FINAL ACTIVITY REPPORT
DISTRIBUTION AND EVALUATION OF THREATS OF THE AMPHIBIANS IN THE SANCTUARY OF FAUNA AND FLORA GUANENTÁ-ALTO RÍO FONCE, COLOMBIA.

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RESUMEN
This research arose from the current problems that affect the composition, structure and dynamics of high mountain ecosystems in Colombia and the resident fauna. This work focused on the search for the distribution and evaluation of the main threats of amphibians, by means of sampling by visual encounters (VES in the Santuario de Fauna y Flora Guanentá Alto Río Fonce; records of species such as *Niceforonia nana, Centrelene acanthidiocephalum, Pristimantis miyatai, Pristimantis merostictus, Pristimantis elegans, Scinax sp, Rheobates palmatus, Espadarana andina, Dendropsophus mollitor, Centrolene daidaleum* and *Centrolene notostictum* were recorded. The abundances of these species were very low, In addition to the above, a low representativeness of amphibians was obtained, which is worrisome due to the large area that was sampled, the conservation values of the park were not recorded during the field trips, despite the fact that the sampling effort increased output after output. On the other hand, in the social component, we worked with human communities, mainly with school children, considering them to be the priority focus group to cause a high impact in the actions of conservation of local biodiversity. Among the activities carried out, there are workshops, lectures and recreational activities, from which it was possible to detect that the children are rooted by the natural, they care that the amphibian species are conserved, they said that they are animals that take care of and protect the páramo and water. Based on the results obtained with the biological outputs and social work, recommendations were made for the management and conservation of amphibians in the Santuario de Fauna y Flora Guanentá Alto Río Fonce.

1. INTRODUCTION

The Colombian territory has a very wide diversity of ecosystems in which it harbours the richness of both flora and fauna species, positioning it as a mega diverse country worldwide. Among the most diverse sites in the country, are the Andean region, which is composed of multiple biomes, such as the páramos. The páramos are high mountain ecosystems characterized by specific abiotic conditions such as low temperature, high relative humidity, a high rate of solar radiation during the day and high rainfall. The typical vegetation is shrubby, with the presence of grasslands, wetlands and a high abundance of *Espeletia* species, which make up the typical paramuno landscape (Vásquez and Buitrago 2011).

Colombia has the largest area of páramos that exists worldwide, these are distributed throughout the Andes region and even in the Sierra Nevada of Santa Marta, occupying about 2% of the nation's territory, approximately 1,925,431 hectares, where 70% of the country's water resources come from; besides that it lodges an important number of species of fauna and flora between these can be endemic species and / or threatened species of extinction; the department of Boyacá has the largest extension of the country, 463 thousand hectares of páramo (Rivera and Rodríguez 2011, Rangel-Ch 2018).

Despite the high wealth in páramos, these ecosystems are on the verge of collapse, mainly due to causes of anthropic origin, such as monocultures, mining, livestock, agriculture, causing effects such as fragmentation leading to the loss of more land or the change in the composition, structure and dynamics of the site, all this added to the global problem of climate change, in addition to endangering the biodiversity of the country's ecosystems, drastically affects species sensitive to environmental change such as amphibians. There are different causes that affect the diversity and abundance of anurans and their interaction with the environment such as the transformation of the ecosystem and the fragmentation of habitat that is what is taking place. Changes in habitat structure directly influence the activity of organisms, modifying composition, abundance and distribution (Pérez 2011). Analysing that amphibians are organisms sensitive to changes in the environment, this means that their distribution is restricted to specific conditions for their establishment; therefore, high mountain species that have life cycles adapted only to conditions have a greater threat than lowland species which have broader requirements (Young et al 2004).

The páramos represent the favourite site of habitat for a significant number of amphibian species that are considered high mountain or paramunos, for Colombia there are 39 species (Lynch and Suarez-Mayorga 2002); which their lifestyles are strictly adapted to these sites, although, the country occupies the second place in amphibian wealth with 803 species, of which 55 are in some category of threat according to the IUCN (SIB Colombia 2016), this is where the problem arises because the richness of amphibians are decreasing and the paramunas species are disappearing; like the case of the harlequin toads of the genus *Atelopus* which according to La Marca et al (2005) have experienced significant population reductions of the approximate 81 species, only nine maintain stable populations; on the other species there is no information regarding their state of conservation, which is why they have been included in the category of Deficient Data. In Colombia not only the decrease of amphibians is affected by the factors already mentioned, but the populations are dying because of pathogenic fungi such as *Batrachochytrium dendrobatidis* that has expanded its distribution attacking many species. (Acosta-Galvis et al 2006, Ruiz A, Rueda V.R. 2008). An important fact that must be highlighted is that it has been found that this fungus is not the only one that attacks amphibians in Colombia, in a study conducted by Prada-Salcedo et al (2006), they recorded that fungi of the genus *Saprolegnia* are attacking the populations of *Atelopus miettermeieri* in the Guanentá Alto Fonce Flora and Fauna Sanctuary.

The Santuario de Fauna y Flora Guanentá Alto Río Fonce.is a site belonging to the high Andean forest and páramos system known as the Guantiva - La Rusia - Iguaque

conservation corridor (Morales et al., 2007, National Natural Parks System) is a site which houses around 33 species of anurans, of which three are endemic and are focal species of vital importance that have to be conserved because they are threatened with extinction; *Atelopus mittermeieri* described by Acosta-Galvis et al (2006); *Pristimantis carlosssanchezi* described by Arroyo, S. B. (2007) and *Nymphargus vicenteruedai* described by Velásquez-Álvarez et al (2007). There are other species that stand out for their high abundance in the "La Sierra" sector: *Pristimantis merostictus, Pristimantis miyatai and Pristimantis uisae* (Gutiérrez-Lamus et al 2004); but these are not categorized under threats according to the IUCN because there are not enough data to classify them.

2. OBJECT

Assess the distribution and threats of amphibians in the Fauna and Flora Sanctuary Guanentá-Alto Fonce River, Colombia.

3. SCOPE

The work was proposed to work on two broad contributions in general terms: 1. biological contribution, in which goals were set towards scientific contributions on the evaluation of the distribution of amphibians in the protected area. 2. Social contribution, in which very important contributions were raised about the perceptions and uses that communities make of ecosystems and how these impact directly on biotic communities, especially amphibians.

4. METHODOLOGY

4.1 Study area

The study was carried out in SFF Guanentá-Alto Rio Fonce, where we have the research permit and access to the area. The SFF belongs to the high Andean forest and páramos system of the Guantiva - La Rusia - Iguaque conservation corridor (Morales et al., 2007). The SFF has an extension of 10344.5 he and altitudes between 2150 and 4000 m, is located on the western slope of the Eastern Cordillera, in the departments of Santander and Boyacá (5 ° 57 'and 6 ° 04' N and 73 ° 04 ' and 73 ° 11 'W). According to Galindo et al. (2003), the SFF presents different physiognomies among them: 1. The Sierra, is located south of the river La Russia at 2500 m altitude, with the presence of the following botanical families Rubiaceae, Melastomataceae, Hippocastanaceae, Fagaceae and Clusiaceae; 2. The Chontales, consisting of two levels (High and Low), El Bajo is located between the Chontales and Aguas Claras streams at 2800 m, and this has presence of the families Melastomataceae, Clusiaceae, Araliaceae and Rubiaceae. The Alto is located at 3000 m, this has presence of the families Fagaceae, Melastomataceae, Lauraceae and Podocarpaceae, Clusiaceae. 3. The Deer, located at the source of the Guillermo River at 3100 m, has the presence of the families Asteraceae, Clethraceae, Melastomataceae, Lauraceae and Cunoniaceae. The High Mountain Ecosystem (páramo), has 38 species of *Espeletia* (frailojums), 13 of them are endemic (for example, *Espeletia timotensis, E. argentea* (Cuatrecasas, 1986). In the forest there are Andean species such as *Quercus humboldtii* (oak)), *Podocarpus leifolius* (Colombian pine) and *Polylepis quadrijuga* (coloradito).

Fig 1. Map protected areas of Colombia. Location and delimited area of the Santuario de Fauna y Flora Guanentá Alto Río Fonce.

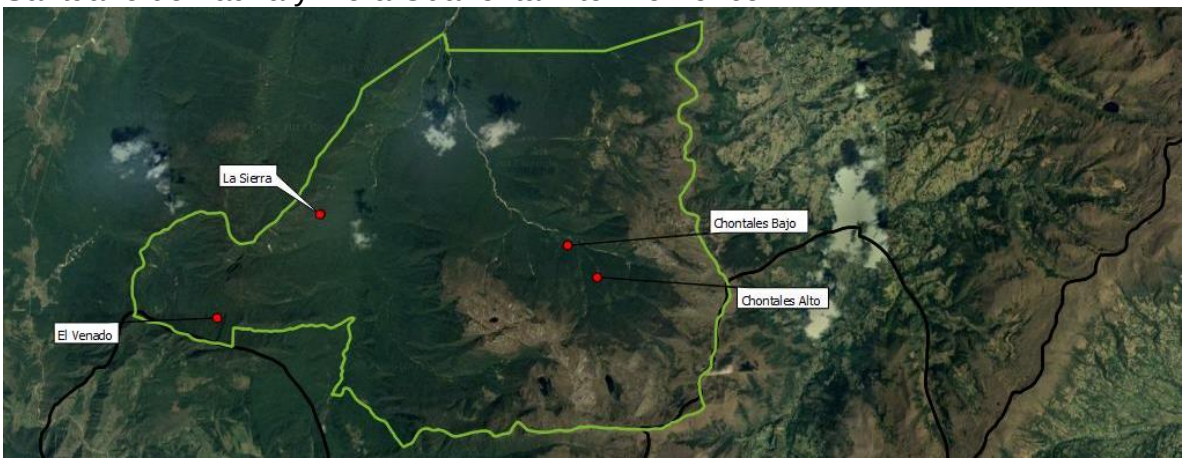


Fig 2. Identification of the localities of the park. The names of the localities are on the part of the park authorities.

La Sierra: We identify fragments of native forests, as well as a very pronounced relief with large mountains with valleys full of vegetation.

Chontales Bajo: In this area we reached the upper basin of the river Cercados, potential areas for sampling were observed near the creeks bordering the river.

Chontales Alto: In this site, it was possible to observe patches of *Polylepis* forest, there are points where a sampling point can be set.

El Venado: In this sector patches of páramo are observed, in addition it is possible to identify a stream which can be a strategic point for amphibian sampling.

4.2 Previous phase or preparation

During the preparation phase, sampling was conducted during the night, potential areas were visited through exhaustive searches, and during the day excursions were

made to the sites, near the streams and other points, the potential habitats of the amphibians were located. The potential habitats. They were sampled systematically.

4.3. Standardization of the work route with human communities.

We select two paths to work with human communities; these are Avendaños I and Avendaños II. These trails are in the area of influence of the SFFand have a sense of belonging to the area and intentions of conservation of natural resources.

4.4 Field work

Nine field trips were made, distributed throughout the year, within which it was done in chronological order first the area was recognized, sampling points were established, the project was socialized with the communities. In each sampling, a social part and the biological information surveys were covered.

For the development of the research, the following methods were followed:

Social component a workshop was held to publicize the project and begin the process of environmental education, this phase was first given to the park rangers, the community and the children of the El Carmen School. Role plays were developed to diagnose the valuation that children give to natural resources, we chose this focus group due to the high impact of education and incentive from an early age and the influence that children have on their parents and other relatives, following the protocols presented by Cárdenas et al. (2011).

Biological component. For amphibians, the method used was through the search of visual encounters (VES). Following the method (Angulo et al., 2006); each researcher carried out a systematic search of individuals along the band transects. In the pre-sampling stage, the sampling points were established in the two main types of vegetation cover found within the SFF (high mountain ecosystem (páramo) and Andean forest). For the manipulation of individuals, the biosecurity protocol presented by (Angulo et al., 2006), which includes, among other aspects, the manipulation of individuals was carried out exclusively with gloves, which were discarded after handling taking into account the possible mushroom buds there may be.

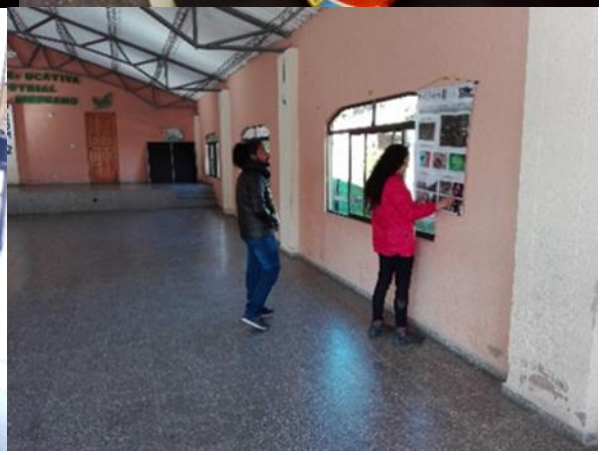
5. RESULTS

5.1 Social component

Very important results were obtained in the social component through training, lectures and games, based on contact and talks with the communities of Avendaños I and ll, due to the availability of people for their work in the field. It was possible to fully realize all the talks focused on them for such a reason we made the determination to focus all our efforts towards the children, because they are a potential group to make a greater impact on social work.

We made contact with the school of the path, the Educational Institution Francisco Medrano El Carmen. As a first approach, we held consecutive talks with school officials, teachers and other people working on the site, there we presented the work, the proposal to work with children and make an environmental education component, based on that, the managers showed interest in the work and accepted the development of the social part, continuous to this, we proceeded to standardize our methodologies to make them more didactic for the children and stimulate their participation.

The work site was the cultural hall of the school; there we organized the work material, the chairs and the projector.



Organization of work material

Socialization poster "Amphibians of Guanentá

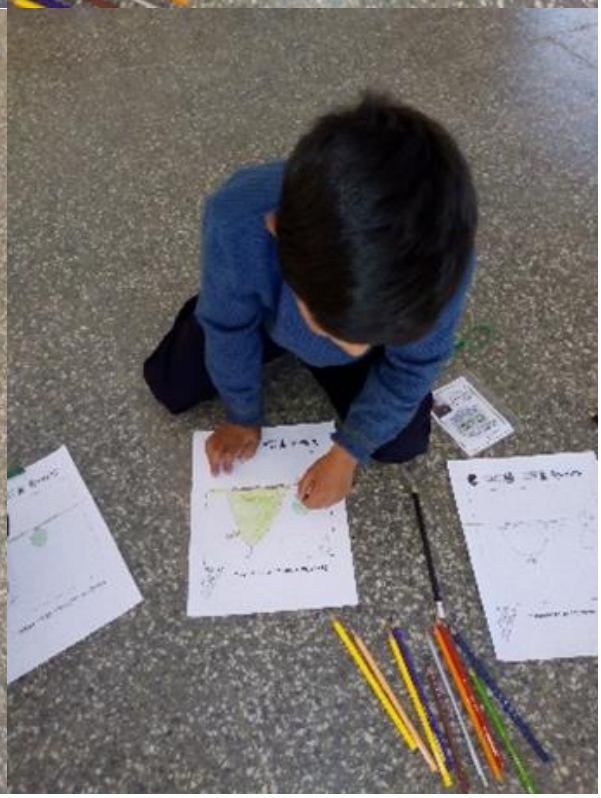
We carried out the presentation of the work team to the teachers and children of the school, we explained the objectives of the project and we projected several videos about the páramos and its importance, likewise a video about the amphibians.

Process of socialization of the project with the children and teachers of the school

Development of social work with primary school children

The work consisted of evaluating the value that children give to biodiversity, games, drawings, questions and contests were held around frogs and páramo.

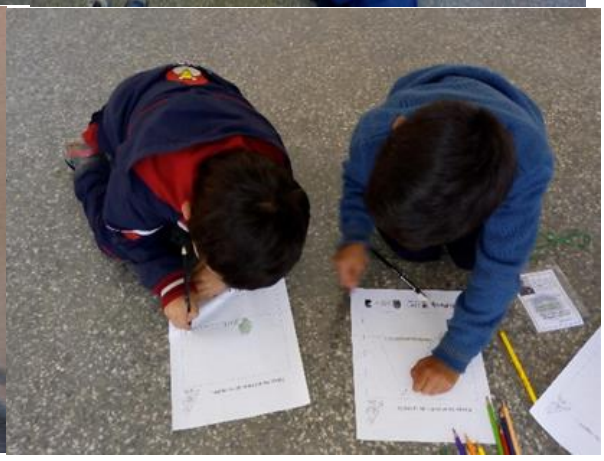















Playful activities with the children of the primary school of the village El Carmen

Organization of the children.

Presentation

There was a short presentation about the work we are doing in the sanctuary, a presentation was made of the richness in biodiversity of our country, as well as the protected area and threats.

Left: Presentation of the project. Right: Presentation of the threats.


Left: Frogs of Colombia. Right: Participation by children.

Development of work with secondary school children.

This activity was based on the children had to make work teams and go outdoors, to develop the activity, this was to make with plasticine any of the frogs that they know of the region, as a motivation there was a special prize for the best Frog and the best description by the team. In the development the activity could see the children very animated and participatory, likewise working as a team, laughing and playing a high knowledge of the main characteristics of the amphibians of the region was observed.



Left: Development of the activity in open place. Right: Work with the children.


Left: Children´s work. Right: The children were excited by the activity.


Team work.



Left: Interaction with the teams. Middle: Work team. Right: Boys working.


Left: Team with their frogs. Right: All groups showed interest in conservation.


Left: More frogs. Right: More children.


Left: Final conclusions by the children. Right: The children told us the importance of conserving.


Some of the works of children

5.2 Biologic Component

The samplings were carried out along streams, since they represent a potential habitat for *Atelopus mittermeiri*, in addition sampled in forest patches since they are the habitats of *Pristimantis miyatai* and *Pristimantis carlossanchezi*.


Left: Some of the potential habitats covered. Right: Some of the potential habitats covered.

Left: The biologist Azarys looking at in the vegetation. Right: The team work in the search of amphibians.

Searching of the amphibians.

Searching of the amphibians in the night.

During the sampling in the Andean forest, none of the conservation objects was found, however, several species were found, which were photographed in great detail to be later identified, and for the manipulation the protocol for the capture was followed of samples to analyse the presence of fungi.

Some amphibians. (*Pristimantis sp*).

Left: Manipulating the amphibians. Right: Taking samples for analysis in search of pathogens.

During the tours several potential threats could be identified, the presence of bovine cattle was observed protected area of the park, added to this it can be evidenced large areas that were at some point forest, but now they are grasslands, some introduced plants with flowers were also observed These threats are latent and will be taken into account for the full assessment of amphibian threats.

Left: Cows in the forest. Right: Threats in the forest.

Left: Transformation of the habitats. Right: Foreign species.

The samplings were carried out in the páramo, an exhaustive search was carried out in different potential microhabitats, such as the vegetation, the necro mass of the *Espeletias,* the edge of lagoons and the edge of the stream.

Left: Lagoon Aguas Claras. Right: The páramo.

The area was characterized, a temperature of 11 ° C and a humidity of 89% was obtained, the predominant vegetation was the frailejones, and a sweep was made by the site.

Left: Search for amphibians. Right: Search on the ground.

Search in the necro mass.

During the tour, the nascent creek of one of the lagoons, called Aguas Claras, was inspected.

Left: Search in edge of quebrada. Right: Pond search.

In this exit, no records of amphibian individuals were obtained, except that we found tadpoles in the stream, these were photographed for later taxonomic identification, an unexpected encounter was obtained from a lizard of the genus Anolis, which was an important finding for the Sanctuary because it was found at a considerable height that has not been reported in the literature.

Individuals' tadpoles.

Individuals of genus *Anolis*

With the advance of the field trips we have been able to obtain important results about the state of the amphibians, although we have not found the objects of conservation we have been able to explore and characterize the habitats, from this we will continue in the search of the values objects of conservation, likewise we are performing analysis on the results we have obtained so far.

The team and guide.

During the last outing, the largest record of amphibian species was obtained, as we can see below, it was possible to register new species that we could not observe in other outlets.

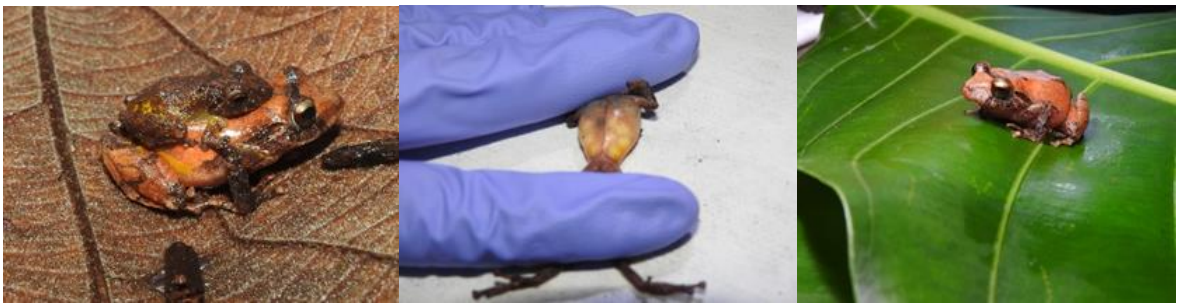
Individual of *Niceforonia nana*

The Andean frog of Santander *Niceforonia nana* is a species of anuran in the family Craugastoridae. It is endemic to Colombia, it is on the red list of the IUCN as Defitient Data (DD), although it has pressures for the loss of its natural habitat, it was an important record since it is a difficult species to find. Continuing with the observations something very important to highlight in was the record of the giant crystal frog species *Centrolene acanthidiocephalum* which had not been found for 29 years since its description by Ruiz-Carranza & Lynch (1986), of this species not nothing is known, so the distribution site provides a high impact, to generate new research about the species.

Individual of *Centrolene acanthidiocephalum*

Another of the frogs found was *Centrolene daidaleum* which is a species of glass frog that is categorized by the IUCN as vulnerable (VU), which is very important to implement monitoring of the population due to the decline it is experiencing. *Pristimantis miyatai* was found, which a common frog for the sampling site is, an important finding was *Pristimantis merostictus* which is a species that is categorized by the IUCN in vulnerable state (VU), and the record allows to have the location to conduct research on their population status.

Individual of *Centrolene daidaleum*



Individual of *Pristimantis miyatai*

Individual of *Pristimantis merostictus*

Individual of *Bolitoglosa sp*

We registered a salamander of the genus *Bolitoglosa*, which is unknown to us, we took the appropriate measures and data of its ecology to later centre a study that allows us to know more about this species. In addition to species already mentioned, *Espadarana andina, Rheobates palmatus, Centrolene notostictum and Dendropsophus molitor* were recorded.

Individual of *Espadarana andina*

Individual of *Reobates palmatus*

Individual of Centrolene notostictum

Individual of Dendropsophus molitor

6. PARTICIPATORY CONSERVATION STRATEGIES:

Amphibians are a key element for the maintenance of high mountain ecosystems in the Guanentá Alto Río Fonce Fauna and Flora Sanctuary, for this reason, based on the results obtained, we proposed conservation strategies directed towards the management of the protected area following the sanctuary management plan together with the lines of action.

Monitoring of the values of conservation objects Line		
Action	**goal**	**product**
Carry out exhaustive searches of each of the values that are the objects of conservation	Know the distribution of the species within the protected area	Records of distribution of the species values objects of conservation
Perform monitoring of the quantity and quality of habitats	Determine the evolution of the state of habits	Report on the status of habitats
Monitor pressures and threats	Evaluate the prevalence of pressures	Report with the prevalence of pressures
Modelling the distribution of conservation objects	Zoonify the sanctuary area	Distribution maps
Model the distribution of threats	Zoonify the sanctuary area	Distribution maps
Environmental Education Line		
Action	**goal**	**product**
Conduct environmental education trainings for communities	Encourage the community to take care of the environment and fauna	Presentations with the community
Involve the community in days of information socialization of the monitoring	Demonstrate the importance of carrying out monitoring	Environmental conferences
Implement new teaching methodologies	Contaminate the community with good practices	Teaching and work protocols
Strategic Alliances Line		
Action	**goal**	**product**
Establish inter-institutional alliances	Form links that facilitate the process of protecting the sanctuary	Agreements for cooperation

Establish cooperation agreements for the realization of research projects	Generate opportunities to provide new important information for the management of the protected area	Research projects

7. Thanks

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8. Cited literatura

Acosta-Galvis, A. R., Huertas-Salgado, C., & Rada, M. (2006). Aproximación al conocimiento de los anfibios en una localidad del Magdalena medio (Departamento de Caldas, Colombia). *Revista de la Academia Colombiana de Ciencias Exactas, Físicas y Naturales*, *30*(115), 291-303.

Angulo, A., Rodríguez-Mahecha, J. V., Rueda-Almonacid, J. V., & La Marca, E. (2006). *Técnicas de inventario y monitoreo para los anfibios de la región tropical andina*. Conservación Internacional.

Cárdenas, J. C., & Ramos, P. A. (2006). Manual de juegos económicos para el análisis del uso colectivo de los recursos naturales.

Cuatrecasas, J. (1986). *Speciation and radiation of the Espeletiinae in the Andes*. Oxford University Press.

Galindo, R., Betancur, J., & Cadena, J. J. (2003). Estructura y composición florística de cuatro bosques andinos del santuario de flora y fauna Guanentá-Alto río Fonce, cordillera oriental colombiana. *Caldasia*, *25*(2), 313-335.

La Marca, E., K. Lips, S. Lötters, R. Puschendorf, R. Ibáñez, J. V. Rueda-Almonacid, R. Schulte, C. Marty, F. Castro, J. Manzanilla- Puppo, J. E. García-Pérez, F. Bolaños, G. Chaves, J. A. Pounds, E. Toral & B. E. Young. 2005. Catastrophic population declines and extinctions in Neotropical harlequin frogs (Bufonidae: *Atelopus*). *Biotropica* 37 (2): 190-201.

Lynch. D. John & Suarez-Mayorga.M. Angela. 2002. Análisis biogeográfico de los anfibios paramunos. Caldasia 24(2) 471-480.

Morales-Puentes, M. E., Gil-Leguizamón, P. A., & Díaz-Pérez, C. N. (2014). Population Assessment and Degree of Threat of Chalybea macrocarpa (Melastomataceae) Endemic Species from Colombia. *Acta Biológica Colombiana*, *19*(2), 261-270.

Prada-Salcedo L Daniel, Franco-Correa Marcela y Acosta-Galvis R Andrés. 2011. Primer registro de Saprolegnia sp. en una población de anfibios en Colombia. http://revistas.javeriana.edu.co/index.php/scientarium/article/view/1800/4251. Received: 27-07-2011; Accepted: 16-11-2011.

Rivera, D. y Rodríguez, C. 2011. Guía divulgativa de criterios para la delimitación de páramos de Colombia. 2011. Ministerio de Ambiente, Vivienda y Desarrollo Territorial e Instituto de Investigación de Recursos Biológicos Alexander von Humboldt. 68 págs.

Ruiz A, Rueda V.R. Batrachochytrium dendrobatidis y quitridiomicosis en anfibios anuros de Colombia. EcoSalud 2008; 5: 27-33.

Ruiz-Carranza, P. M., & Lynch, J. D. (1998). Ranas Centrolenidae de Colombia XI. Nuevas especies de ranas cristal del genero Hyalinobatrachium. *Revista de la Academia Colombiana de Ciencias Exactas, Físicas y Naturales*, *22*(85), 571-586. Sistema de Información sobre la Biodiversidad en Colombia SIB Colombia 2016.

Vásquez, A., Buitrago, A. C. (Editoras). 2011. El gran libro de los páramos. Instituto de Investigación de Recursos Biológicos Alexander von Humboldt. Proyecto Páramo Andino. Bogotá, D. C. Colombia. 208 pp.

Young, B. E., S. N. Stuart, J. S. Chanson, N. A. Cox & T. M. Boucher. 2004. Joyas que están desapareciendo: El estado de los anfibios en el Nuevo Mundo. Nature Serve, Arlington, Virginia. 60 pp.