerus hydrochaeris</i>
	Cuniculidae	<i>Cuniculus paca</i>
	Dasyproctidae	<i>Dasyprocta punctata</i>
	Erethizontidae	<i>Coendou bicolor</i>
	Sciuridae	<i>Sciurus granatensis</i>
Artiodactyla	Cervidae	<i>Mazama americana</i>
		<i>Odocoileus virginianus</i>
	Tayassuidae	<i>Pecari tajacu</i>

### Appendix 3. Distribution of human activities representing main threats to the conservation of tropical dry forests in Cucuta.



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