STATUS, DISTRIBUTION AND CONSERVATION OF THREATENED AMPHIBIANS OF CUBAN RAINFORESTS

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EXECUTIVE SUMMARY

The Problem

Cuba is the largest Caribbean island and harbours the most diverse amphibian fauna, including 62 species and 95% of endemism. Estimates of IUCN consider 47 Cuban species as threatened, and together with the high local endemism rate (about 1/3 of the species), makes this a very vulnerable fauna. Most of the endemic and threatened species inhabits forests in Cuba. Despite this spectacularly rich and unique assemblage, very little attention has been paid to the study of this important indicator group and no field studies have been made to known the status of Cuban amphibians.

Our Objectives

- To establish relative density indexes and a presence-absence matrix for the amphibian species living in Cuban rainforests.
- To identify areas of high-value for amphibian diversity in Cuba and to examine the geographical coincidence of these areas with the Cuban protected areas.
- To recognize threats and conservation needs and to recommend protection and mitigation actions.
- To contribute to the conservation of these amphibians by means of the education of local residents and decision-makers.

Key Findings

Cuban rainforests were originally extensively distributed through the island, but nowadays these are confined to mountain zones in eastern Cuba, namely Sierra Maestra and Sagua-Baracoa, which make less than a fourth part of the Cuban island.

We found 29 species living in rainforests, although some of them are able to live in other kind of forests (for example, evergreen forests) and 11 are able to survive even in secondary habitats.

We observed 776 frogs of 22 species in 37 searches and relative density ranged from a high value of 0.101 ind/m^2 in *Eleutherodactylus glamyrus*, to a low value of 0.002 ind/ m^2 in *Bufo peltocephalus*.

High-value areas (85% of the maximum number) of species and endemic species selected 1626 km^2, representing 11.2% of the area occupied by these mountains and the 69.9% of the current extension of rainforests in Cuba.

In threatened species, the high-value areas occupied 1120 km^2, it is, the 7.7% of the area of these mountain massifs and only the 47.1% of the current extension of rainforests in Cuba.

A total of 666 km^2 (41.0% of the total) of the areas of high value for species richness and 486 km^2 (43.4%) for threatened species were included in at least a protected area, so coincidence between areas of high value and protected areas was low.

Habitat destruction and fragmentation are the biggest and more extended threats to the survival of these frogs. Other minor importance threats to these amphibians were groundwater and surface water contamination and introduced species.

Eight recommendations arose from the project, which aims to reduce threats and protect each species, and to act as guarantor for the conservation of these animals.

One A3 poster and one brochure contented information on characteristics, importance and recommendations to protect the frogs were made and 100 copies of each printed material were distributed.

INTRODUCTION

The Caribbean region is ranked sixth in the world in terrestrial vertebrate diversity and third in endemism among all regions (779 of 1518 terrestrial endemic vertebrates, or 51.3%). Cuba is the largest Caribbean island and harbours the most diverse amphibian fauna, including 62 species and 95% of endemism. Estimates of IUCN consider 47 Cuban species as threatened, and together with the high local endemism rate (about 1/3 of the species), makes this a very vulnerable fauna. Most of the endemic and threatened species inhabits forests in Cuba. Despite this spectacularly rich and unique assemblage, very little attention has been paid to the study of this important indicator group.

Herpetologists and conservationists are aware of amphibian declines and extinctions in Antillean islands, although to date amphibian declines have not been observed in Cuba (but some species have disappeared in specific areas where their natural habitats were modified). Most amphibian population declines and extinction's in Tropics have occurred in species living in natural forests of highlands above 500m altitude.

The importance of, and threats to, Cuban biodiversity are recognized by numerous international conservation organizations, including World Wildlife Fund (WWF), Conservation International (CI), Wildlife Conservation Society (WCS), and World Resources Institute (WRI). CI recognizes the Caribbean region as an important "hotspot" of terrestrial and marine biodiversity, and a parallel effort by WWF ("Global 200 Eco-regions") shows that Cuba harbours four of the world's most representative eco-regions in biological diversity.

No field studies have been made to known the status of Cuban amphibians; the Global Amphibian Assessment presented by IUCN is mainly based on indirect and subjective information on Cuban species, so many Cuban amphibians could be underestimated in that account and their threatened categories could change if sound field research is conducted.

This project aims to produce updated information on distribution, abundance and status of the 29 amphibians living in Cuban rainforests. Since the rainforests-associated species have undergone highest decline rates, these species run the risk of disappear firstly if any decline event occur in Cuba. We provide new data on a poorly studied area (Cuba) in relation to amphibian declines in Neotropical area.

Reserves alone are not adequate for nature conservation but they are the cornerstone on which regional strategies can be built, so it is necessary to set prior targets. We also address this problem of setting prior targets by examining the geographical coincidence of the distribution of high value areas for amphibians with the existing network of protected areas.

For this, we propose the following objectives:

1- To establish relative density indexes and a presence-absence matrix for the amphibian species living in Cuban rainforests.

2- To identify areas of high-value for amphibian diversity in Cuba and to examine the geographical coincidence of high-value areas with the Cuban protected areas.

3- To recognize threats and conservation needs and to recommend protection and mitigation actions.

4- To contribute to the conservation of these amphibians by means of the education of local residents and decision-makers.

METHODS

Objective 1:

We carried out 16 intensive field expeditions (5-10 days each) aimed to extensively survey relatively unexplored portions of Cuban rainforests, making 119 intensive searches in these areas (Fig. 1). Also we placed 37 8x8-m^2 plots in 13 localities and we recorded 776 specimens in those plots (some plots yield no specimens).

We counted frogs and recorded number of specimens seen or heard in plots. Surveys were conducted from 20:00 to 24:00 hours, when frog activity was highest. The number of individuals per square meter (transformed from the number of frogs by plot) was used as a measure of the relative density for every species. Using hand-held GPS receivers we recorded coordinates for each individual detected in the field.

Objective 2:

We used three sources to known the present distribution of these species: literature review, collection specimens and our field data (see Objective 1 above). We made a literature review and we got and organized data from specimens deposited in national and foreign collections. Both of these let us to identify places in which these species have been reported. Data from literature and collection specimens were considered only if they were from recent dates in order to avoid mistakes in distributions due to changes occurred in habitats or places.

These data were integrated in a presence/absence matrix and assembled into a GIS database along remote sensing data, including habitat type, altitude, slope, river/stream presence, road presence, and human buildings. We used GIS technology to model distribution and obtain potential distribution maps of every species. For this, we assigned different suitability values to selected landscape variables based in published papers and our field observations of habitat association for these frogs. Higher values corresponded to more suitable habitat, so 0 stood for habitat characteristics where the species is not known to occur and 2 stood for the most suitable habitat characteristic. GIS layers for each habitat variable were multiplied, combining them to create a single layer of all considered variables, and then it was reclassified into categories based on the value of each cell. Thus, potential habitat suitability was determined by a combination of the landscape variables based on species specific habitat affinities.

Potential distribution maps of individual species were summed to obtain number of species, number of endemic species and number of threatened species by square kilometre. These maps were reclassified with the GIS in order to select high-value areas of amphibian diversity, it is, cells with at least 85% of the maximum number of species, the maximum number of endemic species, and the maximum number of threatened species. We acknowledge this threshold is totally arbitrary, but any other choice would have been arbitrary as well.

Next, we overlaid the produced maps with a map of the existing Cuban network of protected areas to examine coincidences between high-value areas for amphibian diversity and protected areas. We examined the proportion of the distribution of species, endemic species and threatened species included in protected areas and the proportion that was excluded from them, considering both the complete network and the different categories in the Cuban system of protected areas.

Objective 3:

During the field work, every thing that may be threatening these frogs, both human induced and with natural causes were noted and quantified. Threats to the conservation of the amphibians, together status of species and ecological information, were analyzed in order to recommend general and species-based actions to protect and conserve these animals and to reduce these threats. Also we used the information gathered in this project to assess the status of these species using the IUCN Red List Categories and Criteria.

Objective 4:

We made two posters and two brochures with information on these frogs which we distributed in the human communities (especially in schools) living in/around the distribution areas of the species. This graphic material contented information on characteristics, importance and recommendations to protect the frogs. Also we met and give talks with local residents and persons in charge of Reserves, approaching characteristics and importance of the conservation of amphibians.

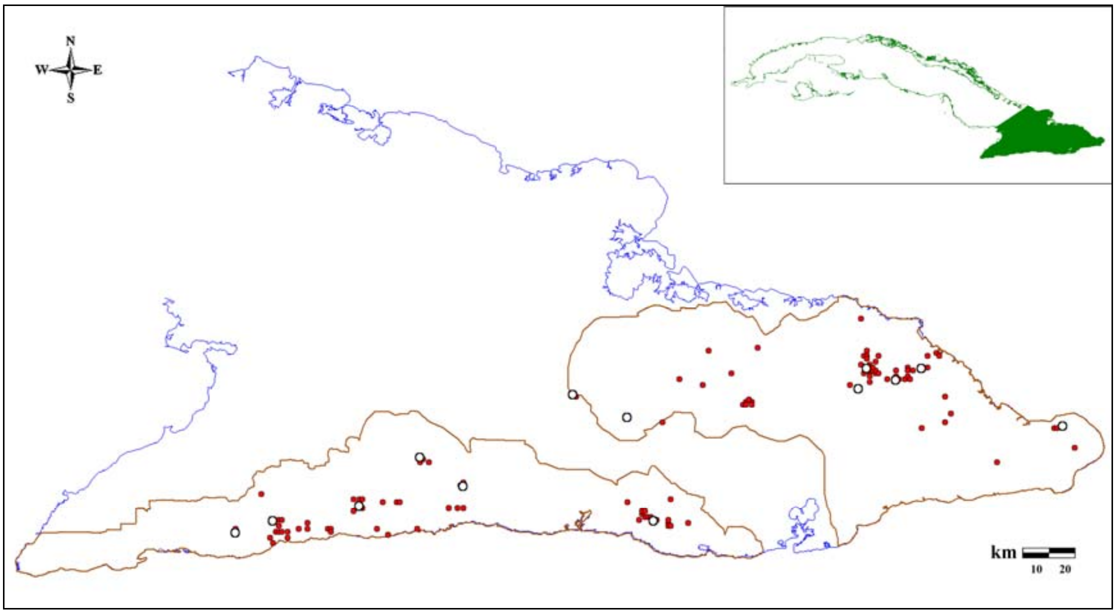

Figure 1. Location of the study area, brown line marks the limits of mountains in Eastern Cuba. Red circles denote the surveyed localities and white points denote sites where plots where set up in order to obtain quantitative data. Inset: Location of main map within Cuba.

RESULTS

Cuban rainforests were originally extensively distributed through the island, as the "Map of Potential Vegetation" of the Nuevo Atlas Nacional de Cuba shows (García *et al*., 1989). Since rainforests were destroyed or degraded in western and central Cuba, we focus our study in eastern Cuba, specifically in mountain zones (Fig. 1), which are the only areas in Cuba where rainforests survive. These mountains, namely Sierra Maestra and Sagua-Baracoa, make less than a fourth part of the Cuban island.

We found 29 species living in rainforests, although some of them are able to live in other kind of forests (for example, evergreen forests) and 11 are able to survive even in secondary habitats, it is, in zones affected by human activity, such as coffee plantations, timberlands and trail edge vegetation. Our study focused in natural vegetation without taking into consideration other anthropogenic areas.

Taxonomically, these 29 species are divided in two genera (*Bufo* and *Eleutherodactylus*) and two families (Bufonidae and Eleutherodactylidae), with *Eleutherodactylus* being the dominant group in number of species. It is typical of the Cuban amphibian native fauna, which are compounds only by three genera and three families and where the named genus is dominant in species number. List of the species included in this project follows:

Class Amphibia
Order Anura
Family Bufonidae

- *Bufo peltocephalus*
- *Bufo taladai*

Family Eleutherodactylidae

- *Eleutherodactylus acmonis*
- *Eleutherodactylus albipes*
- *Eleutherodactylus auriculatus*
- *Eleutherodactylus bartonsmithi*
- *Eleutherodactylus bresslerae*
- *Eleutherodactylus cubanus*
- *Eleutherodactylus cuneatus*
- *Eleutherodactylus dimidiatus*
- *Eleutherodactylus glamyrus*

Eleutherodactylus guantanamera
Eleutherodactylus gundlachi
Eleutherodactylus iberia
Eleutherodactylus ionthus
Eleutherodactylus intermedius
Eleutherodactylus limbatus
Eleutherodactylus maestrensis
Eleutherodactylus mariposa
Eleutherodactylus melacara
Eleutherodactylus michaelschmidi
Eleutherodactylus orientalis
Eleutherodactylus pezopetrus
Eleutherodactylus principalis
Eleutherodactylus ricordii
Eleutherodactylus ronaldi
Eleutherodactylus tetajulia
Eleutherodactylus toa
Eleutherodactylus turquinensis

Abundance

We observed a total of 776 frogs in 37 searches and obtained the relative density values given in Table 1. We only get quantitative data for 22 species; other seven frogs went unnoticed, these were some species with restricted distribution to a few kilometres. So, we can not give any consideration about abundance in those species.

Relative densities ranged from a high value of 0.101 ind/m^2 in *Eleutherodactylus glamyrus*, to a low value of 0.002 ind/ m^2 in *Bufo peltocephalus*. Nevertheless, the depleted relative abundance for the latter species could be due to this toad is not a typical rainforest amphibian; it is more abundant in less humid habitats, many times in anthropogenic ones. Confirming this approach is the fact that *Bufo peltocephalus* was found only in one search in a unique locality.

Other four species were found only in one search (Table 1) as a result of their relative reduced distribution area. These four species are frogs known only from one or a few localities in Cuba, and their distribution areas stretch ranges of only a few kilometres. That is why these values of relative densities should be watch with caution.

Table 1. Relative density (ind/m^2) of 22 amphibian species of Cuban rainforests. SD stands for "Standard Deviation", N is the number of plots in which each species was found.

	Mean	SD	Min	Max	N
B. peltocephalus	0.002	--	--	--	1
B. taladai	0.008	0.001	0.007	0.009	2
E. albipes	0.020	0.014	0.010	0.030	2
E. auriculatus	0.042	0.051	0.004	0.188	19
E. cubanus	0.048	0.056	0.008	0.135	5
E. cuneatus	0.026	0.022	0.002	0.063	9
E. dimidiatus	0.043	0.052	0.000	0.125	15
E. glamyrus	0.101	0.104	0.000	0.250	9
E. guantanamera	0.099	0.035	0.063	0.156	9
E. gundlachi	0.041	0.084	0.000	0.375	19
E. iberia	0.003	--	--	--	1
E. intermedius	0.030	0.027	0.000	0.063	12
E. ionthus	0.067	0.021	0.050	0.090	3
E. limbatus	0.025	0.031	0.000	0.094	15
E. maestrensis	0.035	0.007	0.030	0.040	2
E. melacara	0.033	0.022	0.002	0.065	7
E. pezopetrus	0.064	--	--	--	1
E. principalis	0.014	--	--	--	1
E. ricordii	0.020	0.014	0.001	0.035	5
E. ronaldi	0.027	0.032	0.007	0.064	3
E. toa	0.015	0.007	0.010	0.020	2
E. turquinensis	0.080	--	--	--	1

Distribution

We made an exhaustive search in Cuban and foreign literature, looking for locality or distribution records for Cuban amphibians. We found 194 papers reporting such data for Cuban frogs, but only 58 of these works included locality records for the species living in rainforests (Appendix A).

We got catalogue data from six Cuban collections and 19 foreign collections (three from Europe, 16 from USA), but only 18 collections had specimens of the species we are focus in. Collections considered and data from them are showed in Appendix B.

From literature and collections we obtained 327 localities reported for these 29 frogs and toads. In addition, during the field surveys of this project we observed these species in 79 additional sites not included in literature and collections records.

With all this information and remote sensing data we assembled a GIS database, which was used to model distribution with a GIS, obtaining the potential distribution map for every species. Below we include the analysis made for one of these species, including the map of potential distribution and the causes of the resulting distribution, only as an example. Analysis like these was made for every one of the 29 species considered in the project, and will be included in a scientific paper we are preparing.

Example of analyzes of potential distribution for *Eleutherodactylus gundlachi*, one of the species considered under the project:

The map of potential distribution for *E. gundlachi* (Fig. 2) shows that suitable habitats for this species are limited primarily to the central region of Sierra Maestra and central-southern regions of Sagua Baracoa mountains.

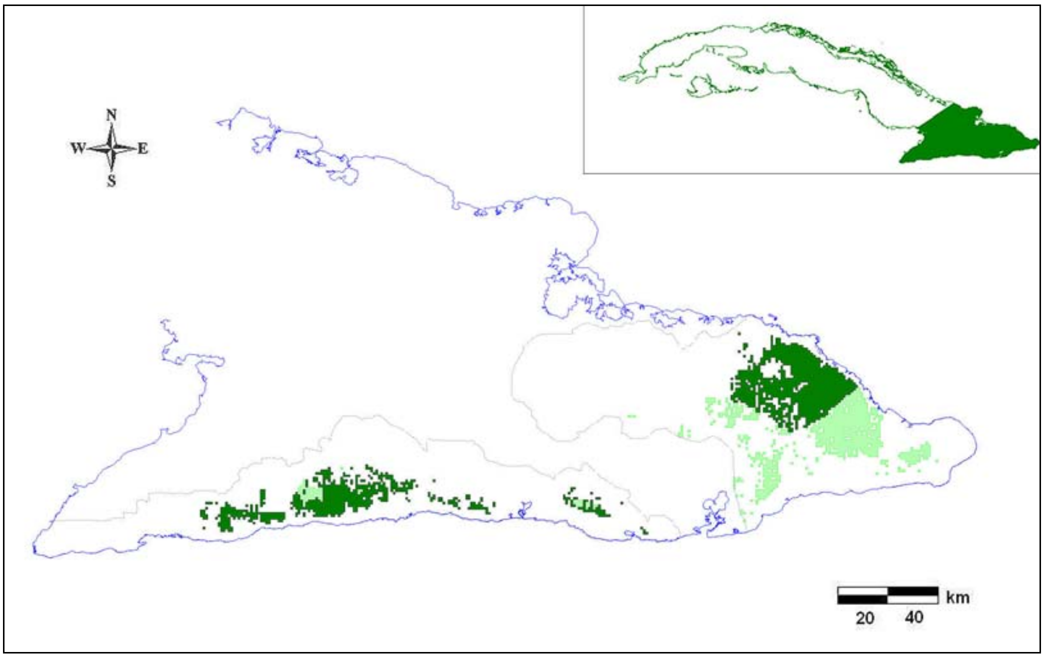

Figure 2. Potential distribution map showing the predicted distribution for *E. gundlachi*. Dark green denotes areas more suitable, light green denotes areas less suitable, and white denotes areas not suitable at all for this frog. Grey line marks the limits of mountains in Eastern Cuba. Inset: Location of main map within Cuba.

Ecological requirements for this species contribute to the patterns, e. g., a large proportion of distribution areas of this frog are concentrated in the highest zones of Sierra Maestra and

Sagua Baracoa mountains, since the higher precipitation and lower evaporation rates provide a greater humidity. Areas below 720 m altitude in Sierra Maestra and below 120 m in Sagua-Baracoa yield no presence of this species.

At the same time, the frog is restricted in their habitat use, using a few habitats, principally natural ones (not anthropogenic habitats), which also affects the distribution. The distribution pattern of this species coincide with the areas harbouring the best conserved forests of Cuba, and conversely, areas without forests, it is, zones with shrubs, cultures, pastures, and towns yield no presence of this frog.

When we summed maps of individual species we obtained that the number of species by km^2 ranged between 1 and 15 (Mean ± standard deviation: 6.2 ± 4.2 species/km^2), it is, the maximum number of amphibian species found in 1 km^2 was 15 and the minimum number was one species. This lowest value is very different to the total number of analyzed species, but far from it, the maximum potential number of species in 1 km^2 (15 species) was close to the actual number of studied amphibians, expressing that about a half of these species could be found in the same km^2, showing a high concentration in the distribution. Because of every studied amphibian is an endemic species, there was no differences between distribution of amphibian species and endemic species.

Unlike the previous case, the number of threatened species ranged between 0 and 12 (Mean ± standard deviation: 3.8 ± 2.9 species/km^2), indicating in these mountains there were square kilometres without threatened species, but also that it is possible to find up to 12 threatened amphibians in a similar area. The maximum number of threatened species in one km^2 represents the 41.4% of the 29 studied species.

Similarity in the results for species/endemic species and threatened species arising from 25 of the 29 studied species are considered as threatened by IUCN (2006), and is a result, maps of potential distribution for both groups look similar.

Conservation

The potential distribution maps were reclassified with the GIS in order to select high-value areas of amphibian diversity, it is, cells with at least 85% of the maximum number of species, the maximum number of endemic species, and the maximum number of threatened species.

Our classification of high-value areas of species and endemic species of amphibians selected 1626 km^2 with at least 85% of the maximum number of these species (Fig. 3). This area represents the 11.2% of the area occupied by these mountains and the

69.9% of the current extension of rainforests in Cuba. These high-value areas are concentrated in two compact cores, one by mountain massif, settled principally on the highest zones of both mountains; it is above 800 m a. s. l (Fig. 3).

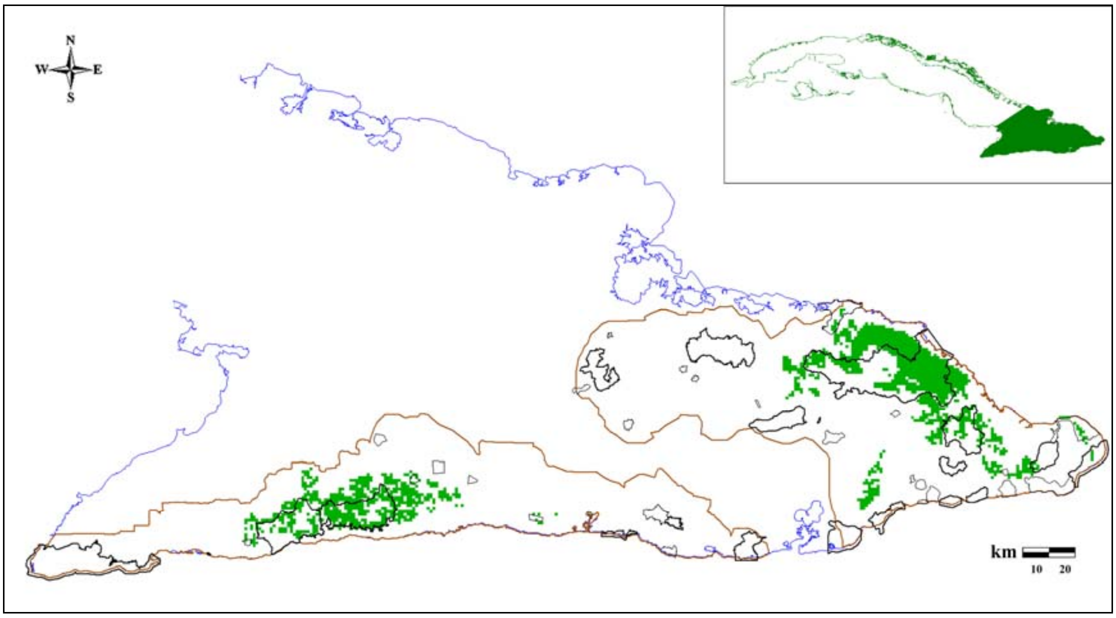

Figure 3. Coincidence of areas of high-value for amphibian species/endemic species (green) and protected areas (black lines). Units in bold type represent National Parks and Ecological Reserves (protected areas of IUCN category I). Brown line marks the limits of mountains in Eastern Cuba. Inset: Location of main map within Cuba.

In threatened species, the high-value areas occupied 1120 km^2, it is, the 7.7% of the area of these mountain massifs and only the 47.1% of the current extension of rainforests in Cuba (Fig. 4).

When these maps were overlaid with the map of the Cuban network of protected areas a total of 666 km^2 (41.0% of the total) of the areas of high value for species richness were included in at least a protected area (Fig. 3), so coincidence between areas of high value and protected areas was low (Table 2).

A total of 486 km^2 (43.4% of the total) of the areas of high value for threatened species were included in at least a protected area (Fig. 4), and likewise the prior analysis coincidence between areas of high value and protected areas was low (Table 3).

Table 2. Coincidence (in Km^2) between areas of high-value for species richness and Cuban protected areas. The statistical significance of the association was tested by means of X^2.

	Inside Protected Areas	Outside Protected Areas
Areas of high-value	666	960
Areas of lesser-value	2 237	10 612

X^2= 499.2, p=0.0001

Table 3. Coincidence (in Km^2) between areas of high-value for threatened species richness and Cuban protected areas. The statistical significance of the association was tested by means of X^2.

	Inside Protected Areas	Outside Protected Areas
Areas of high-value	486	634
Areas of lesser-value	2 417	10 938

X^2= 412.4, p=0.0001

More important, only one third of high-value areas (39.4% for species and endemic species, and 38.7% for threatened species) are included in National Parks and Ecological Reserves (Figs. 3 & 4), two of the more restricted Cuban categories of Protected areas (categories I and II of International Union for Conservation of Nature and Natural Resources).

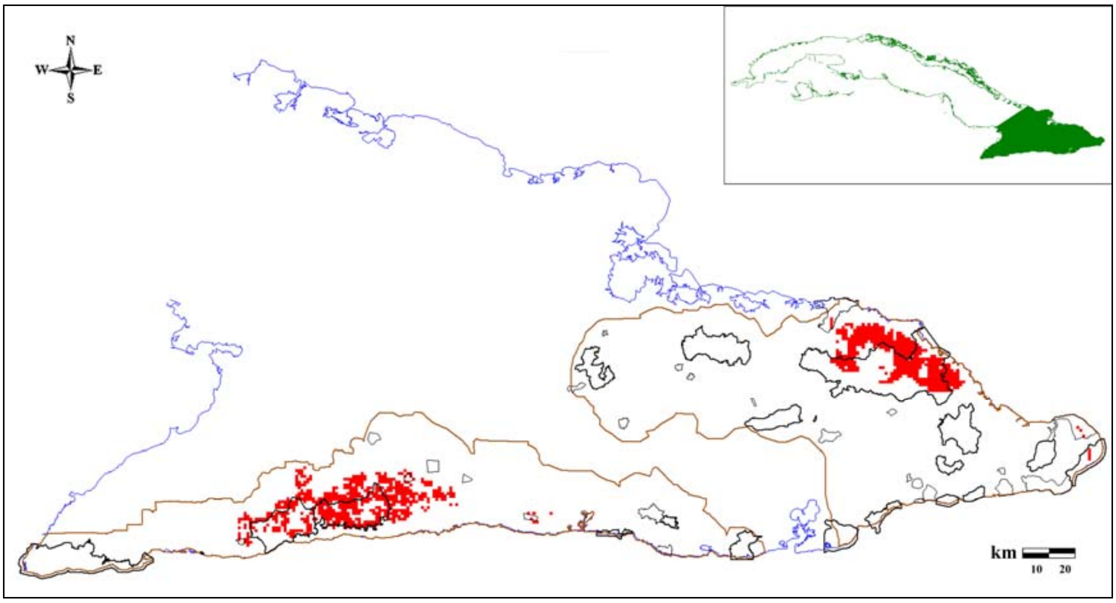

Figure 4. Coincidence of areas of high-value for amphibian threatened species (red) and protected areas (black lines). Units in bold type represent National Parks and Ecological Reserves (protected areas of IUCN category I). Brown line marks the limits of mountains in Eastern Cuba. Inset: Location of main map within Cuba.

Thus, the existing network of Cuban protected areas is not providing a reasonable guarantee for conservation of high value areas for rainforests Cuban amphibians. Nevertheless, it is only one side of the problem and when we analyzed coincidences between distribution of every species and reserves, other results came to light.

Appendix C shows the presence-absence matrix in protected areas for the studied amphibian species resulting from superimposing the maps of potential distribution for these species with the network of Cuban protected areas. Areas of potential distribution for all species were included inside protected areas, although different proportions for every species were excluded. If we consider protected areas are protecting species inside, then we can consider every rainforest species is reasonably protected.

Threats

In our field expeditions we identify a group of factors which are threatening the survival of the frogs in their natural areas, and we will be exposed below.

Habitat destruction and fragmentation are the biggest and more extended threats to the survival of these frogs, especially due to their restricted ranges. This ecosystem fragmentation creates “islands” of habitat and the attendant separation of small populations (added to the natural fragmented distribution in metapopulations of some of these species). Deforestation as a result of land conversion to agricultural uses and logging of timber species are the principal factors causing this destruction and fragmentation.

Since these species live in rainforests and use anthropogenic habitats in a very limited way, the habitat destruction and fragmentation can affect them more rapid and stronger than to other species. Nevertheless, it is unknown how these modifications are acting on frogs and toads and how “deep” are the affectations to the amphibian populations. At the same time, forests-associated frogs have undergone highest decline rates in tropical places, so these species could run the risk of disappear firstly if any decline event occur in Cuba.

We noted other threats to these amphibians, although of minor importance. One of these is groundwater and surface water contamination from mining residuals and waste produced during coffee processing. Both activities liberate organic and inorganic contaminants with direct consequences (still unknown) for the amphibians, although its effects are local in extension. Two introduced species, the domestic dog (*Canis familiaris*) and house cat (*Felis catus*), also could affect these frogs by predation. However, at this point, it is not known how these mammals impact the Cuban native fauna.

Another threat is our general lack of knowledge. Many aspects of the Cuban amphibian’ natural histories are also unknown, for example habitat use and food. This information is essential when developing conservation strategies and planning effective management actions for natural areas. Even these species in which we focused in this project are few known and more studies are necessary to a better understanding of them.

The fact that large pools of amphibian diversity are outside the existing network of protected areas is a threat in itself and could cause populations fragmentation or extirpation due to territories outside protected areas could be considered as “not so important” by decision-makers.

Recommendations for threats mitigation

Arising from these threats, from the ecological information of the frogs, and from the outcomes of this project are the following recommendations, which aims to reduce these threats and protect each species, and acting as guarantor for the conservation of these animals.

- Diminish or eradicate unregulated agriculture and unauthorized forest clearing in the **forested natural areas**. Increasing environmental education programs with the human communities could be an avenue to help decrease these damaging activities.
- Increase vigilance and control **within the protected areas** to eradicate unregulated agriculture and unauthorized or excessive logging, thereby protecting its natural forest remnants.
- Effects of coffee-processing plant residuals on the amphibians should be studied and monitored to know if special measures are necessary to eliminate the waste dumping into the rivers, and to protect the amphibians.
- Understand and quantify effects of introduced fauna on amphibians to use as a basis for implementing control and eradication strategies. However, additional resources and financing are needed to implement plans more efficiently and throughout the protected areas.
- Study habitat requirements of endemic amphibians in order to detail the conditions present in their range, which would be useful for the species conservation and management.
- Increase environmental education programs in human communities (emphasizing importance of conserving Cuban fauna, especially frogs) as a way to stop environmentally damaging practices that harm wild species and to raise conservation awareness.
- Amphibian monitoring programs should be established in different parts of these areas to detect early signs of species declines or extinctions and carry out necessary actions before it is too late.
- The existence of wide high-value zones for amphibians outside protected areas should be considered in future conservation strategies of these mountains, in management schemes of the Cuban forested lands and included in the Management Plans of every one of these protected areas. These strategies should consider changing limits, moving of the existing protected areas, or even creating new areas in order to include those high-value areas currently outside the network.

Citizen education

We made one A3 (11.7x16.5-inches) poster (Appendix D) and one brochure contented information on characteristics, importance and recommendations to protect the frogs. 100 copies of each printed material were distributed in the human communities (especially in schools) living in/around the distribution areas of these species.

Many of this material was handing out in meetings with local authorities and persons in charge of Reserves inside the distribution areas of these frogs, and at that moment some talks with local residents were made, approaching characteristics and importance of the conservation of these amphibians.

Although our project did not include an explicit evaluation of the education impact, we consider the distributed material has contributed to the conservation of these amphibians by building a more interested and engaged public constituency within the worked areas. We could verify it in conversations with local people, especially children, who were greedy for more knowledge on frogs and their characteristics after attend to talks and meetings.

Other accomplishments

- Partial results of this project will be presented in the 6th World Congress of Herpetology (Manaus, Brasil, August 2008) and in the 8th Latin-American Congress of Herpetology (Topes de Collantes, Cuba, November 2008).

- A detailed report with all outcomes of the project will be delivered to decision-makers and conservationists in order to contribute to develop species-based or general conservation strategies.

- Distribution maps and lists of species inside/outside of the Cuban protected areas generated in this study will be giving to persons responsible for every involved protected area for using them in the conservation and management plans of these reserves.

ACKNOWLEDGMENTS

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Appendix A. List of papers with locality or distribution records for Cuban amphibians living in rainforests.

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Appendix B. List of Cuban and foreign collections from which catalogue data on Cuban species were obtained.

Institution	Acronym	Country
Academy of Natural Sciences of Philadelphia	ANSP	USA
American Museum of Natural History	AMNH	USA
California Academy of Sciences	CAS	USA
Centro Oriental de Ecosistemas y Biodiversidad (BIOECO)	BSC.H	Cuba
Florida Natural History Museum	FLMNH	USA
Illinois Natural History Amphibian & Reptile Collection	INHS	USA
Instituto de Ecología y Sistemática (IES)	CZACC	Cuba
Kansas University, Natural History Museum	KU	USA
Los Angeles County Museum	LACM	USA
Museo “Charles T. Ramsden”, Universidad de Oriente	CTR	Cuba
Museo de Historia Natural “Carlos de la Torre”	MHNH	Cuba
Museo Nacional de Historia Natural	MNHNCu	Cuba
Museum of Comparative Zoology	MCZ	USA
Museum of Vertebrate Zoology	MVZ	USA
Museum of Zoology, University of Michigan	UMMZ	USA
San Diego Natural History Museum	SDNHM	USA
United States National Museum	USNM	USA
University of Illinois Museum of Natural History	UIMNH	USA

Appendix C. List of amphibian species with areas of potential distribution inside the network of Cuban protected areas.

Numbers correspond to species as follows: 1=*B. peltocephalus*, 2=*B. taladai*, 3=*E. acmonis*, 4=*E. albipes*, 5=*E. auriculatus*, 6=*E. bartonsmithi*, 7=*E. bresslerae*, 8=*E. cubanus*, 9=*E. cuneatus*, 10=*E. dimidiatus*, 11=*E. glamyrus*, 12=*E. guantanamera*, 13=*E. gundlachi*, 14=*E. iberia*, 15=*E. intermedius*.

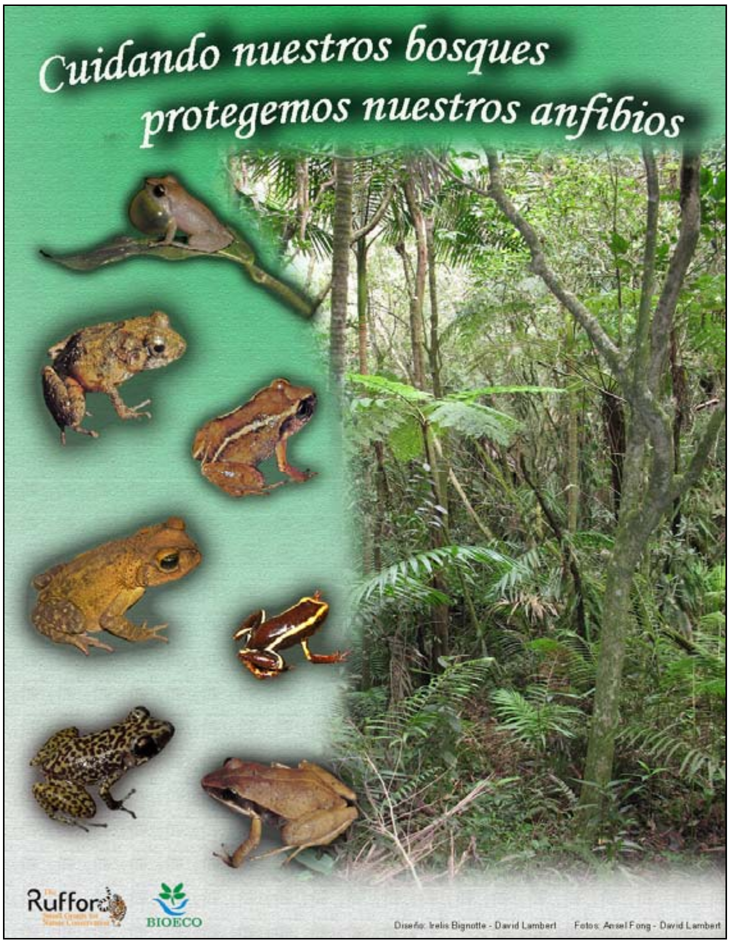
Name of the protected area:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Abra de Mariana	X	X										X			
Alto de Cotilla	X	X	X		X				X	X		X			
La Bayamesa		X		X	X			X	X	X	X		X		X
Boquerón	X											X			
Batalla de Guisa	X				X				X						
Baitiquirí	X				X				X						
Caleta	X	X	X		X	X	X		X	X		X			
Charrascales de Micara	X				X				X	X					
Cañón del río Yumurí	X	X			X				X	X		X			
Cerro Miraflores	X	X			X				X	X			X	X	
Cayo Rey	X	X			X				X	X					
Desembarco del Granma	X				X				X						
El Gigante					X			X	X	X	X		X		X
Esparto	X	X	X		X	X	X		X	X		X			
Gran Piedra		X			X				X	X		X	X		X
Hatibonico	X	X			X				X	X		X			
Alejandro de Humboldt	X	X	X		X				X	X		X	X	X	
Imías	X														
La Caoba	X				X				X	X					
La Españita	X	X			X				X	X					
Loma El Gato		X			X			X	X	X	X		X		X
Maisí	X	X	X		X	X	X		X	X		X			
Macambo	X														
La Mensura - Pilotos	X	X			X				X	X					
Maisí - Yumurí	X	X	X		X	X	X		X	X		X			
Monte Bisse	X	X			X				X	X					
Monte Micara	X				X				X	X		X			
Monte Verde	X		X		X				X	X			X		
Pico Caracas					X			X	X	X	X		X		X
Pico Cristal	X	X			X				X	X		X			
Pico Galán	X	X			X				X	X		X	X		
Pico Mogote					X				X	X		X	X		X
Pinar de Montecristo	X				X				X	X		X			
Parnaso - Los Montes	X		X		X				X	X		X			
Puriales	X				X				X	X		X	X		X
Pozo Prieto	X	X			X				X	X					
Quibiján- Duaba- Yunque	X	X	X		X				X	X		X	X		
Resolladero del río Cuzco	X		X		X				X	X		X			
El Retiro	X								X						
Siboney - Juticí	X														
San Miguel de Parada	X				X				X	X					
Sierra del Convento	X	X										X			
Tacre	X														
Turquino	X	X		X	X			X	X	X	X		X		X
La Victoria - Yumurí	X	X	X		X				X	X		X			

Appendix C. Continued.

Numbers correspond to species as follows: 16=*E. ionthus*, 17=*E. limbatus*, 18=*E. maestrensis*, 19=*E. mariposa*, 20=*E. melacara*, 21=*E. michaelsmithi*, 22=*E. orientalis*, 23=*E. pezopetrus*, 24=*E. principalis*, 25=*E. ricordii*, 26=*E. ronaldi*, 27=*E. tetajulia*, 28=*E. toa*, 29=*E. turquinensis*.

Name of the protected area:	16	17	18	19	20	21	22	23	24	25	26	27	28	29
Abra de Mariana											X			
Alto de Cotilla		X					X			X	X		X	
La Bayamesa	X	X	X		X					X	X			X
Boquerón	X													
Batalla de Guisa	X					X				X	X			
Baitiquirí										X				
Caleta	X	X								X	X		X	
Charrascales de Micara	X									X	X	X	X	
Cañón del río Yumurí	X									X	X			
Cerro Miraflores	X	X									X	X	X	
Cayo Rey	X	X						X		X	X			
Desembarco del Granma	X													
El Gigante	X	X			X					X				X
Esparto	X	X								X	X		X	
Gran Piedra	X	X								X	X			
Hatibonico	X									X	X			
Alejandro de Humboldt	X	X					X		X	X	X	X	X	
Imías														
La Caoba	X	X						X		X	X			
La Españita	X	X								X	X			
Loma El Gato	X	X			X					X				X
Maisí	X									X	X		X	
Macambo											X		X	
La Mensura - Pilotos	X	X						X		X	X			
Maisí - Yumurí	X									X	X		X	
Monte Bisse	X									X	X			
Monte Micara	X									X	X	X	X	
Monte Verde	X	X					X	X		X				
Pico Caracas	X			X	X					X				X
Pico Cristal	X	X								X	X	X	X	
Pico Galán		X								X				
Pico Mogote	X	X								X	X			
Pinar de Montecristo		X		X			X	X		X				
Parnaso - Los Montes	X	X		X			X	X		X				
Puriales		X					X			X	X		X	
Pozo Prieto	X					X				X	X			
Quibiján- Duaba- Yunque		X					X			X	X		X	
Resolladero del río Cuzco	X	X					X	X		X				
El Retiro	X													
Siboney - Juticí	X													
San Miguel de Parada	X													
Sierra del Convento											X		X	
Tacre														
Turquino	X	X			X					X	X			X
La Victoria - Yumurí	X	X					X			X	X		X	

Appendix D. Sample of the poster and brochure (only one side shown) made for the project and handed out in the human communities living in/around the surveyed areas.



Entre las causas fundamentales que han provocado estas declinaciones o disminuciones se han identificado las siguientes:

1- Destrucción y fragmentación del hábitat: Los bosques se talan para crear asentamientos humanos, para la agricultura, los ríos se represan o se drenan, todo esto hace desaparecer los hábitats naturales de los anfibios. Además se construyen caminos y carreteras, los que dividen los hábitats, creando barreras para la dispersión de las especies.

2- Introducción de especies exóticas: Se introducen especies depredadoras que cazan y/o compiten con los anfibios nativos, ya sea por el alimento, el espacio u otro recurso.

3- Epidemias: Muchas veces se desconoce qué fue lo que hizo a los anfibios susceptibles a enfermedades.

4- Cambios climáticos: Es posible que el calentamiento regional, los aumentos en la radiación ultravioleta y las enfermedades epidémicas se generen mediante fenómenos globales.

5- Contaminantes químicos: La toxicidad puede causar mortalidad directa de huevos, larvas y adultos, imitar hormonas endocrinas y eliminar a los animales que los sirven de alimento a los anfibios.

En este momento se está desarrollando un proyecto de investigación para el estudio y la conservación de los anfibios de los bosques de Cuba. Este proyecto pretende aportar información sobre la distribución, abundancia y el estado de conservación de estas especies, así como detectar posibles amenazas y recomendar tareas de conservación a favor de estos animales.

Este proyecto es financiado por la Rufford Society del Reino Unido (Inglaterra) y por el Centro Oriental de Ecosistemas y Biodiversidad (BIOECO) de Cuba.

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Foto y texto por Ansel Fong G. (BIOECO), 2007

Anfibios

Anfibios de Cuba