



INTEGRATED WATERSHED RESOURCES MANAGEMENT

RESULT 2: PROTECTED AREAS MANAGED
REQUIREMENT 2.2: NATURAL RESOURCES IDENTIFIED,
CHARACTERIZED AND MADE AVAILABLE

HERPETOFAUNAL SURVEY OF CERRO GUANACAURE,
MONTAÑA LA BOTIJA AND ISLA DEL TIGRE PROTECTED
AREAS IN SOUTHERN HONDURAS



30, JUNE, 2006

This publication was produced for review by the United States Agency for International Development. It was prepared by Robert Ford, Robert Lovich and their technical team for International Resources

COVER PHOTO

Mexican Burrowing Caecilian, *Dermophis mexicanus*.
By Tony Robison.

INTEGRATED WATERSHED RESOURCES MANAGEMENT

RESULT 2: PROTECTED AREAS MANAGED
REQUIREMENT 2.2: NATURAL RESOURCES IDENTIFIED,
CHARACTERIZED AND MADE AVAILABLE

STANDARD 2.2.1: HERPETOFAUNAL SURVEYS OF
CERRO GUANACAURE, MONTAÑA LA BOTIJA, AND
ISLA DEL TIGRE PROTECTED AREAS IN SOUTHERN
HONDURAS



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Citation guide: Lovich, R.E., T.S. Akre, M. J. Ryan, N.J. Scott, and R.E. Ford. 2006. *Herpetofaunal survey of Cerro Guanacaure, Montaña La Botija and Isla Del Tigre protected areas in southern Honduras*. Report prepared for the United States Agency for International Development. 33pp.

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ACRONYMS

AFE-COHDEFOR	Corporación Hondureña de Desarrollo Forestal
GIS	Geographical Information System
GPS	Global Positioning System
Herpetofauna	Amphibians and Reptiles
MIRA	Manejo Integrado de Recursos Ambientales
MUA	Multiple Use Area
NGO	Non-Governmental Organization
UNAH	Universidad Nacional Autónoma de Honduras
USAID	United States Agency for International Development
UTM	Universal Transverse Mercator
EAP	Escuela Agrícola Panamerica Zamorano

ACKNOWLEDGEMENTS

We are grateful to USAID/MIRA for their awareness of the importance of current and reliable information on species diversity, distribution, relative abundance, and natural history for use in environmental education and improved protected areas management. Their initiation and support of systematic inventories of flora and fauna and natural communities is intended to enhance the management of natural resources and overall conservation of biodiversity in select Honduran protected areas through the collection of scientifically-rigorous, empirical information and the subsequent development of materials for environmental interpretation.

The investigators would like to thank Edas Muñoz, Protected Areas Management Specialist, and all others at the United States Agency for International Development (USAID)/ Manejo Integrado de Recursos Ambientales (MIRA) for their dedication to this project. We also would like to extend special thanks to Professor Gustavo Cruz, Curator of the National Museum of Natural History, UNAH, for facilitating all aspects of our field and museum work in Honduras. We are especially grateful for his hospitality and generosity. His contributions to Honduran herpetology and natural history are unrivaled, and we are thankful for his logistic support and data-sharing, and for entrusting us with his students and colleagues from UNAH while in the field. Regarding students and other personnel from UNAH, this project simply would not have been a success without the assistance of Gerardo Borjas, Sofia Nunez, Ileana Luque and Walther Monge, as well as Wilberth del Cid, Adan Flores, Saul Flores, and Cesar Rodriguez. All specimens were collected under permits from COHDEFOR, to whom we are grateful for their assistance. For assistance at Cerro Guanacaure, we would like to thank Don Rafael Ochoa for his excellence as a guide and facilitator, along with Tim Wall and Gabriel of the Peace Corps, as well as the families who live there. We are grateful to Carlos Vicente Mendoza, and Charles and Hortencia Mayer at Montaña La Botija, who also made us all feel very much welcome and made certain that we had all the access and facilities necessary for the project. Thanks to Javier Tercero of El Jocote, and the family of Antonio Corrales at La Botija who assisted us with lodging and access. At Isla del Tigre we would like to thank the Honduran Navy and the members of the installation there for allowing us access onto Navy land.

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This project was funded by a USAID/MIRA grant awarded to Robert Ford¹.

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EXECUTIVE SUMMARY

Rapid ecological assessment inventory surveys of the herpetofauna at Cerro Guanacaure, Montaña La Botija, and Isla del Tigre Multiple Use Areas were conducted in January and June of 2006 as part of the the larger biodiversity inventory of Honduran protected areas initiated and supported by by USAID/MIRA. The inventory surveys resulted in a considerable increase in knowledge of the resident herpetofauna in these three areas, and in the tropical dry forests of southern Honduras at large. Forty-two species of amphibians and reptiles were collected at the three areas combined, many of which are poorly known to science or of conservation concern. In addition, the capacity for the use of biodiversity and natural resource data in conservation management was enhanced through the establishment of collaborative partnerships with Honduran Universities, NGO's, and local organizations. Current methods in field collection, data procurement management and analyses, the use of GPS and GIS, long-term specimen preparation and storage, and a host of other techniques were shared among team U.S. and Honduran members, and all collected specimens were placed at the National Museum of Natural History, UNAH, Tegucigalpa, Honduras.

INTRODUCTION

NATURAL HISTORY AND CONSERVATION

Honduras lies near the center of Central America, just at the confluence of the North American and South American biogeographic realms (Brown and Lomolino 1998). It is this confluence of flora and fauna from the two continents that makes Central America one of the earth's biologically richest terrestrial areas (Conservation International 2005); there are approximately 17,000 species of plants, 1,100 species of birds, nearly 700 species of reptiles (692 and counting), and 555 species of amphibians – 35 and 65%, respectively, of the latter two groups are endemic (Young et al. 2004, Conservation International 2005). This and the fact that more than 75% of the original forest cover has been lost to anthropogenic conversion make it the third largest biodiversity hotspot in the world (Myers et al. 2000). This global significance coupled with the emerging recognition of the value of biodiversity to ecological integrity, and therefore, to ecosystem goods and services (Costanza et al. 1997, Balmford et al 2002, Hoekstra et al. 2005) places a premium on the need for conservation endeavors in Central America and Honduras in particular (Redford et al. 2003).

The Central American forests consist of five major physiognomic ecotypes: humid tropical, humid mountain, high mountain, arid mountain, and arid tropical (hereafter referred to as tropical dry forest or dry forest), and each has a representative assemblage of plants and animals (Duellman, 1966; Dinerstein et al. 1995; Campbell 1999). The tropical dry forest once covered most of the Pacific versant of Central America from Mexico through Costa Rica, with a disjunctive distribution on the Azuero Peninsula in Panama – an area totaling approximately 550,000 km² – but much of it has been destroyed or degraded for shifting agriculture and cattle production (Campbell 1999; Stoner and Timm 2004).

Because they are so well suited for conversion to agriculture, tropical dry forests are considered to be among the most threatened of all terrestrial ecosystems (Bawa 2004); only two percent of the original cover remains intact, and only 0.09% of that in Central America is under some form of protection (Janzen 1988). With the pervasive need for subsistence agriculture and cattle production, Honduras is no different from most of Central America in this sense; much of the country's dry forests have been converted and many of the remaining patches are small and unprotected (Carrillo et al. 1994). However, because of the eco-geographic position of Honduras (i.e. its function as a biological corridor among the tropical dry forests of Central America), the diversity of landforms and local climates in the dry forest region that provide a home to thousands of rare and endemic species, and the rich array of ecosystem services provided to people by forests of that region (e.g. water for agriculture and drinking), there is an imminent need to protect these last remnants and promote ecological restoration of the larger southern Honduran landscape. Honduras has the ultimate responsibility and is in the unique position to promote biodiversity conservation and improved human welfare through sound scientific management of landscapes and watersheds, sustainable use of natural resources, and ecotourism in protected areas.

The herpetofauna (amphibians and reptiles) of Central America is one of the most species rich and complex in the Neotropics (Duellman 1966; Savage 1966) and the tropical dry forests contain a rich and diverse assemblage of reptiles and amphibians with at least 266 species of amphibians and reptiles including: 2 caecilians, 5 salamanders, 50 anurans, 13 turtles, 3 crocodylians, 76 lizards, and 117 snakes (Sasa and Bolaños 2004). The Pacific coast of Honduras harbors a wide expanse of dry forest habitat that, although fragmented, contains seven localities known to harbor as many as 23 amphibian species and 90 reptile species (Sasa and Bolaños, 2004). As such, the dry forests of Honduras contain one of the richest representative herpetofaunas in Central America (Sasa and Bolaños 2004). Due to widespread deforestation of this habitat, it is presumed that many of the species have experienced population declines or geographic range contractions. Therefore, rapid ecological assessment (REA) inventories designed to estimate and report local species diversity and

abundance are critical to the overarching goal of integrating the scientific, social, and economic aspects of biodiversity conservation for the sustainable use of natural resources and improved human welfare.

PROJECT GOALS AND OBJECTIVES

For this project, we proposed a broad-based effort to build the capacity for biodiversity science, conservation, and environmentally sustainable resource use in the Pacific tropical dry forests of southern Honduras and the country at large. Our focus on the southern dry forest grew from a recent awareness of their rapid and pervasive destruction (Bawa 2004, Sasa and Bolaños 2004) coupled with a scarcity of knowledge on the threatened flora and fauna of that region. The target areas in the southern part of the country, Cerro Guanacaure Multiple Use Area (MUA), Montaña La Botija MUA, and Isla del Tigre MUA, are all of great regional importance to biodiversity preservation and environmental sustainability, yet each has little pre-existing information about the resident herpetofauna (Wilson and McCranie 2002, Kohler 2003), and environmental baseline conditions.

In January and June 2006 we conducted REA inventories of the herpetofauna of the three protected areas with the overarching objective of using REA inventories, and their results, to build the capacity of biodiversity science, conservation, and environmentally sustainable resource use in distinct but integrated ways.

- Our first objective was to raise the capacity for inventory and monitoring of biological diversity by working with Professors Gustavo Cruz (Curator del Museo Nacional de Historia Natural, UNAH), Gerardo Borjas (Departamento de Biología, UNAH), and their students in the field on the proposed inventories.
- Our second objective was to raise the capacity for curation and cataloguing of specimens at the National Natural History Museum (UNAH) by working with Professor Cruz, his colleagues, and students.
- Our third objective was to raise the capacity of biodiversity science in Honduras by integrating the species distribution and abundance data generated from these inventories with current geospatial data and GIS.
- Our fourth objective was to raise the capacity for national, regional and international dissemination of biodiversity distribution and assessment data by building linkages between Honduran institutions and others through the proposed Institute for Regional Biodiversity Institute (IRBio to be based at Zamorano as well as linking to global centers such as IABIN (Interamerican Biodiversity Information Network) and GBIF (Global Biodiversity Information Facility).

This report is submitted to detail the methodology and results of the REA inventory surveys, and to discuss their implications for 1) improving the knowledge of the herpetofaunal diversity, natural history, and conservation status of the dry forests of southern Honduras; 2) improving the management of dry forest protected areas in Honduras; 3) building capacity for the collection and management of biodiversity data in Honduras

METHODOLOGY

FIELD AND LABORATORY SITES

REA herpetofaunal inventory surveys were conducted at three protected areas in southern Honduras from January 3-15 (dry season), and June 3-15 (wet season) of 2006. The central purpose of surveys was to gather presence/undetected data on all species that occur in the protected areas, and to identify indicator or umbrella species, and their habitats, as priorities for national and regional conservation. Cerro Guanacaure was surveyed on 3-7 January and June, Montaña La Botija on 8-13 January and 9-13 June, and Isla del Tigre on 15 January and 14-15 June. Surveys included day and nighttime sampling of available habitats within focal areas (Table 1). Specimen identification, cataloguing, and preparation took place at local housing at, or nearby, each protected area. Specimens were accessioned and catalogued at the National Museum of Natural History, UNAH, under the direction of Professor Gustavo Cruz and his colleagues.

Sites represent the three protected areas in Choluteca and Valle Departments, Honduras, C.A., and focal areas represent the ca. 1 km radius locations within each site that were targeted for field surveys

Table 1. Amphibian and reptile survey dates by site and focal area.

Site (Focal Area)	January	June
Cerro Guanacaure	3-7	3-7
Finca La Libertad	3	3
La Fortuna quebrada	3-7	4-6
Cima La Cruz	4	5
La Fortunita	5	-
Finca Santa Fe	-	5
Finca El Rubi	-	6
Tablones Abajo	-	7
Montaña La Botija	8-13	9-13
Finca Jayacayan, Quebrada del Horno	8	9
Quebrada de la Florida	9	9
Las Moras	10	10
La Pacaya quebrada	11	9
La Isnaya	11	11
Tres Pilas, Quebrada Iguazala	12	-
Finca Santa Clara	13	12-13
Ojochal	-	13
Isla del Tigre	15	14-15
Amapala and vicinity	15	-
La Laguna	15	14
Playa Negra	-	15

SURVEY PROTOCOL

The primary objectives for the inventory surveys were as follows: 1) to provide baseline data on herpetofaunal diversity by developing and providing a system by which chosen areas could be sampled systematically and repeatedly, 2) to document of the presence of amphibian and reptile species that may be sensitive to ecological changes, natural or anthropogenic, that are taking place or could occur in an area, and 3) to therefore, enable follow-up monitoring of these sites that would detect changes in the species assemblages identified during the initial surveys. The system was designed to average out the variation that naturally occurs in sampling conditions and effort, especially weather, personnel, and collecting effort through the use of repeated sampling.

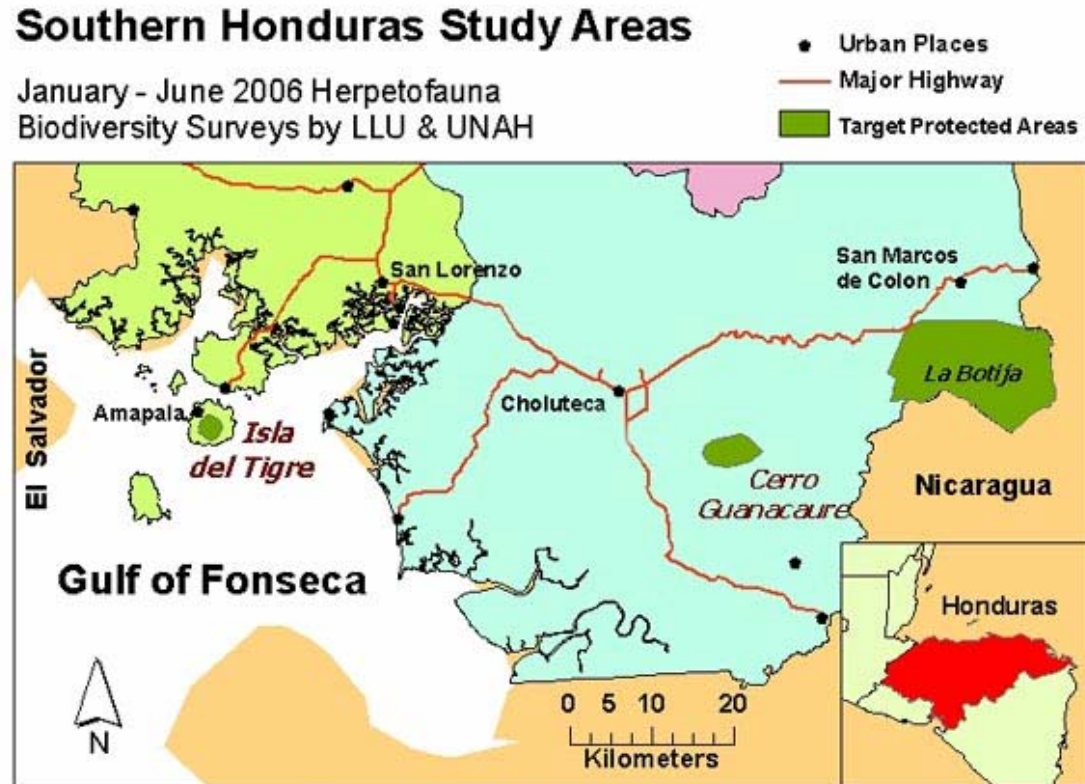
The sampling program chosen was an adapted version of a combined area/time constrained sampling method (Heyer et al. 1994). Using Heyer et al.'s protocol, the term Site is used for the major localities (e.g. Cerro Guanacaure, Montaña La Botija, and Isla del Tigre). Within sites, Focal Points are those locations that are chosen to center a circle with a one km radius (= Focal Area). Each focal point is fixed with geographic coordinates collected in real-time by GPS. Sampling and collecting is then haphazard and opportunistic within the circle. This method is based on the rationale that different competent herpetologists would, in the long run, sample the same area in roughly the same manner, and it is robust to variation (as mentioned above) because it can be used with a variable number of collectors working a variable amount of time. Total collecting time in hours for all collectors and the number and names of species observed are tabulated after each field excursion (e.g. each day and each night).

TYPES OF DATA GENERATED

The preliminary result of the Heyer et al. (1994) survey protocol is the number of species encountered per person per unit time (effort). These data are an initial approximation of species richness and relative abundance, and can be compared across seasons and years, and between sites. The secondary result is a species-accumulation curve. The total number of unique species is plotted on the ordinate and effort is plotted on the abscissa. These curves are then compared among sites, giving an approximation of their relative diversities. If the one site yields twice the number of species found in an equivalent effort at another site, the first site probably holds more species. The curves can also be used to gauge the effectiveness of the collecting effort. When sites are sampled long enough, each curve will approach an asymptote (the true estimated number of species present). When many hours of collecting fail to yield new species, the asymptote is near for that year or season or period. The described system needs to be refined in the first few attempts, but comparative data can be generated as soon as focal points are established, and thereafter, monitoring can be carried out by anyone familiar with the sites and focal areas and the system protocol. Data were recorded in the form of voucher specimens, annotated field observations, and geographic coordinates using GPS that were later plotted on high resolution topographic maps in a GIS. Representative samples of all herpetofauna encountered were collected and vouchered according to standard protocols, and genetic material was extracted from all species collected. Maps showing transects, focal points for surveys, and selected habitat characterizations were also produced.

Honduran colleagues were directly involved in the implementation of as many different methods in order to enable long-term monitoring at established sites and their focal areas. Likewise, all methods and protocols were shared with all local/national team members to the greatest extent possible. Multiple surveys and/or teams, made up of project participants, appropriate local volunteers (e.g. students, local residents, NGO representatives, etc.), Peace Corps volunteers, and others, were used to survey the areas. Digital photographs were taken and categorical descriptions of the vegetation and other physical attributes of each locality were recorded (Appendix I). Vouchering, specimen processing and cataloging has taken place in cooperation with Professor Cruz and his staff at UNAH.

Figure 1. Map of the survey sites, Cerro Guanacaure, Montaña La Botija, and Isla del Tigre, Choluteca and Valle Departments, Honduras, C.A.



Drafted by: Robert E. Ford, Loma Linda University, 05/06

Figure 2. Map of focal areas at Cerro Guanacaure

Cerro Guanacaure

Target Herpetofauna Specimen
Collection Zones Jan. 4-8, 2006

- Cima/Cerro
- La_Fortunita
- La_Fortuna_1
- La_Fortuna_2
- ⬡ Finca La Libertad
- Protected Area
- Roads
- More Zones June 6-13

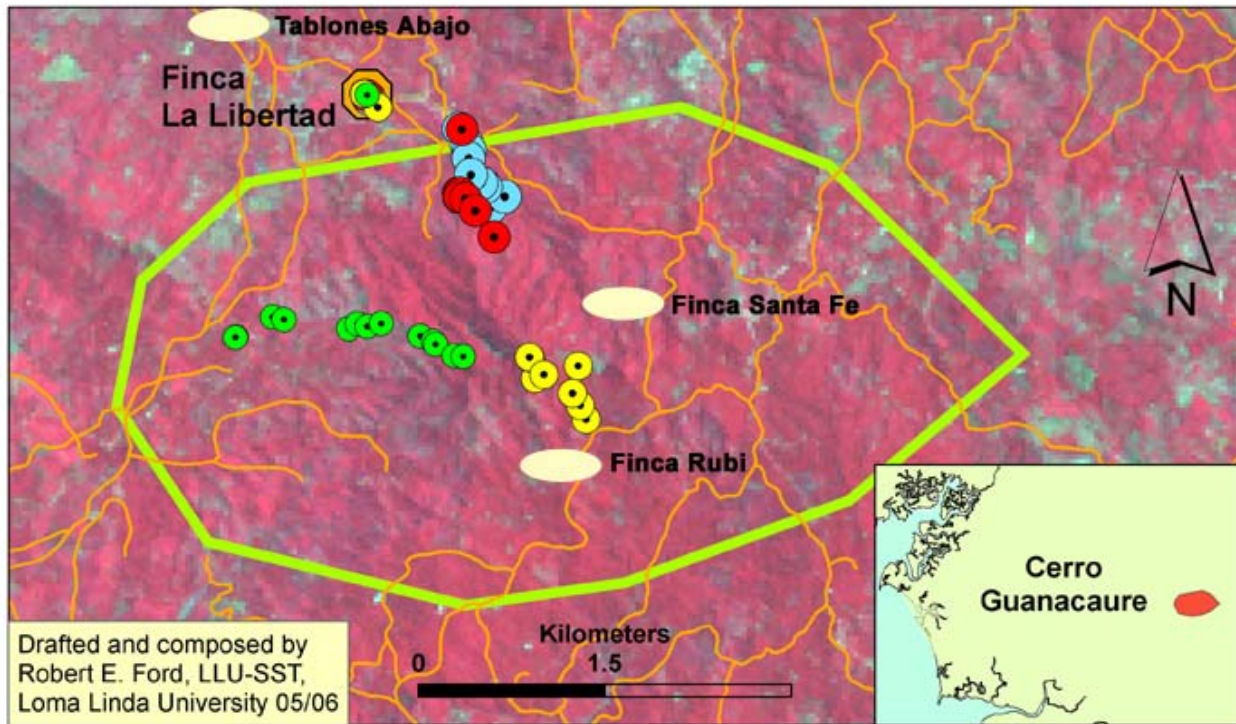


Figure 3. Map of focal areas at Montaña La Botija

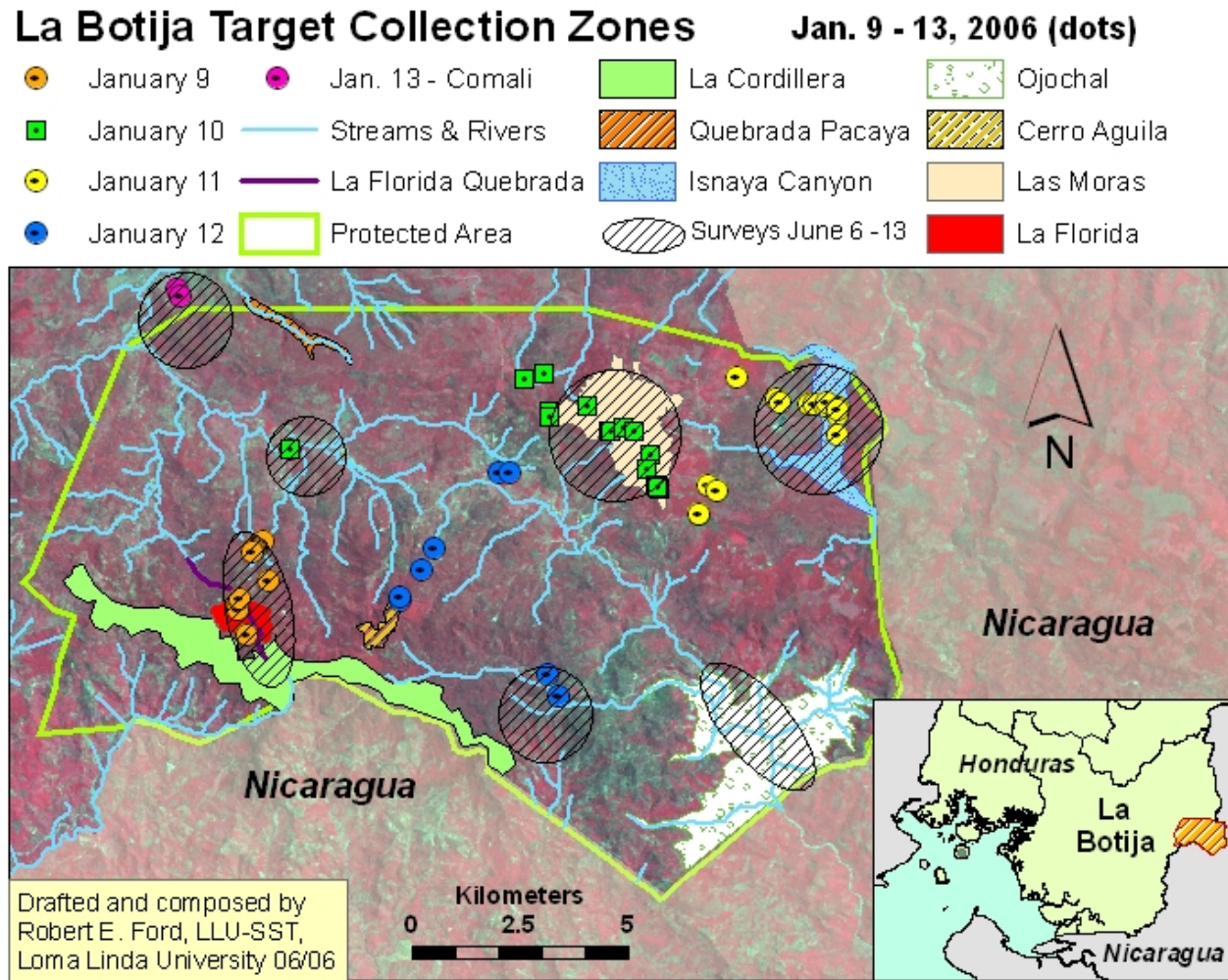
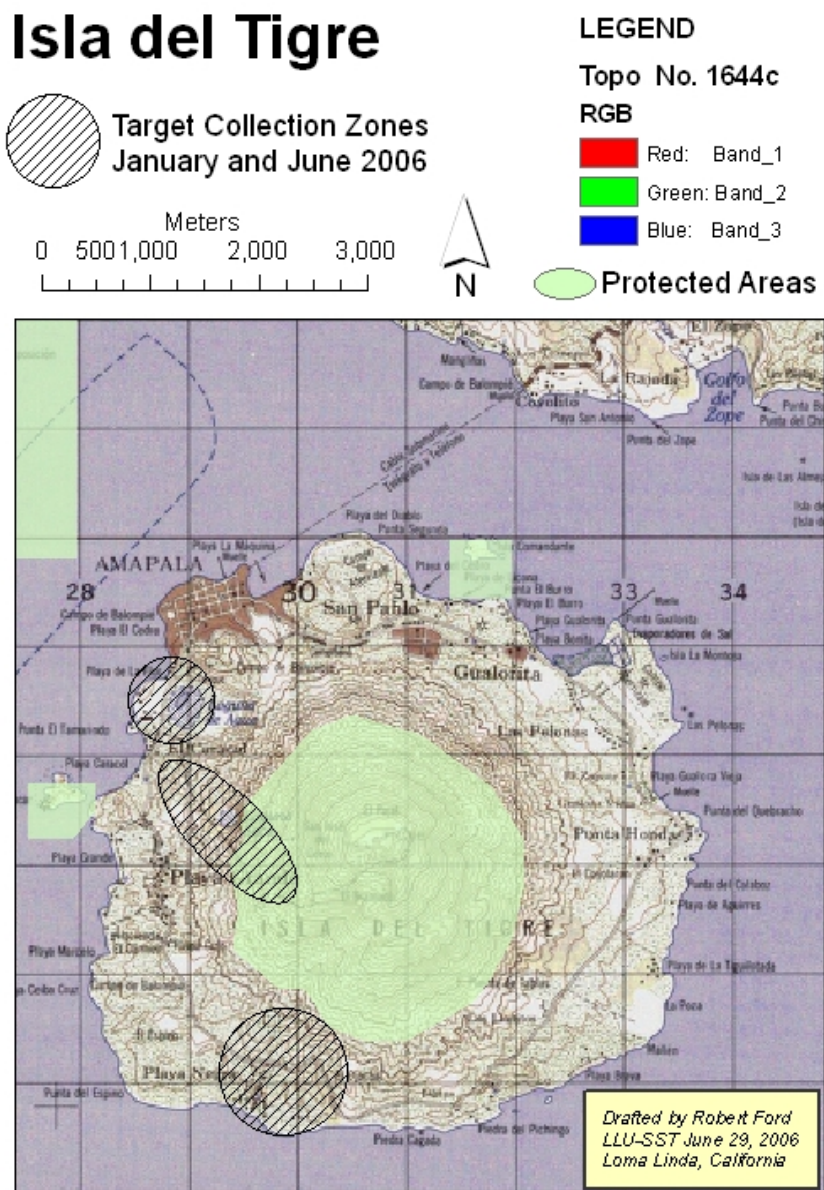


Figure 4. Map of focal areas at Isla del Tigre



RESULTS

Inventory surveys at the three protected areas resulted in the collection of 370 specimens and the subsequent identification of 42 amphibian and reptile species (Table 2). This collection represents 13 amphibian species in 10 genera and six families and 29 reptile species in 24 genera and 13 families. Twenty-six species (amphibians: 10 species, 8 genera, five families; reptiles: 16, 14, 11) were collected at Cerro Guanacaure, 32 (amphibians: 10, 7, 5; reptiles: 22, 18, 11) were collected at Montaña La Botija, and 14 (amphibians: 5, 4, 3; reptiles: 9, 8, 7) were collected at Isla Del Tigre. An additional set of amphibian and reptile species that were either encountered but not collected during surveys, shown to us as photographs by C. Mayer, or collected incidentally during a reconnaissance trip in November, represent 20 species in two amphibian families and three genera and eight reptile families and 16 genera (Table 3). These records constitute an additional eight species from all three sites combined (see below for details) and one additional snake species for this project (*Trimorphodon biscutatus*). All tolled, this project documented, through collection and/or observation, the presence of 14 amphibian species (10 genera, six families, 2 orders), and 36 reptile species (31 genera, 15 families, 3 orders) at the three protected areas. All 370 vouchered survey specimens and most of those that were collected incidentally were deposited at the Museum of Natural History, UNAH.

Thirty-nine of the aforementioned species' total were collected during surveys of all focal areas at sites (the remaining three species – snakes from Montaña La Botija: *Lampropeltis triangulum* [Coral Falso], *Leptodeira nigrofasciata*, *Micrurus nigrocinctus* [Coral] – were collected incidentally between survey forays) within approximately 634 person hours (Fig. 5). All 39 species were actually collected in 522 person hours (82% of total effort), and the remaining 112 hours failed to yield any new species. In fact, the majority of representative species – 32 of 39 (82%) – was collected in January alone (48% of total survey effort). However, several notable species, including some from previously unrepresented families – and even a class – of amphibians and reptiles were collected in June (see immediately below).

Cerro Guanacaure yielded 25 species in 190 total person hours; one turtle species (*Kinosternon scorpioides*) was collected incidentally between survey forays (Fig. 6). Like all sites combined, surveys at Guanacaure yielded all species in less than the total time surveyed (i.e. 158 person hours), and most species (76%) were collected in January – 19 species in 109 hours. However, a caecilian (*Dermophis mexicanus*), two toads (*Bufo coccifer*, *B. leutkenii*) a mud turtle (see above), a skink (*Mesoscincus managuae*), and two snakes (*Boa constrictor*, *Imantodes gemmistratus*) were all collected at Guanacaure for the first time in June and a frog (*Leptodactylus labialis*) was heard calling in June. While not considered to be rare, both the caecilian and the skink are significant collections for the site and for the project overall, as they are considered elusive species and were not collected elsewhere. The snake (*I. gemmistratus*) was represented by two specimens both found on the same night (4 June), and was only collected at Guanacaure. Likewise, the frog (*L. labialis*), was not heard or collected elsewhere. The two toads, the turtle, and the boa, while not uncommon species in Honduras or collected only at Guanacaure, were not seen, heard or collected there in January although all but one (*B. leutkenii*) was collected elsewhere in January.

Taken together, dry and wet season visits to Guanacaure yielded seven unique species among 27 documented species (i.e. 25 collected during surveys, one heard during surveys, and one collected incidentally), including those mentioned above and a frog (*Eleutherodactylus laevisimus*), two lizards (*Basiliscus vittatus*, *Aspidoscelis deppii*; but see below and Table 3), and a threadsnake (*Leptotyphlops goudoutii*). Specimens of the frog were collected at approximately the same location (La Fortuna quebrada) in both seasons and represent one of the most interesting and significant finds of the project because this species is especially sensitive to habitat degradation and belongs to a group that is of international conservation concern due to rapid and pervasive population declines throughout Central America (see below in Discussion).

Montaña la Botija yielded 28 species in 372 total person hours; four snake species (see above and *Boa constrictor*) were collected incidentally between survey forays (Fig. 7). Like all sites combined and Guanacaure, surveys at La Botija yielded all species in less than the total time surveyed (i.e. 293 person hours), and most species (86%) were collected in January – 24 species in 172 hours. Nonetheless, of the four new species collected in June, one frog (*Hypopachus variolosus*) was not collected elsewhere and represents a family (Microhylidae) previously undocumented for the site and, depending on further diagnoses and discussion with experts may represent a significant range extension for the species in Honduras. In addition, in June a live specimen of a turtle (*Rhinoclemmys pulcherimma*), that had previously only been documented as skeletal remains at one focal area in January, was collected as a live adult female at the same focal area. Likewise, in June two more sightings of the lizard (*Basiliscus vittatus*) were made at two focal areas, confirming its presence, and we heard a previously undocumented frog (*Scinax staufferi*) at one focal area.

Taken together, dry and wet season visits to La Botija yielded 18 unique species among 38 documented species (i.e. 28 collected during surveys, one seen, one heard, and one collected as a shed during surveys, four collected incidentally, and three shown as photographs), including the two mentioned above and two frogs (*Phrynobyas venulosa*, *Rana forreri*), one lizard (*Sceloporus malachiticus*), 11 nonvenomous snakes (*Conophis lineatus*, *Lampropeltis triangulum*, *Leptodeira nigrofasciata*, *Masticophis mentovarius*, *Ninia sebae*, *Oxybelis fulgidus*, *Spilotes pullatus*, *Tantilla armillata*; three snake species were documented by photograph: *Drymobius margaritiferus*, *Scolecophis atrocinctus*, *Senticolis triaspis*), one coral snake (*Micrurus nigrocinctus*) and one Cascabel (*Crotalus durissus*).

Although not considered naturally rare, documentation of the turtle and the examples of seven of the snake species are notable because of potential impacts to their populations at La Botija and Honduras at large. For example, specimens of the turtle were found on a working finca with extensive habitat alteration (Finca Santa Clara; see Appendix I) that could impact local population viability. In fact, although farmworkers indicated that the species was common and seen frequently, four of five examples were partial skeletal remains. Additionally, *R. pulcherimma* is increasingly considered of regional conservation concern because of the reportedly large volume of individuals that are collected from the wild and exported into the international pet trade. Also, each of the seven snakes (*B. constrictor*, *C. durissus*, *L. triangulum*, *L. nigrofasciata*, *M. mentovarius*, *M. nigrocinctus*, *S. pullatus*) were documented with at least one example killed during encounters with people. Although not formerly uncommon, Mesoamerican populations of the Cascabel appear to be declining as a result of serial persecution by people and the species' range has contracted substantially over the last 30 years.

Isla del Tigre yielded 14 species in 65 total person hours (Fig. 8). Unlike all sites combined and other sites, Isla del Tigre yielded all species in the total time surveyed and only slightly more than half of the species (57%) were collected in January – eight species in 22 hours. No species of amphibians or reptiles collected at Isla del Tigre were unique to that site. However, two species that were seen but not collected (*Caiman crocodylus*, *Gonatodes albogularis*) were both unique to Isla del Tigre. One of them (*C. crocodylus*) is noteworthy because of the general concern for the conservation of crocodylian populations throughout Central America and the Neotropics coupled with the likelihood that this possibly lone individual would be killed if it were not inhabiting a lagoon on Honduran Naval Base land.

Table 2. Amphibian and reptile species collected during surveys of three protected areas in Choluteca and Valle Departments, Honduras, C.A, in January and June 2006.

Species	Cerro Guanacaure	Montana La Botija	Isla del Tigre
	(26)	(28)	(14)
AMPHIBIA (13)			
Gymnophiona (1)			
Caeciliidae (1)			
<i>Dermophis mexicanus</i>	X		
ANURA (12)			
Bufonidae (3)			
<i>Bufo coccifer</i>	X	X	X
<i>B. leutkenii</i>	X	X	
<i>B. marinus</i>	X	X	X
Hylidae (3)			
<i>Phrynohyas venulosa</i>		X	
<i>Scinax staufferi</i>	X		X
<i>Smilisca baudinii</i>	X	X	
Leptodactylidae (3)			
<i>Eleutherodactylus laevis</i>	X		
<i>Leptodactylus melanonotus</i>	X	X	X
<i>Physalaemus pustulosus</i>	X	X	X
Microhylidae (1)			
<i>Hypopachus variolosus</i> *		X	
Ranidae (2)			
<i>Rana forreri</i>		X	
<i>R. maculata</i>	X	X	
REPTILIA (29)			
Testudines (2)			
Geoemydidae (1)**			
<i>Rhinoclemmys pulcherimma</i>		X	
Kinosternidae (1)			
<i>Kinosternon scorpioides</i> ***	X	X	
Squamata: Sauria (13)			
Corytophanidae (1)			
<i>Basiliscus vittatus</i>	X		
Iguanidae (1)			
<i>Ctenosaura similis</i>	X	X	X
Phrynosomatidae (3)			
<i>Sceloporus malachiticus</i>		X	
<i>S. squamosus</i>	X	X	X
<i>S. variabilis</i>	X	X	X
Polychrotidae (2)			
<i>Norops cupreus</i>	X	X	

Species	Cerro Guanacaure	Montana La Botija	Isla del Tigre
<i>N. sericeus</i>	X		X
Gekkonidae (2)			
<i>Hemidactylus frenatus</i> [^]	X		
<i>Phyllodactylus tuberculatus</i>	X	X	X
Scincidae (2)			
<i>Mabuya unimarginata</i>	X	X	X
<i>Mesoscincus managuae</i>	X		
Teiidae (2)			
<i>Ameiva undulata</i>	X	X	
<i>Aspidoscelis deppii</i>	X		
Squamata: Serpentes (14)			
Leptotyphlopidae (1)			
<i>Leptotyphlops goudoutii</i>	X		
Boidae (1)			
<i>Boa constrictor</i>	X	X	X
Colubridae (11)			
<i>Conopsis lineatus</i>		X	
<i>Imantodes gemmistratus</i>	X		
<i>Lampropeltis triangulum</i>		X	
<i>Leptodeira annulata</i>		X	X
<i>L. nigrofasciata</i>		X	
<i>Masticophis mentovarius</i>		X	
<i>Ninia sebae</i>		X	
<i>Oxbelis aeneus</i>		X	X
<i>O. fulgidus</i>		X	
<i>Spilotes pullatus</i>		X	
<i>Tantilla armillata</i>		X	
Elapidae (1)			
<i>Micrurus nigrocinctus</i>		X	
Totals	(26)	(28)	(14)

Taxonomic Nomenclature Generally Follows Savage (2002) and Kohler (2003).

* Tentatively assigned to *H. variolosus* until further diagnoses.

** Some authors (e.g. Spinks et al. 2004) consider members of the genus *Rhinoclemmys* to represent an, as yet unnamed, family.

*** The Mesoamerican populations are considered by some authors (e.g. Schilde 2001 and Artner 2003) to be a separate species with the name *K. cruentatum*.

[^] Non-native species.

Table 3. Amphibian and reptile species collected ⁽¹⁾

Species	Date	Site location	Record type
AMPHIBIA (3)			
Anura (3)			
Hylidae (2)			
<i>Scinax staufferi</i>	9 Jun 2006	Montaña La Botija	Heard calling (A)
<i>Smilisca baudinii</i>	14 Jun 2006	Isla del Tigre	Heard calling (A)
Leptodactylidae (1)			
<i>Leptodactylus labialis</i>	7 Jun 2006	Cerro Guanacaure	Heard calling (A)
REPTILIA (16)			
Testudines (1)			
Kinosternidae (1)			
<i>Kinosternon scorpioides</i>	26 Nov 2005	Vicinity of El Triunfo, Choluteca Dept.	Photograph – live (C)
	8 Jun 2006	Km 173 Pan Am Hwy, Choluteca Dept.	Photograph – DOR* (A)
Crocodylia (1)			
Alligatoridae (1)			
<i>Caiman crocodilus</i>	15 Jan 2006	Isla del Tigre	Seen – live (A)
Squamata: Sauria (5)			
Corytophanidae (1)			
<i>Basiliscus vittatus</i>	8 Jan 2006	Montaña La Botija	Seen – live (A)
	12 Jun 2006	Montaña La Botija	Seen – live (A)
	13 Jun 2006	Montaña La Botija	Seen – live (A)
Iguanidae (2)			
<i>Ctenosaura similis</i>	26 Nov 2005	Vicinity of San Bernardo, Choluteca Dept.	Photograph – live (C)
		Vicinity of El Triunfo, Choluteca Dept.	Photograph – live (C)
<i>Iguana iguana</i>	26 Nov 2005	Vicinity of El Triunfo, Choluteca Dept.	Photograph – live (C)
	14 Jun 2006	Isla del Tigre	Photograph – live (A)
Gekkonidae (2)			
<i>Gonatodes albogularis</i>	27 Nov 2005	Isla del Tigre	Photograph – live (C)
	14 Jun 2006	Isla del Tigre	Seen – live (A)
<i>Phyllodactylus tuberculatus</i>	27 Nov 2005	Bahia de Chismuyo	Photograph – live (C)
Squamata: Serpentes (9)			
Boidae (1)			
<i>Boa constrictor</i>	27 Nov 2006	Vicinity of Coyolito, Valle Dept.	Photograph – DOR* (C)
Colubridae (7)			
<i>Conopsis lineatus</i>	27 Nov 2005	Vicinity of Coyolito, Valle Dept.	Collected – DOR* (C)
	27 Nov 2005	Agua Fria, Valle Dept.	Seen – live (C)
<i>Drymobius margaritiferus</i> **	15 Mar 2006	Montaña La Botija	Photograph – live (B)
<i>Lampropeltis triangulum</i>	26 Nov 2005	Vicinity of Gausaule, Choluteca Dept.	Collected – DOR* (C)
<i>Leptodeira annulata</i> **	27 Nov 2005	Rio Grande do Sul (Nacaome), Valle Dept.	Collected – DOR* (C)
<i>Masticophis mentovarius</i>	27 Nov 2005	Vicinity of San Lorenzo, Valle Dept.	Photograph – DOR* (A)
<i>Scolecophis atrocinctus</i> **	7 Oct 2003	Montaña La Botija	Photograph – live (B)

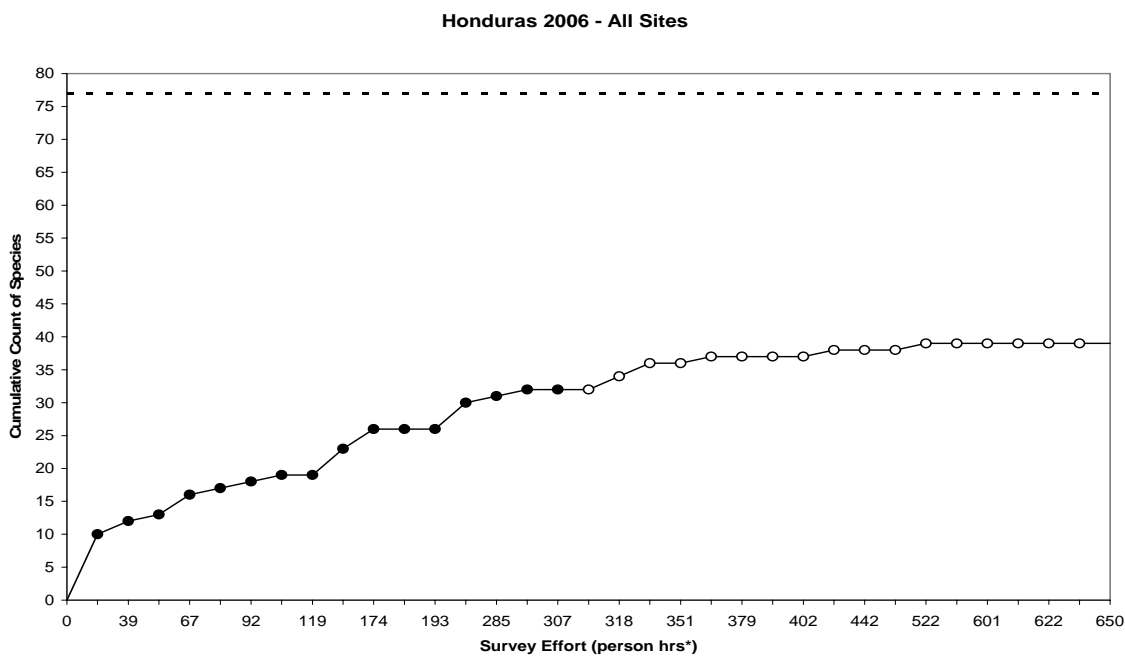
Species	Date	Site location	Record type
<i>Senticolis triaspis</i> **	12 Feb 2005	Montaña La Botija	Photograph – live (B)
<i>Trimorphodon biscutatus</i>	26 Nov 2005	Vicinity of Gausaule, Choluteca Dept.	Collected – DOR* (C)
Viperidae (1)			
<i>Crotalus durissus</i> **	13 Jun 2006	Montaña La Botija	Collected – shed skin (A)

(1) (A) Encountered but not collected during surveys of three protected areas in Choluteca and Valle Departments, Honduras, C.A, in January, and June 2006, (B) Shown to us as photographs with locality data by C. Mayer, or (C) Encountered and/or collected incidentally during a project reconnaissance visit in November 2005.

* Dead on Road.

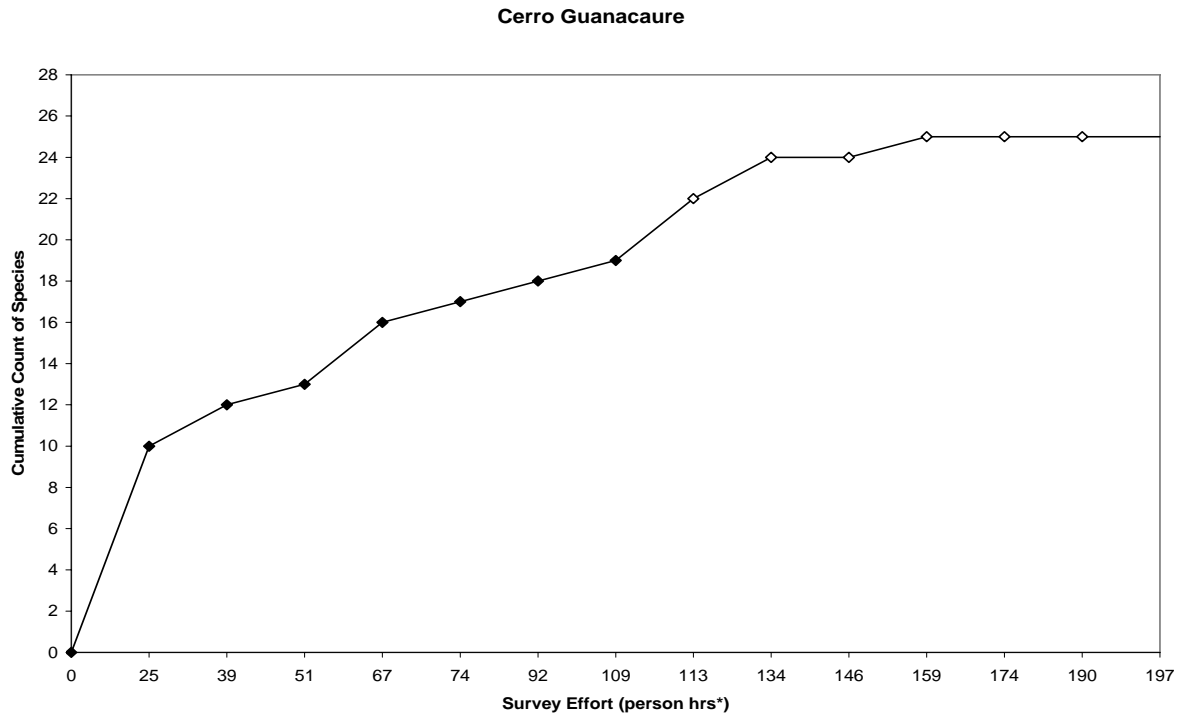
** Tentatively assigned to this species until further diagnosis

Figure 5. Species accumulation curve for all sites.



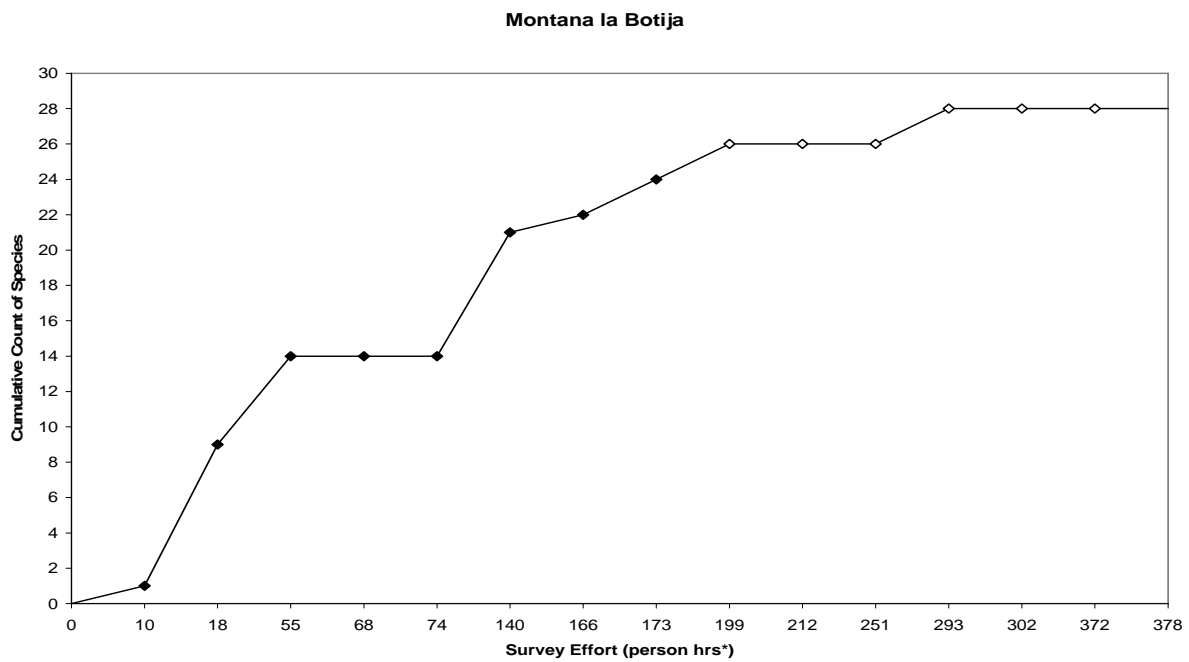
January values are represented by closed circles and June values by open circles. The dashed line indicates hypothesized potential number of species present ($n = 77$).

Figure 6. Species accumulation curve for Cerro Guanacaure.



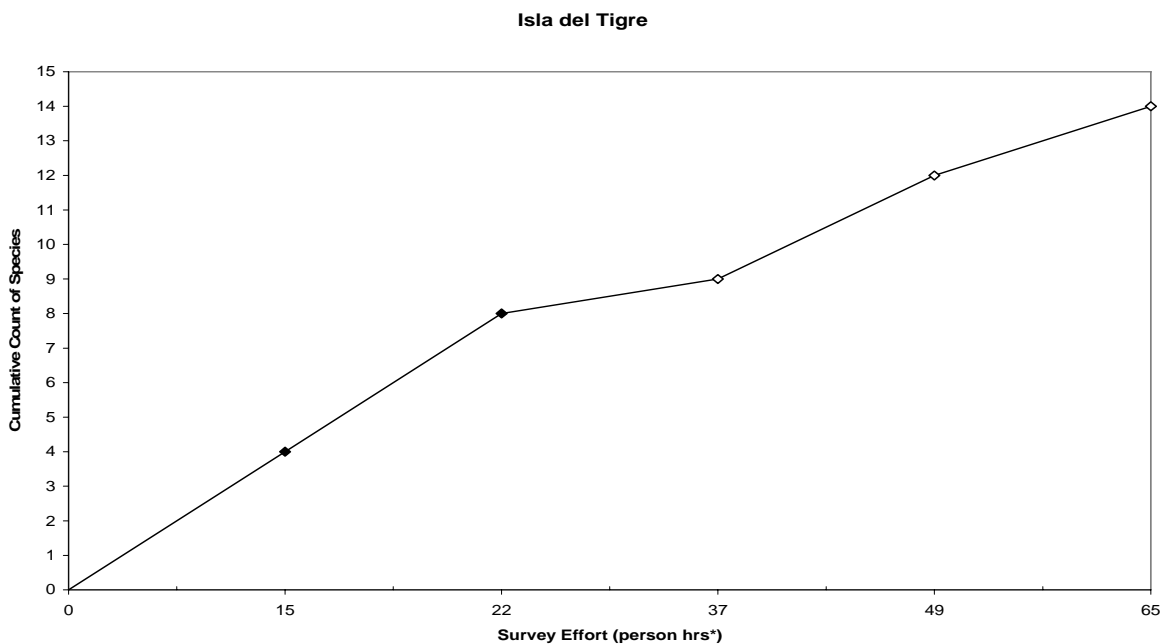
January values are represented by closed diamonds and June values by open diamonds

Figure 7. Species accumulation curve for Montaña la Botija.



January values are represented by closed diamonds and June values by open diamonds

Figure 8. Species accumulation curve for Isla del Tigre.



January Values are represented by closed diamonds and June values by open diamonds.

Figure 9. Typical habitat of Cerro Guanacaure



Figure 10. Typical habitat of Montaña La Botija.



Figure 11. Typical habitat of Isla del Tigre



DISCUSSION

The Choluteca Valley and southern Honduras is considered to have a diverse dry forest herpetofaunal assemblage with 54 known species (Sasa and Bolaños 2004). Previously reported lists include: 1 caecilian, 13 anurans, 2 turtles, 13 lizards, and 23 snake species (i.e. Sasa and Bolaños 2004). In total, our survey efforts, incidental collections, and documented observations by others verified the presence of 50 amphibian and reptile species at the three protected areas in southern Honduras – well less (35%) than the estimate predicted for the lowland dry and premontane moist forests of the Pacific lowland and Southern Cordillera of Serrania regions based on McCranie and Wilson (2002), Savage (2002), Wilson and McCranie (2002), and Kohler (2003) (N = 77 species). Superficially, three of the four accumulation curves (Figs. 5-7) suggest that continued effort will fail to yield a suite of new species at the sites or overall – that is, we have inventoried the sites completely. However, it is likely that, as indicated above, the horizontal trending of the curves for Guanacaure, Montaña La Botija, and the three sites combined represents an approach of the asymptotes for those particular focal areas during the specific times of year that they were surveyed, rather than an approach to the true limit of species that occur there. For example, we know from photographs of at least four species of snakes (some considered quite conspicuous, such as the Cascabel) that we failed to collect as live specimens (Table 3). Nonetheless, alternative explanations remain. One, for example, is that some species of amphibians and reptiles are either naturally rare or such habitat specialists that we failed to encounter them by 1) not investigating all habitats and microhabitats, 2) not spending enough time in a given habitat, and 3) not investigating habitats or microhabitats during the right time of year or during the appropriate environmental conditions. For instance, we know that several species are habitat specialists or highly sensitive to disturbance. *Nevertheless, an accumulation of 65% of the regional species assemblage in 634 hours (< one month of survey days) is an exceptional outcome.*

Discrepancies in the number of species collected from each focal area can for the most part be attributed to not having yet put forth enough effort to locate all species present. For instance, Cerro Guanacaure yielded 17 species in 109 collecting hours, and Montaña la Botija produced 14 in the first 81 hours of collecting. Because nearly the same area was covered at the two sites, this indicates that local species diversity is probably similar at each of the two sites. However, because Montaña la Botija encompasses a greater area with a greater elevational range, and a higher diversity of topographic relief and vegetation types, more collecting effort in the different habitats will likely yield more species.

Over a short geographic distance the herpetofaunal communities varied greatly and in order to effectively conserve and manage herpetofaunal diversity in southern Honduras, all of these sites should be protected and monitored. Even though the region is low in over-all species diversity, 43, when compared to other arid forest localities in Central America (i.e. Sasa and Bolaños 2004) it harbors a unique array of species. Due to the barrier formed by the mountain ranges to the east, this area forms a narrow belt for the exchange of arid forest animals that may have historically moved along the Pacific lowlands corridor (Savage 1966, 1982).

Wilson and McCranie (2003a, b) developed lists of amphibian and reptile species for all of Honduras that included indices of vulnerability, rareness, and status in general. Comparisons of the amphibians and reptiles we encountered with those shown to be of conservation concern in their publications indicated that most of the species documented were not threatened. In fact, few were (e.g. *Caiman crocodiles*, *Scolecophis atrocinctus*). This could be interpreted in several ways. First, that ‘common’ species are commonly encountered, and our effort simply gathered information on the most common species because they were the most easily detected. Second, those species indicated to be rare in Wilson and McCranie 2002 are truly rare, and we did not encounter them because they have either been extirpated in the areas surveyed, or occur in very low numbers. Third, Species listed as rare due to a decline in range or populations from Wilson and McCranie (2003a, b) are harder to detect due to their lower densities, rarity, or being more cryptic. All of

these conclusions as to why our effort favored more common species need to be evaluated through time by monitoring the herpetofauna at all three locations. Monitoring will not only provide the ability to detect change in populations through time, but will also allow for rarer species to be detected through time.

One of the amphibians located during this project, *Craugastor laevisissimus*, is of conservation concern, and could become a “flagship” representative for the proposed protected areas. This species belongs to an endemic Central American clade (28 species) that inhabit medium to high gradient premontane and montane streams from Mexico to Panama (IUCN 2006). All members of this clade have declined throughout their range and many populations are known to have gone extinct (Lips et al. 2004, Lips et al. 2006, Ryan et al. 2006), despite Wilson and McCranie (2002a) scoring them as low vulnerability to extinction. This is the case for all of the Honduran species of this clade (McCranie and Wilson 2002). These declines have been enigmatic because in many cases populations have crashed without obvious causes such as habitat loss or degradation. An emerging, infectious disease, *Batrachochytrium dendrobatidis*, has been implicated in the decline and extinction of numerous species in Central America, and has been documented as the catalyst of the loss of three populations of a closely related frog in central Panama (Ryan et al. 2006). The presence of *Craugastor laevisissimus* at Cerro Guancuare is a significant find and could be the focus of future studies to understand why this species has persisted in light of declines elsewhere. This species can also be considered an indicator species of water and forest quality.

The streams within the surveyed protected areas had a high abundance of *Rana* sp. adults and tadpoles during the January surveys. There is evidence from central Panama that when stream-breeding frog tadpoles are removed from headwater streams, dissolved oxygen decreases, alga abundance increases, and water quality decreases (Ranvestal et al. 2004). The abundance and presence of tadpoles in the stream control algae populations through grazing, thus limiting stream primary productivity (Ranvestal et al. 2004).

Because we surveyed in both the wet, and dry seasons, information on reproductive phenology and activity for some species of amphibians and reptiles was gained. Based on the presence of eggs and tadpoles in the streams it appeared that the *Rana* sp. reproduce in the dry season when the streams are less likely to experience a scouring high-water rain event. In general most of the amphibian species were more vocal in the wet season, but *Scinax staufferi*, *Leptodactylus melanonotus*, and *Physaleamus pustulosus* were vocal in during both survey periods. The bufonids were observed calling during the June surveys and we also collected recently metamorphosed subadults of this group.

CONSERVATION AND OTHER RECOMMENDATIONS

The dry tropical forests of Central America have relatively few species of amphibians – 23 are found throughout the region compared to 117 for the whole of Honduras – and the Pacific Lowland Region physiographic region of Honduras has only 13 species (Wilson and McCranie 2002, 2003a). We have identified 13 amphibians as a result of this project. (Tables 2 & 3) Of 217 species of reptiles in Honduras (Wilson and McCranie 2003a) 54 are known from this region (Wilson and Meyer 1985, Köhler 2003). We have identified 30 reptiles as a result of this effort (Tables 2 & 3).

Cerro Guanacaure, Montaña La Botija, and Isla del Tigre share many of the same habitats (e.g. Dry tropical forest) and thus, share many of the same threats. However, the risk that there may not be continuous financial support for ongoing research and the establishment of conservation-based management could be the biggest threat to their ecological integrity and therefore, the viability of rare species populations and the welfare of the local human populations. There is scant data on herpetofauna or other vertebrate species, not to mention invertebrates and flora, and sound management and land-use decisions need to be based on the best available data. Our surveys represent a considerable contribution to understanding species' occurrence in the three areas, but much remains to be done. The species accumulation curve (Fig. 5) shows that we have not come close to the total number of species of amphibians and reptiles, but have documented a little over half of that predicted.

In order to learn more of the species that inhabit these protected areas and therefore, of their value to human welfare, the single prerequisite is maintenance of the diversity of habitats and forests present. At each of the three areas, considerable impacts were documented and threats to the longterm viability of the local biodiversity and the sustainability of resource extraction appear to exist. Land conversion for grazing, pasture, agriculture, and timber loss/extractions do not seem to be unsustainable, but when considered together along with repeated and pervasive burning, overgrazing, and large-scale timber extractions they amount to a significant loss of ecological integrity and therefore, biodiversity, natural resource and environmental quality, and ultimately, human welfare. All efforts in the three protected areas seem to be geared largely toward extraction of resources more than understanding what is sustainable, or attempting any restoration of degraded habitats like the cloud forest of Las Moras, La Botija MUA. Cerro Guanacaure is making a tremendous example in the conservation of the Quebrada La Fortuna, which has a healthy and intact forest and watershed for municipal uses, but other areas in this and the other MUA's are not as healthy. Our baseline efforts will establish a starting point for continued research in these protected areas, and for the forests of southern Honduras, but only if the habitats remain.

Of greatest concern for future work in the three protected areas surveyed is the need for ongoing research and support. There is little data on herpetofauna or other species from these protected areas other than our own. Our surveys represent a considerable contribution to understanding what species occur in the three areas, but much more remains to be done. Development of a long-term monitoring plan for herpetofauna is of paramount importance. Monitoring of populations in the MUA's will allow for detection of changes through time.

Another important item to consider is long-term curation of the specimens and data gathered. It is an unfortunate situation when a nation with so much diversity and a wealth of natural resources lacks essential long-term support for curation of natural history information. The Museum of Natural History at UNAH is the only location in the country where the public can view examples of Honduran and other vertebrate species. However, it is in need of being expanded to meet the needs of a basic institution to represent the vertebrate collection of Honduras to the country, and to the world. Lack of space, electronic databases, appropriate staffing and other basic museum items hamper this institution and scientists from investing in it by accessioning their specimens there. With a modernization of this facility, Honduran students, citizens, and scientists from around the world would be able to see Honduran species and data *IN Honduras*. The only other facility equipped for large collections is Zamorano, which has a considerable herbarium collection, but lacks the capacity for long-term curation of vertebrate species. While they too could develop appropriate facilities with an investment in equipment and staffing for vertebrate storage, it would be easier for the time being, and make more sense to enhance an existing facility than to start from scratch.

Numerous other factors are worth considering for long-term recommendations. Fire plays an incredibly important but destructive role at all of the locations surveyed. Once burned, a healthy forest takes considerable time to recover, and over-burning resulting in forest conversion were commonly encountered during surveys. A recommendation would be to develop a fire management plan for each of the areas, with incentives for not burning, and penalties for burning with allowances for permitted burning under appropriate review. Left unchecked, burning may contribute to severe erosion, and complete loss of forest and related resources.

Timber extraction at any level, be it light use or large concessions to logging operations are highly destructive. The forests at the three protected areas are sensitive to disturbance, and the recommendation would be to do a thorough analysis of what types of timber extraction are sustainable before any further logging is allowed. Maintaining the use of dead wood for local communities would allow for firewood and other timber needs, but heavy removal should be evaluated before it continues. The forests at these three protected areas represent the best forests left in Southern Honduras, and once they are gone, they will take many generations to regrow, if ever. This should be considered.

Agriculture was found at all locations visited, and in many cases contributed to forest loss, and erosion. Since so much of the land areas surveyed had been used for agriculture, it would be recommended to utilize once-

used, impacted, or degraded areas rather than cut into forested areas to supply the necessary acreage for agriculture. Once again, sustainability of forest cover should be weighed with the need for more agricultural land.

Specifically, at Cerro Gunacaure, the best forests that we saw were those in the upper reaches of Quebrada La Fortuna. Here, the need for water has driven forest protection, but other areas of Cerro Gunacaure are not as well forested. Isla del Tigre has a recovering forest, as is evident on the photo on the 2 lempira note, which shows the island completely converted to agriculture. The decline in economy of Amapala has allowed for forest cover to return. At La Botija, impacts to the natural resources are rampant, although some of the finest forests in the region surround these areas of timber extraction, burning, grazing, agriculture, and damming. Despite its reputation as a beautiful example of the forests of southern Honduras, much needs to be done to protect what little intact and mature forest remains. The cloud forest at Las Moras is all but gone, La Pacaya is losing acreage to land conversion, upper Tres Pilas is currently being logged or has been logged in the recent past, Isnaya has considerable over-grazing, and many other locations could benefit from more conservation. Most of the northern areas of La Botija MUA lost the forests long ago. Even the 'crown jewel' of the vast forests of Ojochal is being impacted by cattle grazing and land clearing for agriculture. Ojochal is home to the last populations of monkeys remaining in southern Honduras. Without radical steps to preserve this forest, the monkeys will likely go the way of all other monkey populations to extirpation.

CONCLUSIONS

This project resulted in vouchering of herpetofauna from previously un-catalogued regions of Honduras. Sound management of the biodata resources from the three areas will be required for effective decision and policy-making, and these inventories are an important contribution toward that goal. Of the many species expected to occur in the region of focus, we have verified 43 through collecting, highlighting the need for further efforts to truly inventory all resident herpetofauna. Also, further surveys may yet yield important discoveries of novel morphotypes or species after only the first efforts. The species accumulation curve growth is pronounced, indicating that more species are likely to be found at each survey site, in keeping with the hypothetical species list (Wilson and McCranie 2002, 2003a, Sasa and Bolaños 2004).

Most importantly, a considerable number of people from diverse affiliations and two different countries have come together under this project to achieve a common goal of herpetofaunal and biodiversity inventories. Under the umbrella of 'capacity building,' an alliance of professionals, students, NGO's, and the local peoples of Honduras have benefited from, and contributed significantly to science at large.

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APPENDIX I

HABITAT CHARACTERISTICS AND THREATS

CERRO GUANACAURE

The slopes were a mixture of houses, coffee plantations, corn fields, mango groves, and cattle pastures, bisected by sparsely vegetated streams. There is evidence of severe erosion at many locations with some gullies three to seven feet deep. The lower slopes have been cut within the last 3-5 years, and perhaps as little as 25% of the area remains forested. The soil in the denuded areas was silty and sandy, and the dominant vegetation was a non-native grass. Closer to the peak were fields of “little corn”, which is used to feed cattle and chickens.

The best stands of forest on this mountain were located in the most inaccessible areas that were too steep to access. Examples are the peak and steeper slopes of the mountain and adjacent ridges. Remnant forests are composed of small tracts of primary forest or very old secondary forest. The trees were 25 – 30 m in stature with an established epiphyte community (mainly orchids and tilanziod bromeliads). There was also a well established understory plant community and vines and lianas.

Threats: Small timber extractions, erosion, conversion to agriculture, burning

CIMA LA CRUZ

It consists of some heavily forested slopes, mixed among corn fields, fruit tree (mango) groves, and small streamside riparian second-growth forests.

Threats: Area generally too steep, but agriculture occurs immediately below the summit, and some coffee was being grown beneath the canopy even at the upper elevations. Burning could do great damage to the upper forests of the Cerro.

LA FORTUNITA

Contains mixed vegetation corn fields, fruit tree (mango) groves, streamside second-growth riparian buffers, etc. Cane, maiz grande, pasture, thorn scrub, secondary growth, scattered houses. Pasture with severe erosion, very steep slopes. This habitat was very degraded. It was composed of a matrix of degraded pasture, maize grande, and sugarcane. The actual forest was on a steep slope that was fenced off. The forest edge was a thicket of thorny scrub and vines. It was only possible to enter by crawling on your hands and knees. The forest itself was well structured for a dry forest (i.e. vines present, sparse epiphytes-mainly orchids).

Threats: Small timber extractions, erosion, conversion to agriculture, and burning.

LA FORTUNA QUEBRADA

La Fortuna consisted of a matrix of secondary growth, riparian stream vegetation, and a small remnant patch of primary forest. The stream headwaters began at a spring in the primary forest which consisted of very tall *Quercus* sp., *Brosimum* sp., various Piperacea, and other locally abundant tree species. The riparian and upland habitats had well established epiphyte communities that consisted of vines, lianas, small tank bromeliads, orchids, and occasional bryophytes. The understory has a well developed herbaceous layer as well as a well defined leaf litter layer.

The downstream vegetation was dominated by Piperacea, Marantacea, Heliconeacea, Melostamaceae, and *Miconia* sp. There were also two stream impoundments that provide water to the municipality of La Fortunita.

Threats: This is probably the most intact quebrada at Cerro Guanacaure, and because of forest protection for water extraction there are few threats. Some timber extraction still occurs, but is rather minor.

FINCA EL RUBI

This is an area with an ample amount of vegetation and a healthy diversity of species. In the lower part intermediate regrowth predominates, and ample areas of cultivated coffee [ericaceas], cultivated plantains and bananas, and fruit trees such as mamey and mango can be observed, among others. Ornamental exotic plants are also in this part of the farm. In the upper part of the Finca, second growth forest is the dominant vegetation. A good corridor of forest follows the riparian zone with very little alteration of the vegetation observed. The epiphytes and bryophytes are very abundant, with more than 15 different species of ferns observed. Also, one can observe large trees with a height greater than 15 meters, [piperaceas, miconia sp., marantaceas, quercus sp.], and some asters. The bromeliads are not abundant in this zone, but some species were observed.

Threats: Finca Rubi is an old coffee plantation that is not used as extensively as before. As a result, much of the forest is recovering where coffee used to be harvested. Threats here would be to resume extensive agriculture, or change to another destructive harvest such as timber extraction.

FINCA LA LIBERTAD

Finca La Libertad is a mountain lodge and home to the Williams family at one time in the recent past. It has very little forest present, except for the trees planted for shade and decoration around the property, like palms, Ficus, papaya, avocado, and others. Surrounding land is for corn and other agriculture, with light grazing and horse pasture.

Threats: Since this is a home, it is disturbed with a manicured lawn and surrounding area. However, much of the adjacent land that surrounds the property has been converted to agriculture, and some restoration is advisable in the form of allowing or enhancing forest regrowth.

FINCA SANTA FE

This forest on the upper slopes of Cerro Guanacaure has fairly extensive second-growth forest with a healthy diversity of tree species and other vegetation. There was extensive coffee growing, and platano groves along small streams in the area, and beneath existing overstory of forest. This area was relatively wet, even in the dry season due to aspect and the fact that it is in a small canyon.

Threats: This area is a disturbed forest that grades upward to a better forested area on the upper slopes of Cerro Guanacaure. Timber extraction was observed here, and is a threat.

TABLONES ABAJO

The flat area at the base of the slopes that surround Cerro Guanacaure has been almost entirely converted to grazing for cattle. Other smaller areas here are used for agriculture also and of course for domestic living and houses.

Threats: Threats here are erosion, overgrazing, and continued burning. In short, this is a heavily disturbed area with little forest remaining.

MONTAÑA LA BOTIJA

FINCA JAYACAYAN, QUEBRADA DEL HORNO

The dominant vegetation along the stream was: Riparian vegetation dominates the banks of the quebrada. Some species are guanacaste, carbón, guanijiquil, chilamate, alacumén, grasses, rushes, *Baccharis* sp., *Guazuma ulmifolia*, *Cecropia* sp. and *Ficus* sp. The figs were the largest trees in the area, sparsely covered in epiphytes such as *Tilandsia*, orchids, etc. Part of the forest was broken up with cultivation of coffee, sugar cane, and other crop plants. The coffee was shade grown, with *Sterculia* sp., and a *Liquidambar* sp., *Trema micrantha*, and various leguminous species. A few of the shade trees appeared to be remnants of the original

forest. The coffee was 4 – 5 feet tall, suggesting it was 2-3 years old. Along the river was a patch of *Acacia* sp, which formed a dense thicket. Leaf litter was sparse. There were a few ground bromeliads. The general vegetation of the zone is a dry forest interspersed with cultivated agriculture (sugar cane, coffee, etc) and land cleared for cattle grazing.

Threats: This area is well used for cattle grazing, and thus the only observed threats would be those resulting from overgrazing. Timber extraction should be kept at a minimum since much of the original forest cover has been removed. Burning, as with most areas, is a threat to the forests here.

FINCA LA FLORIDA

The vegetation here is sparse and was composed of a mixed oak-pine forest with the following component species: *Quercus* sp., *Pinus* sp., *Myrtaceae*, *Psycotria* sp., *Solanum* sp., Asteraceae, *Pluchia* sp., and *Baccharis* sp. The top of the mountain was covered in a remnant patch of primary or very old second-growth forest that had few observable impacts. There were small human settlements and agricultural fields on the lower slopes of the mountain. The vegetation of La Florida was dominated by *Quercus* spp., with a low abundance of bryophytes throughout the zone. There were stands of pine-oak forest transition zones with various species of ferns and grasses. The riparian zones consisted of typical riparian vegetation for this region. The vegetation was very diverse, with pines, white oaks, and live oaks, some more than 60(?) m tall. There were also abundant grasses and shrubs, the latter less dense than those already mentioned. There was a thick leaf litter layer, mainly of *Quercus* sp., and the understory vegetation layer consisted of widely spaced evergreen shrubs. The riparian vegetation was dominated by a species of Marantacea which formed thick clumps, as well as Piperacea and Melastomacea. The stream substrate was made up of mainly boulders, with scattered areas of cobble and sand. There was ample evidence that the local human population is clearing the zone for wood for house construction and for the cultivation of vegetables and cattle grazing. It also appeared that sections of the forest had been recently burned, possibly to encourage the growth of grasses to feed grazing cattle.

Threats: Timber extraction has had a profound impact on this area, and remains a significant threat. Burning is also a threat as the forest is highly susceptible to large fires, and grazing remains a threat as well.

LAS MORAS

This forest was dominated by *Quercus* sp. and occasional *Pinus* sp. The term forest is used loosely because it is obvious that this area has been affected by tree harvesting and fire. At this point in time the trees were restricted to clumps, and for the most part the canopies did not overlap. The forest patches were separated by a 2-3 foot high grass, and the understory was dominated by a short bush that formed dense clumps. There was a high abundance of small to very large epiphytic tank bromeliads of at least 7 species (flowers were present). There was also a well established bryophyte community in the forest patches. It would be beneficial to learn the history of this site in order to piece together how the original forest looked.

Threats: This location represents only a small remnant of what was once a large and continuous cloud forest. Unfortunately, almost all of it has been removed for agriculture and grazing. Just downslope from the peak, timber extractions of large mature oaks took place between January and June visits, as did large and destructive burning. This area should receive a very high degree of protection from further impacts, or very soon no cloud forest of this type will remain at La Botija.

LA PACAYA

The upland vegetation consisted of *Quercus* sp. and *Pinus* sp., and the understory had representatives from: Asteracea, Rubiaceae, and grasses. There was still primary forest without human intervention in the uppermost part of the canyon, but there was extensive cultivation in the lower zones: predominantly corn, tomato, and coffee. The lower water courses were very contaminated because trash is dumped directly into the stream. The upper stream, near its source, was not as contaminated as were the waters below. The vegetation was different in the upper and lower zones. In the upper part, the trees had heavier epiphyte loads of ferns, mosses, vines, and lianas. The soil was somewhat rocky with a thick layer of leaf litter and old

decomposing logs. Between the January and June trips, several acres of excellent habitat tropical dry forest were cut and burned for agriculture, a road was graded well back into the canyon, and several large mature oaks were cut for lumber.

Threats: Continued timber extraction, and clearing for agriculture are clear threats to this remnant of mature tropical dry forest.

LA ISNAYA

The Isnaya zone was rich in animal and plant species. The forest cover was predominately pine-oak mixed stand, but we did see several leguminous trees throughout the zone. We also saw representatives of *Miconia* spp., Asteraceae, and *Psychotria* spp. The riparian forest was distinct from the upland forest. The trees were covered with bryophytes, bromeliads, ferns, orchids and other type of epiphytes. This area represents a deep canyon and habitats transition from the Las Moras cloud forest well above La Isnaya, to pine and oak forest, and tropical dry forest in the lower parts of the canyon.

Threats: Heavy grazing takes place on the oak forest above La Isnaya Canyon, and burning and grazing have removed almost the entire understory. Lower areas of the canyon are too steep and inaccessible, but small agriculture threatens some areas.

OJOCHAL

The vegetation of Ojochal was very diverse consisting of *Cecropia* spp., *Bursera* spp., *Byrsonima* spp., *Ficus* spp., *Brosimum* spp., and various leguminous trees. The epiphyte community was composed of bromeliads, orchids, and philodendrons. The under-story vegetation consisted of *Psychotria* spp., grasses, ferns, and mimosas. The riparian vegetation was dominated by *Cecropia* spp., Piperaceae, Rubiaceae, and *Ficus*. The riparian zone had a higher abundance of epiphytes than the upland forest. This area represents the best tropical dry forest remaining in La Botija.

Threats: Freshly cleared and burned agricultural operations in the upper part of the canyon, and cattle have been moved into the lower part of Ojochal only recently.

TRES PILAS, QUEBRADA IGUAZALA

This upper canyon of the Quebrada Iguazala is a pine and pine oak forest with a deep and steeply cut staircase of waterfalls and pools surrounded by fairly healthy forest. The area had been burned recently for cattle grazing, and there was evidence of timber extraction. Several streams feed the main stem of the Iguazala, and flowed even in the dry season. There were pines, acacias, and epiphytic *Tilandsia* sp.. This area is surrounded by fairly continuous forest, and the waterfalls are quite scenic. Habitat is varied, and relatively intact and healthy.

Threats: Overgrazing, burning, light forest clearing, larger timber extractions occurring farther upstream threaten the pine forests of this area of La Botija.

FINCA SANTA CLARA

A working Finca and north-facing canyon with an upland oak forest intermittently used for cattle grazing, and ringed by pines at the higher elevation, with a dry forest that stays relatively wet even during the dry season because of its aspect. The forest gives way to pasture, cattle and irrigation ponds and agriculture at its lowest point and meets the upper floodplain of the river.

Threats: Overgrazing, burning, light forest clearing.

ISLA DEL TIGRE

La Laguna: This area was dominated by open water with emergent vegetation along the shore. Along the north shore was a groomed pasture. The trees along the laguna were: *Ficus* sp, *Guazuma ulmifolia*, *Miconia* sp., and members of the Melostomaceae.

Threats: The fact that this area is on military lands will keep impacts and disturbance to a minimum, however there was some light grazing of livestock within the area.

AMAPALA/UPPER SLOPES

This was a closed canopy forest, mainly secondary growth with occasional emergents (*Bursera* sp.). *Acacia* sp., *Ficus* sp, *Guazuma ulmifolia* dominated this low species forest. There were lianas and vines (unknown classification). There were few epiphytes which consisted of orchids, a cactus, and a couple of tilandriid bromeliads.

Threats: This forest is a recovering second growth forest, with little human impacts at this elevation. Most of the agriculture and grazing impacts are farther downslope.

PLAYA NEGRA

This area was completely impacted. It consisted of a few tall *Ficus* and *Bursera* along the fence rows of current, or fallow agricultural uses. Most of the forest had been cleared already. It was mainly a highly intensive agriculture area, appearing to be beans. The few non-agriculture plants were early succession *Melastomaceae* and *Rubiaceae*. The fence rows broke up the homogeneity of the agricultural fields, but were narrow and well traversed with human trails.