CLP project ID : 02186714

Conservation of Salamanders from Santander

Conservation Status Assessment of Salamanders in Santander, Colombia.

Overall aim:

The aim of this study was to provide baseline information regarding species richness, population densities, distribution and conservation status of plethodontid salamanders in Santander, Colombia.

Authors:

Carlos Andrés Hernández-Jaimes
Grupo de Investigación en Biotecnología Industrial y Biología Molecular.
Escuela de Biología. Universidad Industrial de Santander.
c.andreshj@gmail.com

Oscar Yesid Hernández-Lagos
Grupo de Investigación en Biotecnología Industrial y Biología Molecular.
Escuela de Biología. Universidad Industrial de Santander.
megoskr@gmail.com

Fabio Leonardo Meza-Joya
Grupo de Estudios en Biodiversidad.
Escuela de Biología. Universidad Industrial de Santander.
fabio.meza@correo.uis.edu.co

Eliana Patricia Ramos-Pallares
Grupo de Estudios en Biodiversidad.
Escuela de Biología. Universidad Industrial de Santander.
elianar86@gmail.com

Contact infromation:

Host country and site location:
República de Colombia, Santander Department

Permanent contact address:
Calle 35 N° 27 – 78, Barrio La Aurora, Edificio San Pietro, Apartamento 801, Bucaramanga, Santander, Colombia.

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Conservation Leadership Programme

TABLE OF CONTENTS

Project partners & Collaborators

During the course of this project we had the invaluable opportunity to meet a lot interesting and caring people including scientists, conservationists, teachers and community leaders with a strong environmental focus. In this sense, we wish to extend our acknowledgements to everyone that participated in any way in our project. None of this could have been possible without the financial support, training, and most importantly, the trust and support that Conservation Leadership Programme deposited on our team and work so as to become ambassadors and represent our country with our first conservation project.

Special thanks to all of the wonderful people from CLP staff: Robyn Dalzen, Iain Dickson, Julie Jackson Lewis, Christina Imrich, Stuart Paterson and Kiragu Mwangi, their teachings and memories will always be the seed that turned us into conservationists. Also, the staff from Barrier Lake Station in Alberta, Canada for their logistic help during the training workshop. Thanks to all of the 2014 CLP alumni and the teachers for their feedback during the different sessions that took place during the CLP International Training Course: Martin Fowlie, Maureen Ryan, Christine Ageton, Martin Davies and Nalini Mohan.

We want to thank professor Dr. Jorge Hernández and Oriana Serna from *Centro de Innovación en Biotecnología Industrial y Biología Molecular* (CINBIN) of Universidad Industrial de Santander, who provided us with laboratory space and equipment, as well as their constant interest and support. Dr. Christine Bacon from University of Gothenburg was an important input in terms of scientific advisory, the analysis of nucleotide sequence data, and financial support involving molecular biology equipment, supplies, and sequencing costs. Dr. Martha Ramírez from the Herpetological Collection and Laboratorio de Biología Reproductiva de Vertebrados of Universidad Industrial de Santander allowed us to inspect the salamander specimens deposited there.

Oswaldo Acevedo and all the staff from *Hacienda El Roble* kindly allowed us to perform several visits to their coffee fields to search for salamanders and taste a wonderful organic coffee. The executive director James Murillo from the conservation organization *Cabildo Verde* permitted us to visit their natural reserve in Sabana de Torres to look for salamanders. The scientific organization *Asociación Colombiana de Herpetología* (ACH) helped us with funding for the development of a small conservation project derived from our main CLP project.

Professor Martha Lagos from the public urban High School *Colegio Santander* was very enthusiastic about our work and kindly invited us to present our project to students from different class years to share our education and outreach materials. Also, professor Mireya Valbuena and Felix from the rural school *Colegio El Santuario* helped us encourage their students to commit to the task of protecting their natural resources. 2014 CLP alumnus professor Luis Alberto Rueda from Universidad del Magdalena helped us sharing our education and outreach materials with his students. Special thanks to community leader and environmentalist Pablo

Zambrano from Virolín, Santander, who contributed to our project with his vast experience and helped us during fieldwork activities and community work.

SECTION 1

Summary

Our project's main focus was to study the diversity of the salamander fauna present in Santander and assess their conservation status by using ecological, distributional and genetic data. We worked closely with the community in order to spread the conservation message for the protection of natural forests and the amphibians that live there. We conducted fieldwork in natural lowland and Andean forests, as well as agroecosystems. We found four species of salamanders: *Bolitoglossa nicefori*, *B. guaneae*, *B. lozanoi* and a newly discovered species *B. yariguiensis* sp. nov. For each species, we determined relative densities and microhabitat use for the most abundant populations, identified major threats, created maps of the potential distribution, and assessed their conservation status. In addition to salamanders, we registered other 43 anuran species present in the study area, many of which are endemic and threatened species. We designed and printed education and outreach materials for the community, targeting children, students and adults as well, especially community leaders, farmers, landowners, parents and teachers. We experienced some delays during fieldwork due to environmental factors; as a consequence, the schedule was very tight, however, we were able to accomplish our project goals and successfully managed to stay within our budget.

Introduction

Salamanders have become an icon of the global amphibian crisis given the decline in their natural populations, something that is happening at an unprecedented rate [1, 2, 3]. Recent efforts suggest that a multifarious scenario, related to factors such as habitat destruction, climate change, infectious agents, and the use of pesticides for agriculture, among others, are responsible for this alarming situation [3, 4]. Well-documented declines of formerly abundant salamander species have been reported in several regions of Central America, with the apparent extinction of two species [3, 4, 5]. Currently, there are 695 species of salamanders described [6]; however, this number changes constantly, at a relatively high rate, with the discovery of new species. Most of these newly discovered species have very restricted geographic ranges and are prone to be susceptible to all factors currently threatening amphibians [4].

The Neotropical genus *Bolitoglossa* (Plethodontidae) is the most diverse salamander genus of the world (with 130 species formally described to date) and also the most widely distributed, extending from northeastern Mexico through Central America to central Bolivia in South America [6, 7, 8, 9]. In Colombia, 23 species of salamanders are currently known [6], 18 have been assessed by the International Union for the Conservation of Nature (IUCN) Red List [10].

As a result of the IUCN assessment, only four species are included in any threat category (1 species as Critically Endangered, 1 as Endangered, and 2 as Vulnerable), whereas more species are listed in unthreatened categories (2 species as Near Threatened, 4 as Data Deficient, and 8 as Least Concern).

The IUCN conservation status of many Colombian salamanders is questionable for several reasons: (i) the salamander genus *Bolitoglossa* exhibits convergent morphological features making species delimitation difficult [8], (ii) the knowledge about ecology, natural history, and distribution of many species is still incipient, (iii) estimating salamander abundances is a difficult task because of their secretive nature and since detection probabilities could vary with weather conditions [1, 2, 3], and (iv) the current assessment of 11 species needs urgently an update [10]. In this sense, the aim of this study was to provide baseline information regarding taxonomic status, species richness, microhabitat use, population abundances, distribution, and threats for plethodontid salamanders in Santander department, Colombia.

The information provided by our project is crucial to update the conservation status of the plethodontid species inhabiting the study area and to identify priority sites for their conservation as a first step to develop conservation strategies using salamanders as umbrella species, and to educate local residents and organizations about their primary role in the conservation of natural ecosystems and its associated biota. Furthermore, we document a major decline from a formerly abundant population of *B. nicefori* in Santander. In this sense, our results highlight the urgent need to understand the causes of salamander declines to propose adequate conservation plans towards the protection of amphibian diversity.

Project members

CARLOS ANDRÉS HERNÁNDEZ-JAIMES
AGE: 27. BUCARAMANGA, SANTANDER, COLOMBIA.

Professional experience:

I am a biologist from Universidad Industrial de Santander. During my undergraduate programme I explored the field of Herpetology and became interested in the study of biodiversity and conservation biology.

Role in the project:

I represented my team as the leader of this project. I coordinated fieldwork activities; contributed to collecting and processing DNA samples; performed the phylogenetic analysis of the nucleotide data; determined the taxonomic identification of salamander species based on molecular data. I participated in the edition and design of the education and outreach materials and the preparation of manuscripts. Also, I performed an active part during the activities with the stakeholders.

Current occupation:

Currently I work as an independent environmental consultant and also as a researcher in the *Centro de Innovación en Biotecnología Industrial y Biología Molecular* and the NGO *Asociación Colombia Endémica*, which was created by our team as part of our CLP Project.

FABIO LEONARDO MEZA-JOYA
AGE: 35. BUCARAMANGA, SANTANDER, COLOMBIA.

Professional experience:

I received my bachelor's degree in Biology from Universidad Industrial de Santander, where I am finishing my MSc in Biology, studying the distribution and diversification patterns in frogs of the genus *Pristimantis* in the Tropical Andes. I have been working since 2007 with amphibians and reptiles in different fields, including management and conservation projects.

Role in the project:

My work involved amphibian sampling methods, taxonomy, molecular, and phylogenetic techniques, species' distribution modeling, and biodiversity management and conservation. As a part of our CLP project, I contributed to (i) the development of the fieldwork methodology to collect relative density and microhabitat use data, (ii) the taxonomic identification of amphibian species registered in field, (iii) estimate relative densities, (iv) generate the species' distribution models, (v) assess the conservation status of salamander species, and (vi) write manuscripts and reports. I also actively participated in the preparation of texts and contents of the educational materials.

Current occupation:

Researcher. Currently I am working as external consultant and as coordinator of the *Programme for the Conservation of Threatened Species* in the NGO *Asociación Colombia Endémica*.

ELIANA PATRICIA RAMOS-PALLARES
AGE: 29. BUCARAMANGA, SANTANDER, COLOMBIA.

Professional experience:

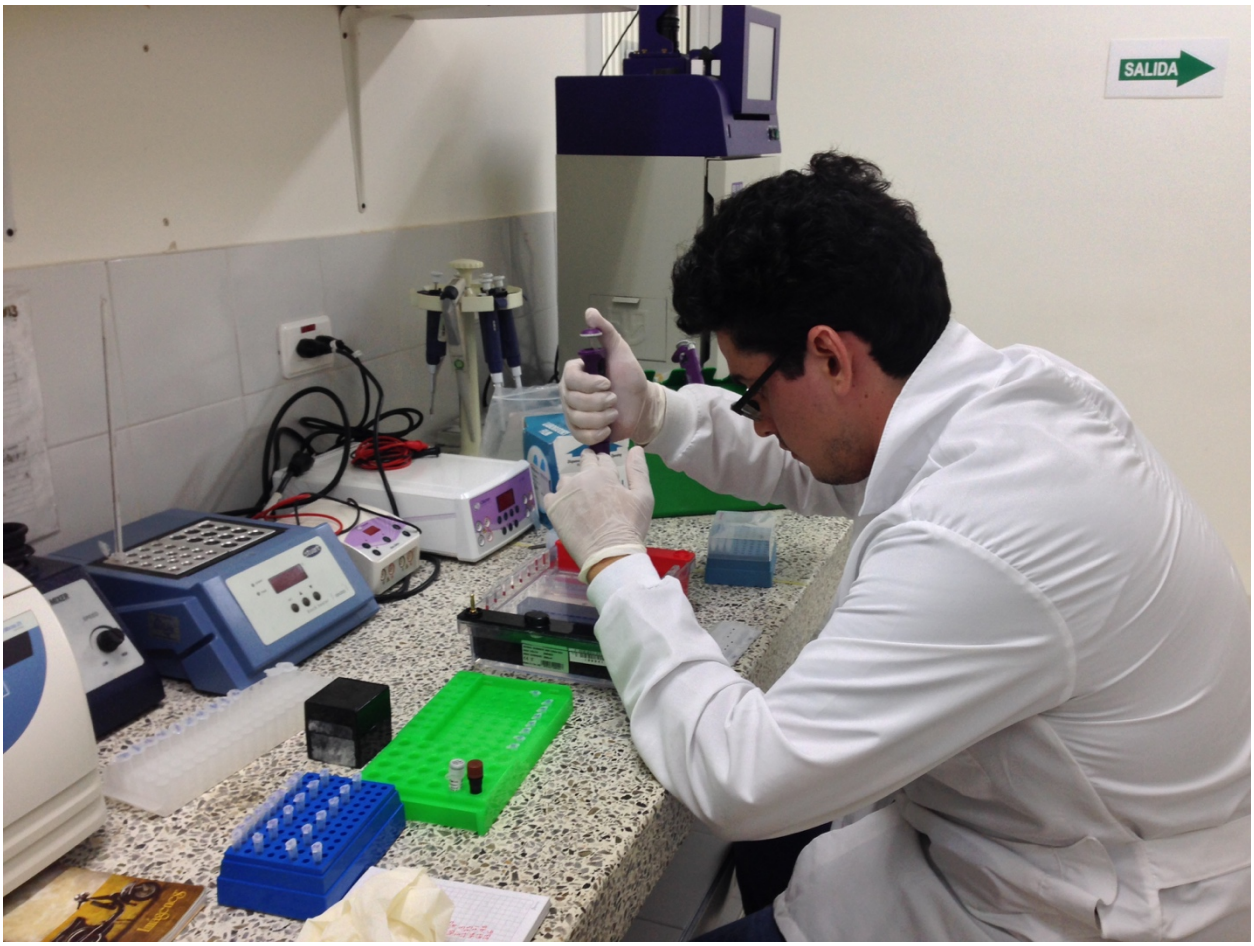
I am a Biologist and actually I am coursing my last level of my Master's degree in biodiversity. I have experience in wildlife management, design field methods to obtain data of abundances and densities, analysis biodiversity data, write technical and scientific report. I have about five years of experience working with amphibians and reptiles in different fields, including species conservation.

Role in the project:

During the project I actively participated in the analysis of density data, microhabitat use and helped in the modeling of species geographic distributions. I participated in the design of the field methods to obtain data of abundances and densities, I played a role in the design of texts and contents of the educational materials.

Current occupation:

Currently I work as a biologist in a wildlife management project and as associate researcher in NGO *Asociación Colombia Endémica* in different projects.



OSCAR YESID HERNÁNDEZ-LAGOS
AGE: 25. BUCARAMANGA, SANTANDER, COLOMBIA.

Professional experience:

I am a biologist from Universidad Industrial de Santander, throughout my bachelor's programme I worked with the invertebrate group of velvet worms (Onychophora) with emphasis in their reproductive biology. Later, I became enthusiastic and interested in the field of herpetology and participated in a project for the organization and systematization of the herpetological collection of the Natural History Museum of Universidad Industrial de Santander.

Role in the project:

My main role in the CLP Project was to leader the activities regarding community work, media/social communication, as well as the production and design of the educational materials and the elaboration of project reports. Also, I participated in fieldwork activities and in the processing of samples in the laboratory.

Current occupation:

Currently I work as a researcher in the *Centro de Innovación en Biotecnología Industrial y Biología Molecular*. In 2016 I will start my Master's programme with emphasis in the field of conservation biology at Universidad Industrial de Santander.

SECTION 2

Aim and objectives

Inform the scientific community and the general public about the salamander species present in the tropical Andean forests in Santander Department, Colombia; inform the assessment of their conservation status; generate scientific knowledge about salamanders, and foster public awareness and education programs.

Objective 1: Determine the salamander species composition within the study area and register other amphibian fauna.

Objective 2: Determine the present and future distribution of salamander species inside the study area.

Objective 3: Determine the population density and habitat of salamander species present in each study site.

Objective 4: Assess the conservation status of salamander species within the study area and the existing threats to their populations in order to promote conservation initiatives involving local communities and authorities.

Changes to original project plan

During the implementation of the project, we experienced some fieldwork delays and methodological issues:

1. Some visits to the study site could not be completed on schedule due to unusual climate phenomena, specifically “El Niño” (drought) and “La Niña” (heavy rains). These environmental factors negatively impact salamander populations and thus impeded us from finding salamanders during those visits to the field.

2. Given the environmental factors mentioned above, the density of salamander populations could not be estimated for every locality; instead, we estimated this parameter from the four populations with the highest number of specimens recorded.

3. The density of the salamander populations could not be estimated using a distance sampling approach because of the low number of specimens recorded in field; instead we calculated the encounter rate as a surrogate of relative abundance [11].

4. Methodological limitations to generate the potential distribution models excluded three species from this analysis: *B. yariguiensis* sp. nov. was excluded because there was not enough

geographic data to build the models [see 12]. *B. lozanoi* and *B. adspersa* were excluded because the unknown taxonomic status of populations outside of Santander department could lead to misleading species' distribution models [13].

Methodology

We visited twenty-one (21) localities (Fig. 1), searching for salamander species and other amphibian fauna. Each locality was visited during three consecutive days during the rainy and dry seasons. In each study site, twelve random transects (200x2m) were surveyed at night. Sampling was performed using Visual Encounter Surveys [14].

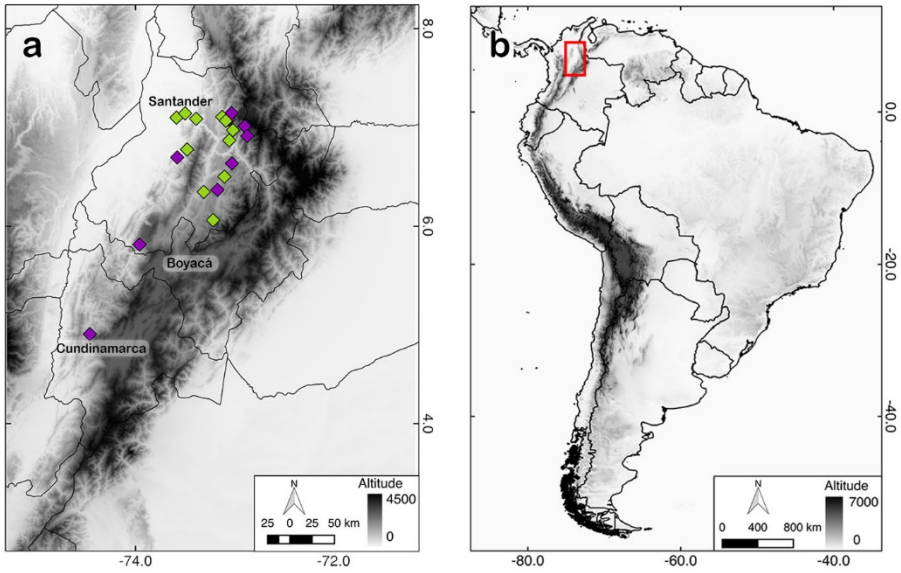


Figure 1. Map of the localities that were sampled during the development of the project.

Relative abundances for salamanders were estimated by encounter rates using the data from the four localities with the higher number of recorded specimens (Fig. 2). Microhabitat use for salamanders were determined registering, for each individual, the substrate type, perch height, time of capture, and activity. We also measured the animal's body temperature, substrate temperature, environmental temperature, and environmental relative humidity.

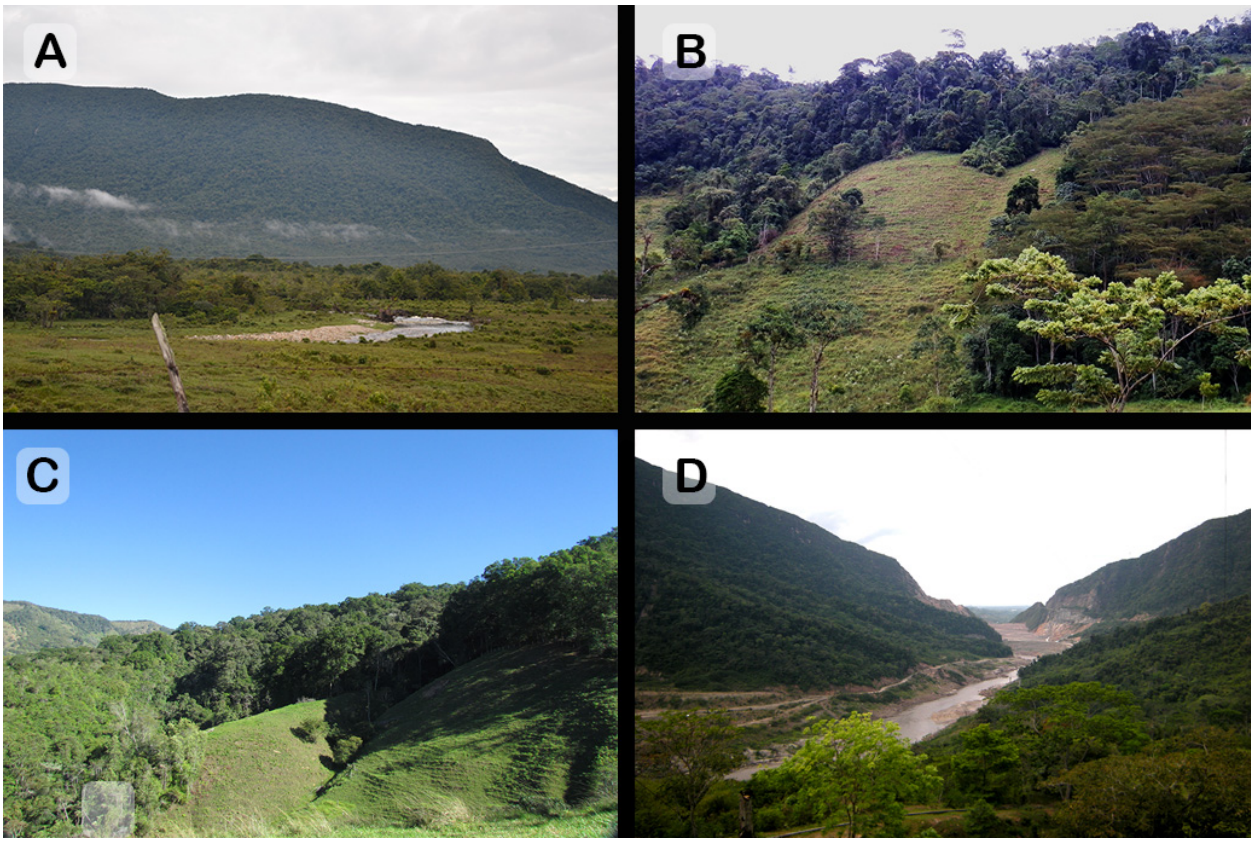


Figure 2. Localities and species for which relative abundances were calculated. *B. guaneae*: municipality of Charalá, corregimiento Virolín, vereda El Palmar (A), *B. yariguiensis* sp. nov.: municipality of San Vicente de Chucurí, vereda La Colorada, (B), *B. nicefori*: municipality of Tona, vereda Vegas del Quemado (C), and *B. lozanoi*: municipality of Sabana de Torres, vereda Campo Tigre, site La Bodega (D).

We took tissue samples from a few salamanders from each site and processed them to extract the DNA. Posteriorly, DNA samples were processed using PCR to amplify the mitochondrial sequence from 16S rRNA gene. The nucleotide data obtained were used to construct a maximum likelihood tree showing the phylogenetic relationships between the salamander species under study and other species from Cordillera Oriental of the Andes (*B*. *leandrae*, *B*. *tamaense* and *B*. *adspersa*), and to reveal the taxonomic identity of each species. The genetic information was contrasted against morphology and known distribution data for each species.

Species' distribution models (SDM) were generated for two species (*B. nicefori* and *B. guaneae*) based on new and former geographic data. Models were generated using 19 bioclimatic variables and elevation [15] with the software MaxEnt v.3.3.3k [16], using the cross-validated approach [12] and the maximum training sensitivity plus specificity threshold. The species' extent of occurrence was calculated using the number of pixels of the final presence/absence models. To predict the persistence of ecological niche in a relatively close future, we generated two maps representing the potential distribution of each species in 2050, under 'optimistic' and 'pessimistic' climatic scenarios.

Based on the distributional, ecological, morphological, and molecular data here presented, we updated the salamander species' conservation status according to the IUCN Red List guidelines and reviewed its representation in the protected areas across their distributional geographic ranges.

We designed, produced and shared educational and outreach materials like brochures and calendars, based on the information gathered during our research project. In order to instruct the community in topics related to amphibians and conservation. We organized meetings, that included different activities such as drawing exercises, debates and brainstorming of ideas and opinions from everyone in the groups we worked with: i) schools in urban and rural regions ii) high schools, and iii) landowners, community centers. Additionally, media communication tools like social networks were implemented in synergy during the project.

OUTPUTS AND RESULTS

OBJECTIVE 1:

During fieldwork, we found four species of salamanders: *Bolitoglossa nicefori*, *B. guaneae*, *B. lozanoi* and a newly discovered species *B. yariguiensis* sp. nov. (Fig. 3). Additionally, we registered other 43 anuran species inside the study area, many of which are listed in the threatened categories of the IUCN as Data Deficient (3), Vulnerable (3), Near Threatened (1) and Endangered (4) (Table 1, appendix II).

The phylogenetic analysis showed that the salamander species from the Andean Cordillera Oriental form seven distinct subclades (Fig. 4). The species *B. guaneae* and *B. nicefori* are closely related to each other and form a subclade that is sister to *B. yariguiensis* sp. nov., however, the genetic distance between the three species is big enough to support their species status (> 3%). Also, the analysis revealed that the Genbank sequence KC257105 was mistakenly identified by Acevedo et al. [18] as *B. nicefori* and actually corresponds to a new unreported population of *B. guaneae* from the municipality of Arcabuco, Boyacá department.

Figure 3. Species of salamanders found during fieldwork. *Bolitoglossa nicefori* (A), *B. lozanoi* (B), *B. guaneae* (C), and *B. yariguiensis* sp. nov. (D).

Table 1. Photographs of the anuran species found in the study area with their current IUCN status.

Table 1. Continued.

Table 1. Continued.

Table 1. Continued.

Figure 4. Maximum likelihood tree of *Bolitoglossa* based on sequence data of the 16S rRNA gene for the salamander species studied here (colored branches). Values indicate ML Bootstrap support values for each node.

OBJECTIVE 2:

The species distribution model (SDM) was built for two species of salamanders (*B. guaneae* and *B. nicefori*), for the other salamander species we did not construct a SDM given the uncertainty of the records and the low quantity of data (Fig. 5). The SDM confirmed the restricted distributional range of *B. guaneae* and *B. nicefori* in the Cordillera Oriental of Colombia and how future scenarios of climatic change could impact the populations of these species. Under the best future scenario of climatic change *B. guaneae* and B. *nicefori* loses, respectively, nearly 41% and 57% of the potential habitats across its distributional ranges and with them, several known populations inhabiting these areas (Fig. 6).

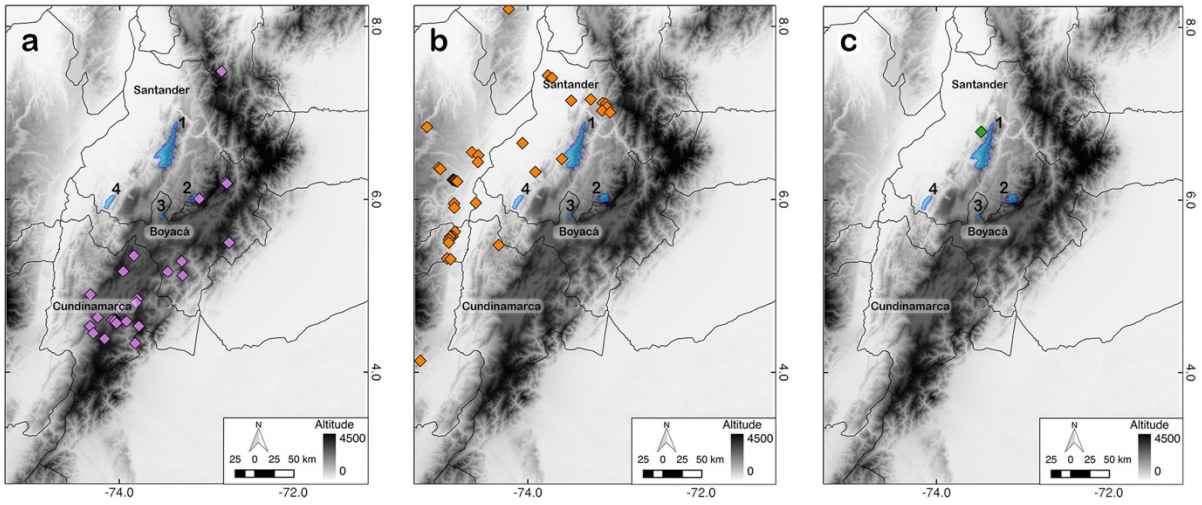


Figure 5. Distribution map of records of the salamander species. a) *Bolitoglossa adspersa*. b) *B. lozanoi*. c) *B. yariguiensis* sp. nov. Blue polygons correspond to national protected areas 1) National Park Serranía de Los Yariguíes. 2) Santuario de Fauna y Flora Guanentá Alto Río Fonce. 3) Protective Forest Reserve Sierra El Peligro. 4) Protective Forest Reserve Cuchilla El Minero.

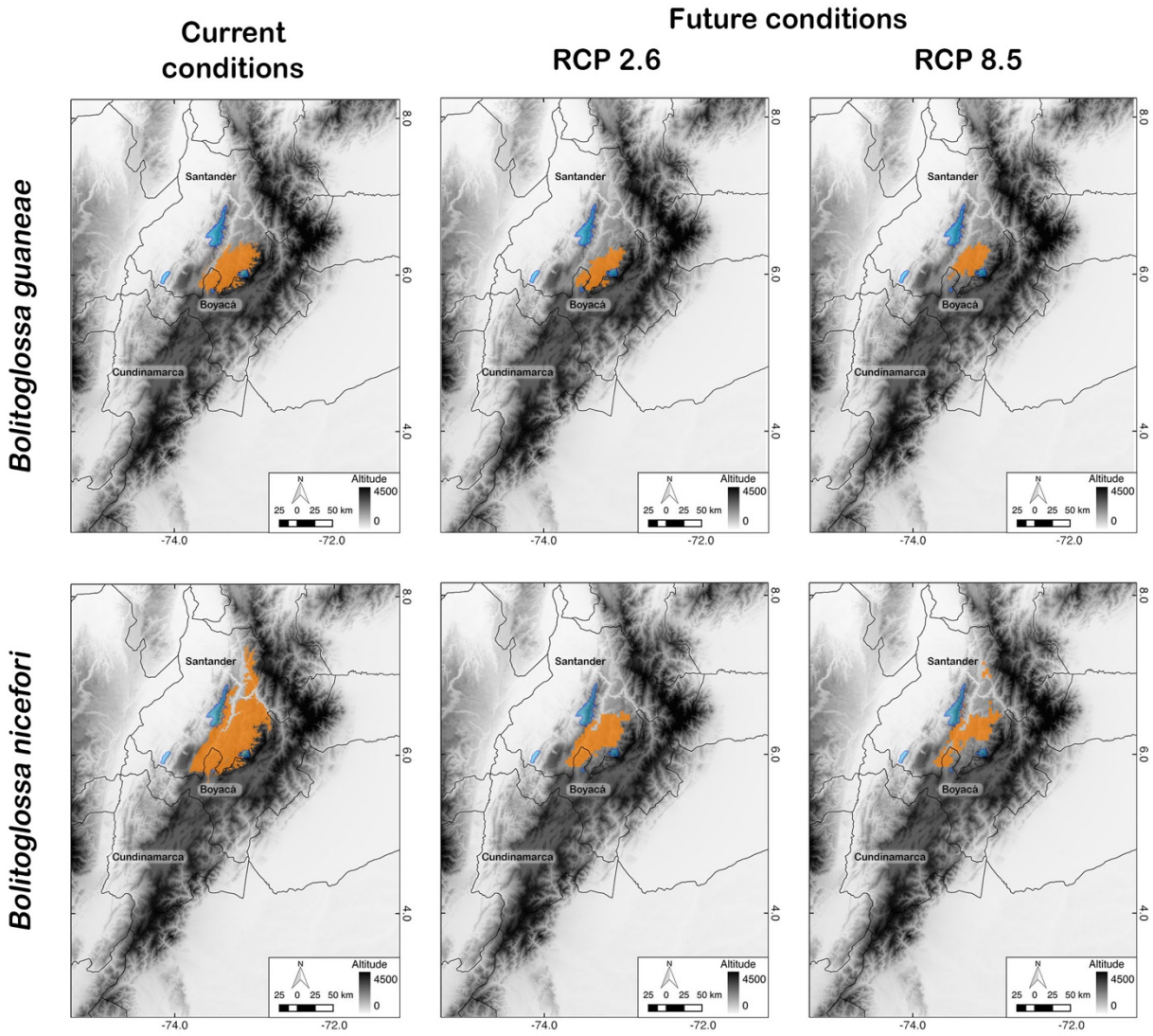


Figure 6. Maps with current and future distribution models of the salamander species *Bolitoglossa guaneae* and *B. nicefori* under two climate change scenarios: an optimistic (RCP 2.6) and a pessimistic scenario (RCP 8.5).

Table 2. Extent of occurrence of the modeled species under current and future climate change scenarios.

Species	2015	2050 RCP26	2050 RCP85
B. guaneae	3012 Km^2	1786 Km^2	1733 Km^2
B. nicefori	7155 Km^2	3118 Km^2	2627 Km^2
Future climatic change scenarios: optimistic (RCP26) and pessimistic (RCP85).			

OBJECTIVE 3:

The studied populations of salamander species presented low relative abundances (Table 3) and were categorized either as uncommon species (*B. guaneae, B. nicefori*, and *B. lozanoi*) or rare species (*B. yariguiensis* sp. nov.).

Table 3. Relative abundances for salamander populations studied here.

Species	Number of specimens	Relative abundance	Abundance rank
B. guaneae	43	1.19	Uncommon
B. nicefori	20	0.56	Uncommon
B. lozanoi	9	0.25	Uncommon
B. yariguienses sp. nov.	2	0.06	Rare

The analysis of microhabitat use showed that *B. yariguiensis* sp. nov., and *B. guaneae* presented more restricted thermal tolerances relative to *B. nicefori* (Table 4), which could be responsible (at least in part) for the restricted known distributional range of these species.

Table 4. Microhabitat use for salamander populations studied here.

Species	Body T (°C)	Substrate T (°C)	Ambient T (°C)	Relative humidity (%)
B. guaneae	17 ± 0.66	16.9 ± 0.72	17.1 ± 0.95	80.7 ± 3.31
B. nicefori	16.7 ± 1.5	16.8 ± 1.50	17.6 ± 1.08	79.6 ± 6.38
B. yariguienses sp. nov.	18.8 ± 0.32	18 ± 0.28	19.4 ± 0.20	79.6 ± 2.51

We documented a population decline of a formerly 'abundant' population of *B. nicefori* in Vereda El Carrizal, Los Santos municipality (Table 5), where 33 specimens were collected from 2005 to 2009 (15 surveys, 180 h of survey effort, mean encounter rate of 0.154 ± 0.077 SD). Our surveys from 2013 to 2015 showed a dramatic decline in the size of this population, with only two 2 specimens recorded (10 surveys, 120 h of survey effort, mean encounter rate of 0.014 ± 0.024 SD).

Table 5. Collection records and encounter rate per year for *B. nicefori* from Los Santos, Santander.

Year	N° of visits	N° collects	Survey effort	Encounter rate
2005	2	4	24 h	0,167
2006	4	13	48 h	0,271
2007	6	12	72 h	0,167
2008	1	1	12 h	0,083
2009	2	3	36 h	0,083
2013	4	0	48 h	0,000
2014	4	2	48 h	0,042
2015	2	0	24 h	0,000

OBJECTIVE 4:

The main threats to salamanders' diversity in Santander are (i) habitat quality and extent decline due mainly to livestock grazing, agricultural activities, poultry breeding, and selective logging; (ii) extreme climate events such as Niña and Niño phenomena; (iii) infection with the chytrid fungus *Batrachochytrium dendrobatidis* may also threaten the species [see 17]. This information combined with the taxonomic, geographic, ecological, and population data provided here, allowed us to update the conservation status of four salamander species (Table 6, Appendix 3), using the IUCN Red List Categories and Criteria [10]. Also we gathered new distributional and population data of one of the endangered anuran species found in our study *Andinobates virolinensis*, which allowed us to update its conservation status by submitting a paper for publication in *Oryx* journal and sharing our results with the IUCN [see 18].

Table 6. IUCN assessment of salamander species found in Santander department. The extent of occurrence and known localities were two parameters used to define the threat status of these species.

Species	Extent of occurrence (Km^2)	Known localities	IUCN category (actual)	IUCN category (proposed)
B. guaneae	3012	10	NE	EN B1ab(iii)
B. nicefori	7155	12	LC	VU B1b(iii)c(iv)
B. lozanoi	30004*	19	DD	NT
B. adspersa	28379*	16	LC	LC
B. yariguiensis sp. nov.	<100**	1	NE	EN B1ab(iii)
*Extend of occurrence calculated from a minimum convex polygon **Extend of occurrence estimated for the type locality				

The project experience has been shared through a total of 600 calendars with photographs of threatened amphibians of Santander (Fig. 7), and 1000 brochures (Fig. 8) showing relevant information about salamanders, presented in a didactic way. Also, media communication was developed with the local people during meetings and recreational activities (Figs. 9-10), and through a Facebook Fan Page updated with photographs and videos showing our work in the field.

Figure 7. Calendar 2015-2016 with pictures of some amphibians registered in this study.

Figure 8. Brochure with relevant information about salamanders' biology and how to help preserve their habitat.

Figure 9. Examples of educational activities and some members of the community involved in our project. Community leader Pablo Zambrano from Virolín (A), Professor Mireya Valbuena from Colegio El Santuario (B), Professor Martha Lagos from Colegio Santander (C), People from the biological reserve Cabildo Verde (D), Students from Universidad del Magdalena (E).

Figure 10. Examples of community work with students from different educational centers. Preschool Colegio El Santuario, municipality of Charalá (A), High school Colegio Santander, municipality of Bucaramanga (B, C), High School and preschool Colegio El Santuario (D, E).

We organized meetings with local stakeholders: community leaders, landowners, teachers, students, and the scientific community through academic conferences and publications in scientific journals. We visited a total of 5 educational centers in different municipalities in Santander department (Table 7).

Table 7. Places where meetings with local stakeholders took place.

Place for the activity	Directed to	Municipality	Vereda	Date
Finca La Armenia	Landowners	Tona	Vegas del quemado	12-03-2015
Colegio Virolín	Teenagers	Charalá	Virolín	25-03-2015
Escuela Virolín	Young students	Charalá	Virolín	26-03-2015
Pablo Zambrano	Community leader	Charalá	El Palmar	27-03-2015
Colegio Santander	Teacher and students	Bucaramanga	La Universidad	19-05-2015
Colegio María Goretti	Teacher and students	Bucaramanga	Real de Minas	20-05-2015
Colegio La Salle	Teacher and students	Bucaramanga	La Victoria	21-05-2015
Parque tecnológico Guatiguará	Researchers	Piedecuesta	Guatiguará	04-05-2015
Hacienda El Roble	Landowners	Los Santos	El Carrizal	14-06-2015
Cabildo Verde	ONG	Sabana de Torres	-	16-08-2015

Communication & application of results

The results of this project were disseminated through different communication channels targeting a varied public, including a Facebook Fan Page https://www.facebook.com/ConservacionSalamandrasSantander; printed materials like brochures and calendars; meetings with local stakeholders such as: community leaders, landowners, farmers, teachers, students from ages 7-15 belonging to rural schools as well as public and private urban schools; and the scientific community through academic conferences and publications in scientific journals.

These results were useful to achieve our project goals because they allowed us to make inferences about the threats, as well as the taxonomic and conservation status of the salamander species studied.

Monitoring and Evaluation

To measure the effectiveness and progress of the project activities we conducted monitoring sessions through weekly meetings where the team members socialized different aspects of the project including difficulties and potential solutions. Additionally, monthly meetings were held to discuss the progress of the different activities, assess the strengths and weaknesses of each of the components of the project and in this way find solutions to such problems.

We also carried out working sessions with advisors, collaborators and stakeholders of the project, and with their help we reviewed the different indicators proposed and determined their effectiveness as well as the state of progress.

Achievements and Impacts

Our phylogenetic analysis allowed us to confirm the taxonomic identity of the salamander species studied; knowing to which species corresponded the data collected in the field was very important in order to conduct the analysis of population data and perform the models of the current and future distribution, which in turn were necessary to assess the conservation status of each of the salamander species.

Our project outputs for community work: calendar, brochure, Facebook Fan Page (Conservación de Salamandras en Santander, Colombia) and meetings with the local people, worked in synergy to achieve an ultimate goal, get people informed about salamanders, their importance for the ecosystems, their main threats and engage them with the idea and the need to preserve the natural resources and the associated fauna and flora. People were very receptive with the educational materials and conferences, being amazed of salamanders, participating actively and expressing their concerns and ideas about nature conservancy and their will to help preserve amphibians and their habitats.

All information produced reached people both in the urban and rural areas, as well as through social media allowing this initiative to be widely spread. The greater significance of these outputs is that young generations and adults will become ambassador conservationists that will keep our conservation messages alive and will transmit them to the next generations. We were also able to give advice and feedback to some of the high school students of professor Mireya from the rural school Colegio El Santuario in Virolín (Santander) who are interested in the field of biology and conservation and are trying to carry out their own small projects with the conservation and sustainable use of orchids, which are highly abundant in the zone and present a high species richness and endemism.

Capacity Development and Leadership capabilities

Each of the team members was in charge of leading one of the project objectives with the collaboration of the other members. This project helped us to improve our teamwork skills, as well as to build leadership capabilities, communication and resource management skills. In addition, the work with the community developed during this time helped us to understand the needs of local people and how to identify all the stakeholders and learn how to approach to them; also, using these skills we learned to raise awareness of the importance of environmental

care and species conservation. In addition, all team members gained experience in different fields and learned the skills of the other members.

We were able to build a conservation organization Asociación Colombia Endémica as a way to strengthen our ties as a team and improve our collaborative and fundraising skills, as well as to make a lasting contribution to conservation and science.

SECTION 3

Conclusion

The successful achievement of our objectives contributed to generate basic knowledge about the taxonomic status, diversity, relative abundances, geographic distribution, and microhabitat use of salamander species in the study area, as well as to identify the major threats faced by each salamander species in the study area, and ultimately to update their conservation status. The achievement of our goals even led to the discovery of a new species of salamander and to document a major population decline of a formerly abundant salamander population. Our outreach materials and activities had a high impact in the targeted groups involved in the project, especially in the local community, particularly students from all ages, teachers and community leaders. Because salamanders' distribution is mainly found outside of national protected areas, the local community represent a keystone to establish future adequate conservation and management programs. This project represents a precedent for the conservation of salamanders and the amphibian diversity in Colombia and shows the important role of baseline scientific data analysis and information gathered in the field, and of educational work with different stakeholder targets, for the establishment of successful conservation actions. Finally, the successful completion of this project represent an invaluable experience for all team members and the first step to future conservation initiatives directed toward the conservation of amphibians and other taxa in the Colombian Andes.

Problems encountered and lessons learnt

Finding salamanders in the field was generally not easy, in some cases we spent many days and were only able to find a few specimens; also, some forest areas were really hard to access, for these reasons we searched for members of the community that knew very well the zone and were known by many, so they could help us get access to private lands.

We had to work hard to learn how to work effectively as a team, this means that we had to identify each team-member strengths, split our work as equitably as possible between the team-members, and also learn to trust in each other's work. Fortunately, we learned how to do that through our CLP training workshop.

Sometimes, during the development of the project we had to reschedule some project activities, especially field surveys, due to environmental phenomena like El Niño (drought) and La Niña (heavy rains), both of which affected negatively our work because salamanders are almost impossible to find in conditions of drought and they also hide during heavy rains.

We realized that printed educational materials alone were not enough to raise awareness, for this reason, it was necessary to meet with community leaders, landowners, teachers and students together to read the contents and comment on the materials, which also allowed us to

receive feedback. On the other hand, we learned that four people were not always enough to carry out all of the project activities mainly because sometimes the personal work of each team member could interfere with the schedule for the project activities, thus, it might be best to work in groups of at least six people, and include someone in the team specialized in working with kids and people in general.

In the future

We are preparing a manuscript with the description of the new species of salamander *Bolitoglossa yariguiensis* sp. nov., which we aim to submit for publication in the journal *Zootaxa* by the end of 2015.

In February of 2016, the team leader Carlos Hernández is going to start his Master studies at Universidad Industrial de Santander (UIS). His project will be related with the phylogenetic results and molecular data obtained in this project. Carlos will be working with two collaborators Christine Bacon and Jorge Hernández.

Based on the data obtained, two team members (Eliana Ramos and Leonardo Meza) are running a project related with the taxonomy, distribution, and conservation status of amphibian species of the Colombian Andes, starting in January 2016.

Our results will be of outmost importance to develop, during a second phase of the project, a strategic action plan for the management of the salamander species that we identified as more sensible to natural and anthropogenic perturbations (as umbrella species). This plan involves the conservation of all the biota associated to the areas inhabited by salamanders.

Financial Report

Note: Due to the delays that we experienced during fieldwork we were unable to include the report of the project spending along with the Preliminary Report that we provided; thus, in order to complete the activities of the project we asked for a loan and used our own money to temporarily cover for the remaining project expenses while we delivered the Final Report to CLP and waited to receive the reimbursement of the final instalment.

Itemized expenses	Total CLP Requested (USD)*	Total CLP Spent (USD)	% Difference
PHASE I - PROJECT PREPARATION			
Communications (telephone/internet/postage)	200.00	200.38	0%
Field guide books, maps, journal articles and other printed materials	100.00	98.99	-1%
Insurance	340.00	339.97	0%
Visas and permits	760.00	654.53	-14%
Team training			
Reconnaissance	80.00	80.00	0%
Other (Phase 1)			
EQUIPMENT			
Scientific/field equipment and supplies	1,780.00	1771.52	0%
Photographic equipment			
Camping equipment	510.00	509.53	0%
Boat/engine/truck (including car hire)			
Other (Equipment)			
PHASE II - IMPLEMENTATION			
Accommodation for team members and local guides	1,080.00	1077.04	0%
Food for team members and local guides	2,700.00	2700.96	0%
Travel and local transportation (including fuel)	3,750.00	3856.54	3%
Customs and/or port duties			
Workshops	200	199.05	0%
Outreach/Education activities and materials (brochures, posters, video, t-shirts, etc.)	1,500.00	1500.00	0%
Other (Phase 2)	1,800.00	1799.89	0%
PHASE III - POST-PROJECT EXPENSES			
Administration			
Report production and results dissemination			
Other (Phase 3)			
Total	**14,800.00**	**14,788.41**	

SECTION 4

Appendices

Output	Number	Additional Information
Number of CLP Partner Staff involved in mentoring the Project	6	All the staff from 2014 CLP Conservation Management & Leadership Training Workshop.
Number of species assessments contributed to (E.g. IUCN assessments)	5	We recently contributed our assessments to the IUCN and are still being studied.
Number of site assessments contributed to (E.g. IBA assessments)	0	
Number of NGOs established	1	NGO: Asociación Colombia Endémica.
Amount of extra funding leveraged ($)	2	Asociación Colombiana de Herpetología: USD 1000. University of Gothenburg: USD 5000.
Number of species discovered/rediscovered	1	*Bolitoglossa yariguiensis* sp. nov.
Number of sites designated as important for biodiversity (e.g. IBA/Ramsar designation)	0	
Number of species/sites legally protected for biodiversity	0	
Number of stakeholders actively engaged in species/site conservation management	4	Community leaders, landowners, farmers, scientists.
Number of species/site management plans/strategies developed	0	This preliminary study gathered baseline information important to develop a management plan in the future.
Number of stakeholders reached	7	Community leaders, landowners, farmers, teachers, students, housewives, scientists.
Examples of stakeholder behaviour change brought about by the project.	0	
Examples of policy change brought about by the project	0	
Number of jobs created	0	
Number of academic papers published	2	One paper submitted to *Oryx* is under review. One more paper is being prepared for submission to *Zootaxa* in 2015.
Number of conferences where project results have been presented	1	IV Congreso Colombiano de Zoología (2014).

Appendix 4.1 CLP M&E measures

ORDER	FAMILY	GENUS	SPECIES	ENDEMISM	IUCN STATUS
CAUDATA	Plethodontidae	*Bolitoglossa*	*guaneae*	Endemic	Not Evaluated
		Bolitoglossa	*lozanoi*	Endemic	Data Deficient
		Bolitoglossa	*nicefori*	Endemic	Least Concern
		Bolitoglossa	*yariguiensis* sp. nov.	Endemic	Not Evaluated
ANURA	Hylidae	*Dendropsophus*	*microcephalus*	Not endemic	Least Concern
		Dendropsophus	*ebraccatus*	Not endemic	Least Concern
		Dendropsophus	*subocularis*	Almost endemic	Least Concern
		Dendropsophus	*virolinensis*	Endemic	Least Concern
		Phyllomedusa	*venusta*	Almost endemic	Least Concern
		Agalychnis	*terranova*	Endemic	Not Evaluated
		Hypsiboas	*crepitans*	Not endemic	Least Concern
		Hypsiboas	*pugnax*	Almost endemic	Least Concern
		Hyloscirtus	*callipeza*	Endemic	Near Threatened
		Hyloscirtus	*denticulentus*	Endemic	Endangered B1ab(iii)
		Scinax	*rostratus*	Not endemic	Not Evaluated
		Scinax	*ruber*	Not endemic	Least Concern
		Smilisca	*phaeota*	Not endemic	Least Concern
	Microhylidae	*Elachistocleis*	*pearsei*	Almost endemic	Least Concern
	Dendrobatidae	*Dendrobates*	*truncatus*	Endemic	Least Concern
		Allobataes	sp	-	-
		Hyloxalus	*subpunctatus*	Endemic	Least Concern
		Rheobates	*palmatus*	Endemic	Least Concern
		Andinobates	*virolinensis*	Endemic	Endangered B1ab(iii)
	Centrolenidae	*Espadarana*	*andina*	Almost endemic	Least Concern
		Centrolene	*daidaleum*	Almost endemic	Vulnerable B1ab(iii)
		Hyalinobatrachium	*fleischmanni*	Not endemic	Least Concern
		Centrolene	*notostictum*	Almost endemic	Least Concern
	Bufonidae	*Rhinella*	gr. *margaritifera*	-	-
		Rhinella	*marina*	Not endemic	Least Concern
		Lithobates	*vaillanti*	Not endemic	Least Concern
	Leptodactylidae	*Engystomops*	*pustulosus*	Not endemic	Least Concern
		Leptodactylus	*savagei*	Not endemic	Least Concern
		Leptodactylus	*colombiensis*	Almost endemic	Least Concern
		Leptodactylus	*fuscus*	Not endemic	Least Concern
	Craugastoridae	*Craugastor*	*raniformis*	Almost endemic	Least Concern
		Pristimantis	*douglasi*	Endemic	Vulnerable B1ab(iii)
		Pristimantis	*bacchus*	Endemic	Endangered B1ab(iii)
		Pristimantis	*gaigei*	Not endemic	Least Concern
		Pristimantis	*acutirostris*	Endemic	Endangered B1ab(iii,v)
		Pristimantis	*taeniatus*	Almost endemic	Least Concern
		Pristimantis	*batrachites*	Endemic	Data Deficient
		Pristimantis	*ixalus*	Endemic	Data Deficient
		Pristimantis	bicolor	Endemic	Vulnerable B1ab(iii)

Appendix 4.2. Species list of the salamanders and other amphibians found in the study area.

JUSTIFICATION FOR OUR CONSERVATION STATUS PROPOSAL
Bolitoglossa guaneae is listed as Endangered (EN) in the criteria B1ab(iii) because its estimated extent of occurrence is ca. 5000 km ^{2}, its distribution is severely fragmented, and the quality of habitat continues to decline due to livestock grazing, agricultural activities, and selective logging.
Bolitoglossa nicefori is listed as Vulnerable (VU) in the criteria B1b(iii)c(iv) because its extent of occurrence is less than 20000 km^2, there is continuing decline in the extent and quality of its habitat due to livestock grazing, agricultural activities, and poultry breeding; and there is extreme fluctuations in the number of mature individuals in some of its populations as reported here.
Bolitoglossa lozanoi is listed as Near Threatened because, although its estimate extent of occurrence is about 30,000 Km^2 and the species survives in disturbed habitats, it occurs in several small, relatively widely separated sub-populations, in an area historically deforested for agricultural, mining, oil and gas exploration and exploitation activities, and the remaining artificial (pastures and cultures) and natural habitats (forest patches) has been replaced in the last years by large oil palm plantations and large dams (e.g., La Miel and Hidrosogamoso), making the species sensible to qualifying as Vulnerable in the close future.
Bolitoglossa yariguiensis sp. nov. is listed as Endangered (EN) in the criteria B1ab(iii) because its estimated extent of occurrence is ca. 5000 km ^{2}, it is thought to be endemic to a small area (<100 Km ^{2}), it is known from a single, small population, and the quality and extent of habitat continues to decline in the type locality due to livestock grazing, agricultural activities, and selective logging.

Appendix 4.3. Justification for the salamanders' conservation status proposed here.

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Address list and web links

The Lab. of Dr. Jorge Hernández, *Centro de Innovación en Biotecnología Industrial y Biología Molecular* (CINBIN) of Universidad Industrial de Santander. http://ciencias.uis.edu.co/biologia/grupo-de-investigacion-en-biotecnologia-industrial-y-biologia-molecular-cinbin/

Dr. Christine Bacon from the Lab. of Alexandre Antonelli of the University of Gothenburg, Sweden. http://www.antonelli-lab.net/index.php

The scientific organisation *Asociación Colombiana de Herpetología* (ACH). http://www.acherpetologia.org/

The Herpetological Collection of the Natural History Museum of Universidad Industrial de Santander. http://ciencias.uis.edu.co/museocolecciones/

The private conservation organisation *Cabildo Verde* from Sabana de Torres, Santander. http://www.cabildoverde.org/

Oswaldo Acevedo, owner of *Hacienda El Roble* in Santander, a coffee-shade farm that commercializes organic coffee in Colombia under the brand *Café Mesa de Los Santos*. http://www.cafemesa.com/

Distribution list

This report was distributed among the different sponsors and partners involved in the project as well as the Universidad Industrial de Santander and key stakeholders.