



Executive Summary

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Executive Summary

Juan M. Guayasamin and Elisa Bonaccorso

INTRODUCTION

The Rapid Assessment Program (RAP) was created in 1990 by Conservation International with the objective of rapidly collecting the biological information necessary to catalyze conservation actions and protection of biodiversity. Typically, RAP study areas are poorly known, but based on their geographic location or preliminary studies, they are expected to have exceptionally high species richness and/or a large number of threatened species. RAP surveys are designed so that, in a short period of time (2-4 weeks), an interdisciplinary group of researchers can obtain sufficient biological information to provide to the institutions responsible for making decisions (e.g., local communities and governments, environmental ministries, countries, international community) so that they can proceed to develop responsible conservation strategies for the area in question. It is also the responsibility of the RAP team to make realistic recommendations for conservation of the surveyed ecosystems and also for the well-being of local human populations.

Results of RAP surveys have been fundamental in the creation of national parks, discovery of species new to science, and development of management plans for terrestrial and aquatic ecosystems with the participation of indigenous communities, colonizers and governments. One of the principal motivations for conducting a RAP survey in upper Nangaritza river basin was the local communities' need to obtain official protection status that would guarantee protection of the area from future threats.

Specific objectives of the Nangaritza Tepuis RAP survey

- Inventory species in specific taxonomic groups (plants, birds, mammals, reptiles, amphibians, katydids, stick insects and ants).
- Document ecosystem diversity.
- Identify the threatened species inhabiting the area.
- Identify the current and potential threats to biodiversity and make recommendations to eliminate or mitigate these threats.
- Provide biological information that will facilitate the local communities in their efforts to obtain increased protection status for the area from the Ecuadorean Ministry of the Environment.

Background

Ecuador, with a land area of only 256,370 km², is considered as the country with the highest biological diversity per unit area in Latin America. Ecosystems as diverse as the Chocó, Amazonía, and the Andes, and as unique as the Galápagos Islands come together in this tiny country. Simultaneously, characteristics of Ecuador's population and history put particularly intense

pressures on its biodiversity. For example, the population of Ecuador is close to 14 million people, making it the most densely populated country in South America. Since 1950, the country's population has quadrupled. This high population density, combined with an ingrained agricultural tradition, recent development of monocultures (e.g., bananas, oil palm, and eucalyptus) and unregulated logging activity are a few reasons why Ecuador destroys approximately 190,000 hectares of forest annually. This is among the top ten highest deforestation rates per unit area in the world. Consequently, immediate action is required to investigate and preserve remaining forests. This is the case with the Cordillera del Cóndor, where the few preliminary studies that have been conducted suggest elevated levels of biological diversity and endemism (Duellman and Simmons 1988, Becking 2004, Neill 2007). One of the areas that still maintains significant forest cover and associated biodiversity is the Nangaritza River Valley. Because of its social and environmental importance to the region, the upper part of the valley was declared the Bosque y Vegetación Protectora Cuenca Alta del Río Nangaritza (BVP-AN).

In 2004, a management plan was proposed which included various concrete actions for management of the territory. As a result of this plan, the Colono-Shuar Nangaritza Tepuis Conservation Area was created under the category of Private Protected Forest. Currently, the San Miguel de las Orquídeas Association of Independent Workers and the Association of Shuar Tayunts manage the area and are petitioning the Ecuadorean Ministry of the Environment to upgrade the protection category of the Nangaritza Tepuis Conservation Area site which would ensure its conservation in the long term. In order to achieve this goal, it is necessary to document the biological and ecological diversity within these territories. For this reason, a RAP survey was proposed to document the fauna and flora of the site and in this way obtain the scientific data necessary to facilitate the upgrade petition to the Ministry of the Environment.

RELEVANT RESULTS FOR CONSERVATION-RELATED CONSIDERATIONS

Criteria for Conservation

Heterogeneity and uniqueness of the habitat

The Cordillera del Cóndor is a mountain chain isolated from the main branches of the Andes. This geographic isolation, combined with unique soil characteristics (i.e., composed of sand with few nutrients), has a notable influence on biodiversity and endemism patterns. For example, the Cordillera del Cóndor is home to species that appear to have their origin in the nearby Andes, but also to forests types and species that can only be found in the Guiana Shield, thousands of kilometers away. Another factor that influences diversity in the area is the presence of both black and white water

streams. It is estimated that 91% of the original forest cover remains intact in the Cordillera del Cóndor (Coloma-Santos, 2007). Together, the factors mentioned above interact to produce unique and diverse ecosystems, as evidenced by the results of this RAP survey.

Current level of threat and fragility

The Cordillera del Cóndor forms part of the most threatened ecoregion in the world, the Tropical Andes. This ecoregion is also home to more endemic species than any other (Myers, *et al.* 2000). The more pressing threats to the biodiversity of the Cordillera del Cóndor are:

- Destruction, fragmentation and contamination of habitat due to agriculture, ranching, forestry, and mining activities. In the case of the mining industry, at the national level the Government is currently exploring the possibility of extracting copper and gold on a large scale; these activities would result in deforestation of the exploited areas, soil erosion, species population decline, and contamination of soils, rivers and streams. In addition, mining would encourage road construction which would likely result in the destruction and/or fragmentation of ecosystems and could introduce invasive species and diseases to the Cordillera del Cóndor.
- Potential damage to plant and animal populations via the introduction of diseases. For example, the extinction of more than 200 amphibian species worldwide has been attributed to the accidental and human-mediated introduction of the fungus *Batrachochytrium dendrobatidis* (Lips *et al.* 2006; Wake and Vredenburg, 2008). In Ecuador, this same global pattern has been repeated; a third of the 480 species of amphibians in the country are threatened with extinction (Ron *et al.* in press).

Endemism

Despite the fact that the results presented here come from a RAP survey only 2 weeks long, the data clearly indicate the biological importance of the area. Surprises included, for example, the discovery of two new reptile species records for Ecuador and one recently described reptile species: *Enyalioides rubrigularis* (Torres-Carvajal *et al.*, 2009). Amphibian diversity was also found to be quite high, with four species identified as new to science (*Dendrobates* sp., *Pristimantis minimus*, *Bolitoglossa* sp., *Nymphargus* sp.). As an unexpected and tremendously important result for the conservation of Ecuadorean amphibians, an apparently healthy population of harlequin frogs (*Atelopus* aff. *palmatus*) was found on one of the tepuis. This genus of amphibians has suffered drastic population declines and/or extinctions throughout the Neotropics (La Marca *et al.*, 2005). In Ecuador, of the 21 known species, the vast majority appear to be extinct. At the moment, only three relatively stable *Atelopus* populations are known: one in Sangay National Park, another near Limón and the third discovered during this study. For birds,

13 globally threatened or near-threatened species, three species restricted to the Forests of the Andean Crest center of endemism, and six species confined to the Eastern Cordillera of Ecuador and Peru were recorded. Additionally during this RAP survey, an incredible 13 new species of katydids and 10 new species of stick insects were discovered.

Potential and opportunities for conservation

The area has at least three particular characteristics that, combined, give it great potential for conservation:

- The inhabitants of the Nangaritza tepuis are organized and interested in the protection of the ecosystems of the Cordillera del Cóndor. As a direct result of this interest, the Colono-Shuar Nangaritza Tepuis Conservation Area was created with Private Protected Forest status, preserving the upper reaches of each tepui.
- The possibility of easily observing globally threatened, Cordillera del Cóndor endemic, and generally rare bird species (e.g. *Heliangelus regalis*, *Hemitriccus cinnamo-meipectus*, *Myiophobus roraimae*, *Oxyruncus cristatus*, *Henicorhina leucoptera*, *Wetmorethraupis sterrhopteron*) gives the Nangaritza tepuis high value and potential for ecotourism. The development of ecotourism in the area has already begun due to an initiative motivated by the presence of *W. sterrhopteron*. For this reason, the potential to implement this type of sustainable ecotourism is high. As an industry that provides important economic incentives without harming the natural resources it uses, ecotourism in general could contribute significantly to the process of conservation in the Nangaritza Tepuis (Sekerçioğlu 2002, Greenfield *et al.* 2006). Nevertheless, it is essential to develop zoning to create areas that can be used for tourism and those that are off-limits to tourists, to build capacity for ecotourism within the Las Orquídeas community, and to implement well evaluated, environmentally responsibly and sustainable practices.
- As a consequence of the Peace Accord between Ecuador and Peru, the Biological Reserve El Cóndor was established. It is composed by two small parks: one with 6,000 ha in Peru and another with 2,400 ha in Ecuador. They are located between the source of the Kuankus and Cenepa rivers. These small “Peace Parks”, adjacent to the Colono-Shuar Nangaritza Tepuis Conservation Area, and to the Cóndor-Cutucú biological corridor, could form the basis for development of a larger conservation project that would include the neighboring Cordilleras (Cóndor and Cutucú), which both have great biological and cultural importance. The possible inclusion of the two Cordilleras in a larger project, would keep the biological and cultural diversity of the Cordilleras intact and could form part of project

proposals for carbon credits to be derived from avoiding potential emissions.

Significance for humans

The Cordillera del Cóndor is the ancestral home of indigenous populations including the Shuar and Ashuar, ethnic groups that have principally inhabited the Zamora, Nangaritza and Pastaza river valleys; and the Aguaruna and Huambisa, who have traditionally inhabited the Cenepa and Santiago river valleys. In some areas of the Cordillera del Cóndor, like San Miguel de Las Orquídeas and surrounding areas, colonists maintain a collaborative relationship with the Shuar, which has permitted them to develop projects together, like the creation of the Colono-Shuar Nangaritza Tepuis Conservation Area. Initiatives such as this would facilitate the development of a large scale project to conserve the biological and cultural diversity of the Cordillera del Cóndor.

SUMMARY OF THE RAP RESULTS

Description of study area

This study was conducted in the Tepuis Conservation Area, which is part of the Colono-Shuar Nangaritza Tepuis Conservation Area, located in the Cordillera del Cóndor, Nangaritza Region, Zamora-Chinchi Province, Ecuador (Fig. 1). The Tepuis Conservation Area (4,232 hectares) is managed by the Association of Shuar Tayunts and the San Miguel de las Orquídeas Association of Independent Workers. Although the word tepui is generally used to identify the mountains in this area, the Nangaritza tepuis are not equivalent to the true tepuis found in the Guiana Shield, which are much larger and older than those of Ecuador; nevertheless, both types of tepuis share similar soils, composed primarily of sand. The Tepuis Conservation Area has a wet subtropical climate. Annual rainfall ranges from 2,000 to 3,000 millimeters. Average temperature is 20-22° C and elevation ranges from 950 to 1,850 meters. The soils of this region are extremely poor and composed primarily of medium to large grain sand high in silica content. The forests atop the tepuis are dwarfed – an adaptation to the low nutrient content of the soils. The vegetation in the area includes the following formations: Paramillo, Dwarf Forest, and Pre-montane Wet Forest. The physical characteristics of the sampled tepuis are summarized in Table 1. The scientific collections made during this RAP survey were conducted with permit N° 006-IC-FLO-DBAP-VS- DRLZCH-MA from Ecuador’s Ministry of the Environment.

	Site 1 (Tepui 1 – Miazí Alto)	Site 2 (Tepui 2)
Coordinates	04,25026 S 78,61746 W	04,25791 S 78,681636 W
Elevation	1256–1430 m	1200–1850 m
Forest Types	Pre-montane Wet Forest Lower Montane Wet Forest Dwarf Forest	Pre-montane Wet Forest Lower Montane Wet Forest Dwarf Forest Paramillo
Sampling Dates	April 6-12, 2009	April 14-20, 2009

Tabla 1. General characteristics of the sampled sites in the Cordillera del Cóndor.

Flora

This study includes an analysis of floristic composition, indices of diversity and similarity, phenology, and recommendations for conservation of the remaining forests on the two surveyed tepuis in the Cordillera del Cóndor in southern Ecuador. We found four forest types: Pre-Montane Wet forest, Lower Montane Wet Forest, Dwarf Forest and Paramillo. At Site 1, 49 families and 162 species of plants were registered, two of which are new to science: *Cinchona* sp. 1 (Rubiaceae) and *Dacryodes* sp. (Bursaceae). At site 2, 68 families and 159 species were detected with one new species, *Cinchona* sp. 2. According to Sorensen and Jaccard similarity indices, the two sample sites are not very similar floristically. Genera and species of great biogeographical interest (because they also occur in the Guiana Shield, Mapiro in Bolivia, or on the eastern slopes of the Andes) were documented including *Pagamea*, *Phainantha*, *Humiriastrium*, and *Podocarpus tepuiensis*.

Ants

A preliminary analysis of the data indicates at least 32 genera and 51 species of ants among the samples (Table 3.1). Identifications of all ant species collected during this RAP survey still need to be finalized in order to determine how many species new to science were found as well as how many species that could be restricted to the Nangaritza tepuis. According to the preliminary analysis, the diversity and composition of the ant fauna appears to be typical of mid-elevation tropical wet forests.

Katydid and Stick Insects

An inventory of katydids produced 27 typical forest species: 21 at Site 1 and 14 at Site 2 (with eight species shared between sites). Thirteen of these species are likely new to science and three also represent new genera. Additionally, two species were recorded for the first time in Ecuador. Stick insects were represented by 15 species (Sites 1 and 2 combined), of

which 10 species are likely new to science, with one of those representing a new genus. The actual diversity of both these groups is certainly much higher than the number reported here.

Amphibians and Reptiles

Twenty-seven amphibian and 17 reptile species were registered during this RAP survey. Four of the amphibian species (*Bolitoglossa* sp., *Dendrobates* sp., *Pristimantis minimus*, *Nymphargus* sp.) are new to science. One of the reptiles species found in the area was recently named as *Enyalioides rubrigularis*. The glass frog *Nymphargus chancas* was recorded and represents a new record for Ecuador. In addition, a healthy population of harlequin frogs (*Atelopus* aff. *palmaris*), a highly threatened group throughout the Neotropics, was discovered. All tests for chytridiomycosis conducted on adults and juveniles of the harlequin frogs were negative.

Birds

A total of 205 species were documented during this survey with 9 more documented by N. Krabbe in a previous study. At Sites 1 and 2, 155 and 127 species were recorded respectively: 68 occurred at both sites, 87 were exclusive to Site 1 and 59 to Site 2. In total, 13 globally threatened or near-threatened and 10 nationally threatened species were observed. Three of the species encountered are restricted to the Forests of the Andean Crest center of endemism and six are restricted to the center of endemism in the Eastern Cordillera of Ecuador and Peru. Twenty-four species were recorded for the first time in the Nangaritza Tepui region, while another 53 were observed outside of their previously reported geographic range distribution. In addition, 16 species considered rare at the national level were documented during the survey. Among these the most interesting may be *Heliangelus regalis* (Solángel Real), which was reported for the first time in Ecuador just one year earlier, also in the Nangaritza region.

Mammals

Sixty-five mammal species in 52 genera, 24 families and 10 orders were recorded. The most diverse order was Chiroptera with 18 species that correspond to 27.7% of the total number of documented species. At the family level, the most diverse was *Phyllostomidae* (Chiroptera) with 18 species. Ninety-five individuals belonging to 20 species of small mammals were captured. The most abundant species was *Dermanura glauca* ($P_i = 0.136$) with 13 captures. Both the Simpson and Shannon diversity indices indicate high diversity ($S = 0.909$; $H' = 2.527$; $H'_{max} = 2.995$). Of the 65 recorded species, 59 were found in Site 1 and 56 in Site 2. The two Sites had 50 species in common, while nine species were only found at Site 1 and six were only found at Site 2. Sorensen ($S = 0.869$) and Jaccard ($J = 0.769$) similarity indices show the two Sites are fairly similar in terms of mammal diversity. The major difference in presence/absence of species can be found among Chiroptera; of the 15 species not common to both sites, 10 are bats. Twenty-nine threatened species were encountered – 44.6% of the total number of species documented. Two species, *Sturnira nana* and *Thomomys* sp., represent new country records for Ecuador.

Threats

The most direct threats to biodiversity conservation in the area are: (i) expansion of agriculture and ranching, (ii) logging, (iii) large and small scale mining, (iv) introduction of diseases to the site and (v) the effects of climate change.

CONSERVATION RECOMMENDATIONS

The recommendations are divided into general and specific recommendations. The general recommendations are those suggested by the majority of RAP scientists involved in this survey, while the specific recommendations refer to particular needs related to each taxonomic group.

General Recommendations:

- Given that the Nangaritza Tepuis are protected by the Association of Shuar Tayunts and the San Miguel de las Orquídeas Association of Independent Workers, we recommend collaboration between these groups to ensure conservation of the area, its diversity, and direct (ecosystem services such as freshwater) and potential benefits (ecotourism) from which the surrounding communities benefit. As an integral part of this process, zoning of the area should be completed and land titles provided to the Association of Shuar Tayunts and the San Miguel de las Orquídeas Association of Independent Workers. Simultaneously, it is necessary to clearly delimit the protected area, including distinctions of zones for scientific use, ecotourism and areas that are

completely off-limits. Sanctions for trespassing within unauthorized zones should be established and enforced.

- The Ministry of the Environment of Ecuador, through the Socio Bosque Program, provides economic incentives to individual and community land owners (with legal titles) who decide to voluntarily preserve native forests on their land. Local populations should consider the possibility of participating in this program and in this way obtain resources that can be used for activities which would benefit the whole community and promote conservation of their forests. Also, conservation of neighboring ecosystems would maintain forest connectivity which is necessary for the survival of long-lived species. Connectivity could also be promoted through reforestation projects that could be financed through carbon capture programs.
- In order to avoid impacts from small scale mining, local communities should investigate, design, and develop viable alternatives to this practice. For example, it will be necessary to establish whether or not tourism is a viable economic activity for the local populations. Other possible sources of income that would promote conservation include the Socio Bosque Program and reforestation, mediated by carbon sequestration programs.
- If the government of Ecuador decides to allow large scale industrial mining, the community should demand environmental impact studies and mitigation plans that include high level interdisciplinary (i.e., biological, physio-chemical, geographical, geological) analyses, that would help to develop concrete strategies to minimize the impact of mining on endemic and/or threatened species, and that guarantee the persistence of biological diversity and the ecosystem services provided by the forest (e.g., freshwater). An efficient and independent monitoring system should also be implemented to oversee mining activities.
- The Association of Shuar Tayunts and the San Miguel de las Orquídeas Association of Independent Workers should be trained and continue to be involved in monitoring biodiversity in the tepuis.
- Creation of a National Park that includes the Cordilleras de Cónдор and Cutucú should be considered. This Park would secure conservation of one of the most biologically and culturally diverse regions in South America.
- The biodiversity of the Nangaritza tepuis is still not completely known. For this reason, we recommend further scientific studies in the area.

Specific Recommendations:**Flora**

- Silviculture, a way in which locals make use of forest products to fulfill their daily needs, can be practiced in areas that have already been altered by humans, utilizing the following woody species: *Humiriastrum baslamifera*, *H. mapiariense*, *Podocarpus tepuiensis*, *Pagamea dudleyi*, and *Dacryodes* sp. Communities can also cultivate forest species with high nutrition value, native fruits such as Chamburo (*Jacaratia digitata*), Yarazo (*Pouteria caimito*), Membrillo (*Eugenia stipitata*) and Apai (*Grias peruviana*), and medicinal plants like Cascarillas (*Cinchona* spp.) and Santa Maria (*Piper umbellatum*), among others.
- We also recommend implementing reforestation programs using fast growing native species like Balsa (*Ochroma pyramidale*), Tunashi (*Piptocoma discolor*) and Sannon (*Hyeronima asperifolia*) in disturbed areas. In addition, communities should consider creating forest corridors to connect the currently isolated tepuis. Reforestation and forest conservation have the potential to be alternative sources of income for local populations through programs for carbon sequestration and maintenance of carbon stocks.

Ants

- Wet forests with average elevations of 1,200 m, like those sampled in this RAP survey, generally have lower diversity than lowland forests and often have different species composition. Because there is high potential for endemism in the tepuis, these forests should be protected.
- The peak of the tepui at Site 2, with its unique paramo vegetation, and those of the other tepuis in the Nangaritza region, are likely home to unique and endemic ant species. Further studies of ant fauna should be conducted in this region with the goal of documenting diversity and species composition on the tops of the tepuis.

Katydid and Stick Insects

- With few exceptions, members of the Neotropical subfamily Pseudophyllinae are restricted to pristine wet forests. They can rarely be found in secondary forest, and are even less likely to be found in deforested habitat or pasture. For this reason, conservation of the remaining forest is fundamental to the survival of these species.

- The Cordillera del Cóndor, with the majority of its diversity yet to be discovered, is of particular interest to biologists and could serve to capture the interest of biology students. Katydid and Phasmids are particularly useful models for studying various biological phenomena such as the evolution of perfect camouflage.

Amphibians and Reptiles

- In order to maintain healthy populations of amphibians and reptiles in the tepuis, forest conservation is essential. The rivers and streams should be bordered by native vegetation and free of contaminants. To ensure this, mining, agriculture and ranching should be avoided in these areas.
- At Site 1, the glass frog *Nymphagus chancas* was recorded for the first time in Ecuador. This species was previously known only from one locality in northeastern Peru (Abra Tangarana). The presence of *Nymphagus chancas* as well as at least two new species of amphibians (*Pristimantis minimus*, *Nymphargus* sp.), one reptile (*Enyalioides rubrigularis*) and endemic species such as *Oreobates simmonsii* and *Bothrocophias microphthalmus*, justify long term protection of this site.
- At Site 2, the discovery of a population of harlequin frogs (*Atelopus* aff. *palmatus*) with apparently healthy tadpoles and adults makes it necessary to take immediate measures to protect this population. Among possible measures, the most important are:
 - o Restrict access of humans (locals and tourists) and non-native animal species to the site in order to reduce the probability of introducing disease (e.g., chytrid fungus) which could be lethal for harlequin frogs as well as other amphibian species.
 - o Implement a research program to establish the status and viability of this population.
 - o Conduct surveys in nearby areas to establish whether other additional populations of this species (or others) of *Atelopus* exist.
- Appropriate conservation measures should be taken at Site 2 as in Site 1 (forest preservation, environmental education, watershed protection, limiting access, prohibit agriculture, mining and ranching) in order to ensure conservation of new species discovered during this RAP survey (*Bolitoglossa* sp., *Dendrobates* sp., *Nymphargus* sp., *Pristimantis minimus*).

Birds

- The majority of endemic bird species in the Cordillera del Cóndor, many of which are considered threatened or near-threatened with extinction, are confined to the upper parts of the tepuis, including the endangered (*Heliangelus regalis*). Without actually quantifying populations of bird species in the area, it appears that protection of the tepuis represents a valid long-term conservation strategy, suggesting that every effort should be taken to protect these forests. Nevertheless, it is important to conduct further censuses specifically within distinct forest types in order to determine species' habitat preferences and evaluate the effectiveness of limiting conservation status to only the upper reaches of the tepuis.
- In the lower part of the study area, corresponding to the Pre-montane Forest, selective logging appears to be intense. This could have grave consequences for *Wetmorethraupis sterrhopteron* (Vulnerable at the global scale) which is restricted to lower elevations and is not found higher up on the tepuis. This particular population of this species, endemic to the Cordillera del Cóndor, could be very important to the survival of the species overall.
- The development of avitourism in the area has begun through an initiative motivated by the presence of *W. sterrhopteron*. This type of ecotourism has the potential to succeed and could provide significant support for conservation in the Nangaritza tepuis. The possibility of easily observing globally threatened, Cordillera del Cóndor endemic, and generally rare bird species (e.g., *Heliangelus regalis*, *Hemitriccus cinnamomeipectus*, *Myiophobus roraimae*, *Oxyruncus cristatus*, *Henicorhina leucoptera*, *Wetmorethraupis sterrhopteron*) improves the value of, and potential for avitourism in the Nangaritza tepuis. Nevertheless, it is fundamental to develop zoning to create areas that can be used for tourism and those that are off-limits, to build capacity for ecotourism within the Las Orquídeas community, and to implement well evaluated, environmentally responsibly and sustainable practices.

Mammals

Because bats, rodents and marsupials are often misunderstood and underappreciated animals, local people typically kill these small mammals when they are encountered. For this reason, it is important to establish an environmental education program that emphasizes the importance of these animals to ecological forest processes (seed dispersal, pollination, pest control) and to clarify that these animals do not represent a risk to human beings.

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