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Biodiversity and conservation of Sierra Chinaja: A rapid assessment of biophysical socioeconomic and management factors in Alta Verapaz Guatemala

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BIODIVERSITY AND CONSERVATION OF SIERRA CHINAJÁ: A RAPID ASSESSMENT OF BIOPHYSICAL, SOCIOECONOMIC, AND MANAGEMENT FACTORS IN ALTA VERAPAZ, GUATEMALA

by

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Biodiversity and Conservation of Sierra Chinajá: A rapid assessment of biophysical, socioeconomic, and management factors in Alta Verapaz, Guatemala

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The Sierra Chinajá is a low lying range of karst mountains in the heart of one of the world's biodiversity hotspots, the Mesoamerican Forests. In 1989 these mountains were declared an area of special protection according to article 4-89 of Guatemalan law. Nevertheless, there is little management implementation on the ground and significant encroachment on important habitat and settlement of public lands by landless *campesino* farmers.

The first step required by Guatemalan law to move the Sierra Chinajá from an area of special protection to a functional protected area is the preparation of a "technical study". The goal of this document is to provide initial characterization of the biophysical, ecological, and socioeconomic features. It also identifies threats and suggests potential management strategies for the conservation of the Sierra Chinajá. Data were collected using biophysical and socioeconomic rapid assessment techniques from May 2005-Jan. 2006. This study represents the first systematic effort to characterize the biodiversity of Sierra Chinajá.

The number of plant and animal species recorded included: 128 birds, 24 reptiles, 15 amphibians, 25 bats, 20 dung beetles, 72 trees, 63 orchids, and 198 plants total. These preliminary lists represent only a fraction of total diversity in this area, but shed light into the region's ecological and conservation significance.

A census of all 18 communities living in and around the Sierra Chinajá revealed more than 3,000 total residents. A socioeconomic survey of the 9 oldest communities, accounting for more than 350 households, was carried out to characterize land use practices in the region. Fifty percent of total income is derived from the production of Cardamom (*Elettaria cardamomum*), which is primarily shade grown in small pockets on karst uplands.

The substantial quantity of remaining forest (+60%) and its unique ecological value warrants protection. The complex pattern of land development and current social and political conditions suggest the need to integrate management with existing land use practices by engaging local communities through land entitlement. A proposal by the Guatemalan conservation organization, ProPeten, for a new category of protected areas management could potentially reconcile conservation and development in the Sierra Chinajá.

PREFACE

Ever since the term "biodiversity" was coined it has been a buzzword that has taken center stage across the world as a priority on the list of every international environmental organization. Through the "greening" of foreign aid in the early 1990's, the international conservation community has begun to take responsibility for what is clearly a global concern: loss of biodiversity. The first integrated conservation development programs (ICDPs) at this time began to highlight the difficulty of working global conservation agendas into local conservation initiatives.

In an effort to "save the tropical forest" conservation biologists have successfully identified many ecosystems and species of global interest, but have done little to assure their ecological integrity. Early conservation biology was concerned with the designation of conservation management units in areas where protected areas systems had not existed previously. Guatemala is a case that illustrates the recent formation of many formal protected areas system in developing nations. It wasn't until 1989 that federal law was passed by the Guatemalan government declaring, at once, all 180 of the protected areas in the country. The ramifications of such a unilateral move based on ecological theory and little ground work caused conflicts that threaten to undermine the alliance between local people and international conservationists.

This knowledge of "what is out there" is an important first step to understanding "where to begin". Armed with baseline information it is possible to understand different ecological elements that are unique and in need of conservation. Where the pioneers in conservation biology left off is precisely where the new generation of conservation professionals needs to begin. This is not to say that conservationists need to pursue certain ideals in the face of contradiction, by privileging some species over others (i.e. nonhuman vs. human). Today international conservation practitioners must avoid narrowly pursuing deterministic policies that serve strict protectionist ideology to the detriment of local human populations. They must attempt to reconcile previous conservation initiatives by being a multi-disciplinary force taking into account not only biological data but also sociopolitical and economic factors as well.

As a Peace Corps volunteer working in northern Alta Verapaz, Guatemala from 2003-2005, I was able to develop a project to work on the reconciliation of one unit of the Guatemalan protected areas system: the Sierra de Chinajá. It was through a grant from the National Foundation for the Conservation of Nature (FONACON), a Guatemalan government entity that we (I and the local association APROBA-SANK) initiated the process that would, hypothetically, lead to congressional declaration of the area. The primary product of this project was the creation of a technical study which would henceforth serve as the basis for management prescriptions in the area. It was also our intention to bring to the negotiation table the interest of the local populations in the area for the regularization and titling of their lands. This work is inherently multi-dimensional requiring communication and collaboration between several state, federal, and municipal government land regulation agencies, local non governmental organizations, transnational conservation organizations, peasants' rights organizations, and local communities.

This paper attempts to take the all important "first step" in the conservation of the Sierra Chinajá. It is less a critique of current conservation problems in the area than it is a document that looks to describe the biophysical and socioeconomic landscape, the constraints to conservation and development, and to offer a plan for future conservation and development. Thus, the goal of this paper is to propose conservation strategies. This document is laid out in two parts Biodiversity and Conservation. In doing so, I hope to establish the distinction that "Biodiversity studies" alone do not constitute conservation; and that conservation is ultimately a social construction which requires the inclusion of socioeconomic and political elements of the debate over the practice of land management. This I believe is a useful framework in understanding protected areas management as the juxtaposition between the "what" or "biodiversity" and the "how" or "conservation".

ACKNOWLEDGEMENTS

Project Chinajá would not have been possible without all the great people that contributed to make it a reality. The multi-disciplinary nature of this work required the participation of a host of actors, institutions, and organizations. The following list is an attempt to recognize some of these vital elements.

First and most importantly, I would like to thank all the SANK-istas (read: members of the association, APROBA-SANK) that have been part of the implementation of this project on the ground, from the beginning. This includes Ernesto Tzi, president of APROBA-SANK, Eduardo Sacayon, biological coordinator, and Pedro Giron, architect and mapping technician. Also among this group are Ervin Molina Caal, Justo Bac, Armando Gutierrez, Rogelio Ico, Hector Asig, Manuel (Vinicio) Lopez, and Teodoro Maas, all of whom were field technicians of APROBA-SANK.

I would also like to thank my good friend Reginaldo Reyes, former Executive Director of CONAP for believing in me and giving me a chance to prove myself. This project wouldn't have been possible without the financing received through a grant from the Guatemalan National Foundation for the Conservation of Nature (FONACON) directed by Ivonne Ramirez.

My appreciation also goes out to all the biologists who participated in the study including: Nicte Ordóñez, Enio Cano, Jack Schuster, Sergio Perez, Mario Veliz, Fredy Archila, José (Pepe) Cajas, Michael Dix, Manuel Acevedo, Carlos Vasquéz, Daniel Teni, Mercedes Barrios, Jorge Ruiz, and Claudio Méndez.

Support from various conservation and development organizations was also instrumental in achieving the scientific depth, rigor, and credibility necessary to promote the high priority nature of conservation of this protected area. The following organizations were among those involved in this effort: Pro Peten, the Center for Conservation Studies (CECON), The University of San Carlos Museum of Natural History, The Laboratory of Entomology at University of the Valley, The National Council of Protected Areas (CONAP), The National Land Fund (FONDOTIERRA), and the forestry office of the municipality of Chisec, Alta Verapaz.

I would be remiss not to mention the residents of the communities of Sierra Chinajá, who were kind, gracious, and supportive throughout the process. From them, I learned that the history of socioeconomic marginalization of indigenous peoples in Alta Verapaz is the deeper cause of biodiversity loss. Despite their concerns over the lack of land tenure, they bestowed their trust in us. This final product is really for them. Thanks for the many meetings and meals we've shared. B'antiox eer'e laa'ex komon.

Thanks go out to all my friends and family, especially my wife Michelle Bonham, for the revision and translation of this document as well as for tolerating the long hours of work and my lack of presence at home.

Finally I would like to thank Dr. Stephen Siebert, for providing insightful editions to this document as well as instilling in me a far deeper understanding of land management and conservation in the tropics.

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Part I

Chapter 1. Introduction

The Sierra Chinajá, a protected area in Chisec, Alta Verapaz, Guatemala, is a range of karst mountains in the heart of one of the world's "biodiversity hotspots" known as the Mesoamerican Forests (Myers, 1988, Mittermeier et al., 1998). The area consists of an assemblage of sub tropical low montane humid forests, comprised of a variety of habitat types and transition zones or 'ecotones'. It is adjacent to both the Lacandon Jungles and Verapaz Highlands; areas of high biodiversity and conservation priorities for multi-million dollar biodiversity conservation finance programs developed by Conservation International's CEPF Grants (http:// www.cepf.net/) and the United Nation's Global Environmental Facility (http://sgp.undp.org/). Although this area is located in a remote frontier zone with low population, it has recently come under significant threat by land invasion, expansion of plantation and small scale agriculture, illegal hunting and logging, unlicensed collection of ornamental plants, oil exploration and limestone mining. The degree to which campesino farmers from 18 adjacent communities have encroached on protected area lands to plant cardamom and other crops is the principal concern of both the government and conservationist groups (R. Reyes, former Director of CONAP (Guatemalan Protected Areas Agency), pers. com.). This document identifies challenges to the maintenance of forest cover in the Sierra Chinaja and critically evaluates opportunities and constraints to forest management involving local resident communities.

It has been suggested that beneath the evident causal factors of forest degradation, such as forest conversion, soil erosion, and hunting, underlie driving forces (Geist and Lambin, 2002). In the case of the Sierra Chinajá these driving forces include socioeconomic, institutional, and policy factors. The lack of formal delineation of the area and implementation of proper management strategy, which accounts for local land use groups, has provoked conflicts over land use and land tenure. The difficulty in establishing an ecologically viable reserve is compounded in the Sierra Chinajá by human settlement previous to protected areas legislation as well as historic antecedents including oil exploration and the destructive legacy of a 36-yr civil war.

The widespread disregard for laws, a result of war, and the social climate of this area, complicates effective protected areas management. Disregard for law is evident in the frequent mob justice, including lynchings, in the municipality of Chisec (Mansel, 2005).

Marginalization of the indigenous Qeqchi Maya people that comprise more than 90% of the region's population (Municipality of Chisec, 2002) has given rise to extensive use of uplands unsuited for agriculture because of the unavailability of more productive lowlands. To reduce the unsustainable and economically destructive agricultural development in the Sierra Chinajá actions must be taken to protect remaining forests. The first step required by Guatemalan law to move the Sierra Chinajá from an area of special protection (a "paper park") to a functional protected area is the preparation of an "Estudio Técnico" or "technical study", as mandated by the Guatemalan National Council for the Management of

Protected Areas (CONAP). The technical study forms the baseline from which a management plan and other multiple-use/concession plans can be formed. This document has as its primary goal the formulation of the 'technical study', including, biophysical, ecological, and socioeconomic data to characterize the area. The explicit purpose of the following study is summarized in the following statement:

To provide initial characterization of biophysical, socioeconomic features, and conservation threats; and to suggest potential management strategies and for the Sierra Chinajá (CONAP, 1999).

The Sierra Chinajá, located in the northwest corner of the municipality of Chisec, Alta Verapaz, Guatemala, is bordered by the municipality of Sayaxche, Péten to the north and Cobán, Alta Verapaz to the south (Figure 1 and Appendix 1).

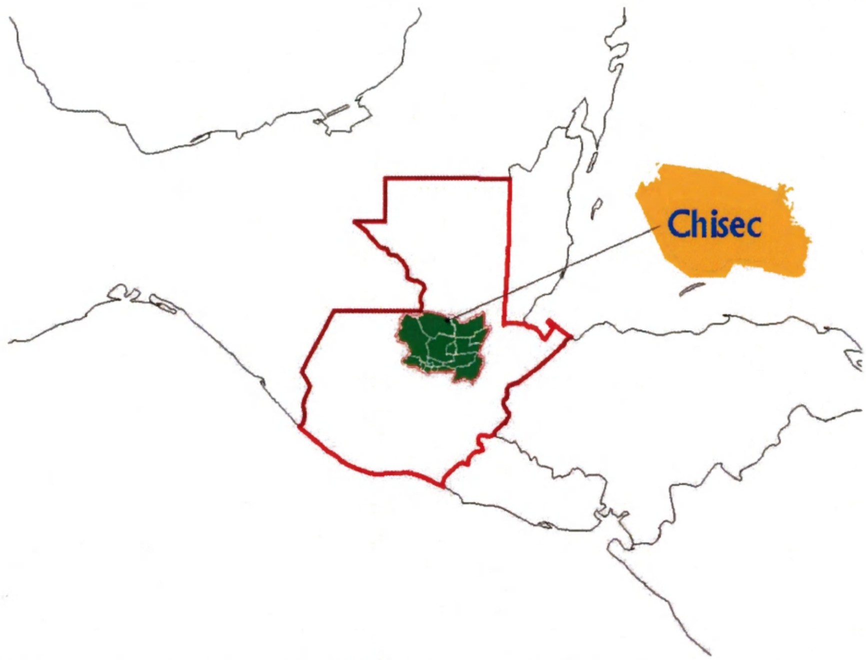


Figure 1. Location of Chisec,Alta Verapaz, Guatemala

The region encompasses an estimated 13,500 hectares delimited by natural boundaries including several rivers to the south and by topographic (ie. foot of the mountain) as well as structural boundaries (i.e. the highway) to the north (see Appendix 2). This area, declared a "special protected area", is a unique chain of conical karst (including "towers") and uplands abruptly rising to 200-800m of elevation. Replete with dissolution caves enshrouded by sub-tropical rainforest, this isolated mountain range marks the last mountain massif between the volcanic highlands of southern Guatemala and the expansive northern lowland limestone plateau of the Péten.

The jungles of Sierra Chinaja were inaccessible until the 1970's when the Guatemalan Institute of Agrarian Transformation (INTA) began its policy of colonization of the 'northern transversal strip' (FTN). Other than sporadic oil exploration since the early 60's this area was in recent times little used by humans. The lack of roads north of Coban required transport on foot or by aircraft to reach the area. The topographical features of consecutive parallel running mountain ridges that separate Chisec from Coban discouraged construction of roads; the first paved roads were not built until 2002.

It is not surprising that within this historically isolated and remote area new species of plants were described in the 1980's (Werff, 1985, Strother, 1989). Explorers and botanists are not the only scientists making discoveries in the Sierra. The discovery (by local residents) of cave paintings, stones carved with hieroglyphics, and ceramic chards hints of historic and perhaps, extensive use by the ancient Maya Civilization. Despite this and two previous studies (Alvarado et al., 1998, Gaitan et al., 2002), the Sierra Chinajá remains poorly known archaeologically and ecologically.

Through the national Protected Areas Law, Guatemala's protected areas management agency, CONAP (Consejo Nacional de Areas Protegidas) declared the Sierra Chinaja a reserve in 1989 due to the abundance and diversity of flora and fauna (CONAP, 1989). However, the current management status (area of special protection) affords little protection and has left undefined its management plan. Due to the lack of administrative coordination and regularization of this area and growing human settlement, the Sierra Chinajá remains a frontier territory where multiple stakeholders vie for control over land. In fact, CONAP declarations may have facilitated the invasion of the area as evidenced by historical precedents of land settlement. The lack of institutional presence and the historical ambiguity of land claims in the area make land invasion of public/untitled lands a viable prospect.

The Sierra Chinajá has an average slope of ~30%, shallow, rocky infertile soils, and thus is largely unsuited for agriculture. Inequitable land distribution in adjacent lowlands however has resulted in widespread settlement of this area. For this reason forest coverage is a mosaic of stand types in different successional stages with only a few blocks of the most remote and inaccessible forest remaining in mature well developed cover.

Because of the wide scope of this project, a holistic approach was required to integrate biodiversity data within the socioeconomic context of the various stakeholders involved. Consequently, I separated the project into two parallel tracks: a technical study (including biodiversity, cadastral, and socioeconomic components) and a mediation process aimed at incorporating local communities in dialogues with land management agencies with the goal of creating conservation agreements and securing land titles for these communities. Community territorial polygons were delineated using "counter mapping" techniques (Eghenter, 2000) and meetings were held at both the community and national level. This document, however, discusses the results of the technical study and only briefly describes the implications of the socialization and political process.

In order to assess the biological diversity, land use, and socioeconomic characteristics of the Sierra Chinaja, a variety of 'rapid assessment' methodologies were adapted and utilized to gather basic information. 'Rapid assessments' of biodiversity, although incomplete due to limited time and financial constraints are nonetheless useful in identifying relavent biodiversity values and potential management options (Sayre, et al, 2000). Various frameworks of sampling biodiversity exist, commonly linking mapping technology such as satellite photography and Geographic Information Systems (GIS) with on the ground sampling of georeferenced points (Fa et al. 2002, Kerr et al. 2000, Oliver and Beattie, 1993, Sayre et al., 2000). Conservation International was a pioneer in this field effectively organizing multi disciplinary teams of expert biologists who assessed and still assess some of the richest ecosystems in the world (Schulenberg and Awbrey, 1997 a,b). These Rapid Assessment Programs or RAP expeditions generate baseline ecological data and compile lists of species presences and distributions. The limitations are obvious of any study which is time bound. However, by targeting certain taxa, through the use of indicator species, these studies can be used to tailor management plans to conserve areas with unique biogeographical value (Gaston and Blackburn, 1995 and Kerr et al., 2000).

Recently the use of community participation and folk taxonomy to rapidly assess local biodiversity has been identified as an effective method (Hellier et al., 1999, Jinxiu et al., 2003, Stocks, 2002). Participatory rural appraisal (PRA) and rapid rural appraisal (RRA) techniques are also commonly used to assess socioeconomic conditions of local communities at a low cost (Chambers, 1992). These techniques, which use surveys, questionnaires, semi structured interviews, "counter mapping", and transect walks have rarely been used to assess biodiversity trends (Hellier et al., 1999). In this project I used a combination of 'biological methods' (ie. transects, quadrats, traps, mistnets, GPS, clinometer, etc.) and 'sociological methods' (ie. structured surveys, focus groups, meetings, transect walks) as modified from the sources noted above. The following section presents a general overview of the sampling design. More specific methodological information is provided in the topical sub sections within the text.

Chapter 2. Methodology

Biological Inventory

I and a team of Guatemalan biologists and field technicians conducted systematic sampling in the Sierra Chinajá between June and October 2005. These activities were complemented by a one week long field trip by the students of Zoology and the Museum of Natural History of the University of San Carlos which took place from 14-21 of September 2005. Several taxonomic groups were selected based on ease of data collection methods, likelihood of ability to serve as 'indicator' or 'surrogate' to environmental quality, and availability of Guatemalan expert consultants and collaborators (see Appendix 1: Protocolo Biologico for more details). Taxa were also chosen based on their perceived potential as indicator species and species of biogeographic importance. Due to limitations of funding, time, and availability of local expertise, this study focused on 7 groups: Plants, Birds, Bats, Reptiles, Amphibians, and Dung Beetles. Additionally a systematic plot level analysis of all tree species (>10cm DBH) and xate (*Chamaedorea spp.*), an ornamental palm with high value on the international market, was also carried out. The data generated through these efforts provides a preliminary understanding of local flora and fauna; and represents the first systematic collection of ecological data in the Sierra Chinajá.

Three study sites in the Sierra Chinajá were selected for sampling based on their degree of accessibility, forest integrity, habitat type, and local contacts in adjacent communities. The sites were sampled to varying degrees as time and resources permitted. Two sites, Mucbilha II and Tzulul Qeqchi/Nueva Chinaja received the most sampling effort. Some of the techniques used to assess particular taxa (e.g. Birds and Dung beetles) were able to distribute effort across sites allowing for a comparison of community composition across sites. Each of these sites is named after the nearest community, although the actual sites of sampling were located several kilometers from the urban center.

The sample sites and the local sub sites of actual collection were selected in an attempt to maximize the number and quality of habitats surveyed. These sites were primarily undisturbed primary forest sites interspersed by a mosaic of permanent and annual agricultural fields. Elevations varied from 300 to 700m, slopes were between 25%-35%, with well drained, clayey soils. Site 1 is a low elevation moist cloud/rain forest, Site 2 is high elevation cloud/dwarf forest, and Site 3 is low elevation dry semideciduous forest. The following section provides a brief description of the three principal sampling locations:

Site 1: Nueva Esperanza

Average elevation: 400 m

The urban center of this village is located at the foot of the mountain on the northeastern side of the range. Forest communities sampled were located 1 km south from the main highway that goes north to Sayaxche. The trail climbs to a steep pass that falls away to a rolling karstic plateau on the otherside where the parcels of Sesaltul are located. The forest sampled in this area was composed of notably larger diameter trees, than in other sites. The small diameter tree species Paatache (*Psidium sartorainum*) is also abundant in the area. The density of large diameter trees and proliferation of epiphytes suggests that this area may receive more precipitation than other portions of the range. This observation could also reflect the degree to which forest integrity has been maintained over time in the area. From this edge, the eastern portion of the Sierra was accessed by climbing a trail that scales up into a system of forested steep craggy hills to the south east. An imposing cave, of possible tourist value and with evidence of archaeological resources, is about 2km from the community in a zone of mature forest.

Site 2: Tzulul Qeqchi

Average elevation: 650 m

This is the easiest access to some of the highest parts of the Sierra. The urban center of the community is found at the top of a spur road which climbs 200 m from the primary dirt road that leads to Tierra Blanca, Peten. Sitting at 400 m the community commands a small "micro valley" that extends SE-NW providing room for nearby farms. From the community it is 5km south along the semi-abandoned service road built by early petroleum exploration companies to the site of radio transmitters which sit atop a ridge at 700m. The majority of sampling took place along this road, which parallels a temporal stream, in adjacent forests. Forests in this area were moist and composed of large diameter individuals with well developed epiphyte communities. It is also in this area that high elevation species were most evident. A fork in this road also leads to the site of the new urban center of the community Nueva Chinajá.

Nueva Chinajá is now being colonized by the sons of the community Tzulul Qeqchi. From here at 615 m it is possible to quickly access well preserved cloud forest and dwarf forest habitats draped in epiphytic bromeliads, orchids, mosses, and ferns. This area, a subsite of the larger Tzulul Qeqchi, was the site of a variety of sampling efforts and posseses the same ecological character as the area occupied by Tzulul Qeqchi, 5km north. The road that spans the network of the well preserved subsites sampled is a large reason for the high number of species recorded in this area. The abundance of high elevation species, typical of montane forests, is most notable in this site. As such it should be a permanent survey area from which to develop baseline data.

Site 3: Mucbilha II

Average elevation: 300 mabsl

The urban center of the community is located next to a small seasonal river. Its source is a cave at the foot of the hills that give rise to the mountain massif. From the community a path to the northeast is taken 2 km through a complex of cardamom patches interspersed within forested hills. Evident is the highly deciduous nature of the forest relative to the rest of the Sierra. This could be a reflection of the geographic location of this area in the south west, which could potentially put it in the rain shadow of the range. The prevalence of the timber tree, Amapola (*Pseudobombax ellipticum*), is characteristic of the area. Despite fires that burned large tracts of land, troops of howler monkeys (*Alouatta paliata*) are commonly seen and heard in this area, owing to the high quantity of intact forest that still exists. In this area it is also reported by local residents the presence of Tapir (*Tapirus bairdi*) in the low forested wetlands that lie adjacent the Sierra.

Cadastral/Land Use/Soil Capacity Mapping

Locally trained technicians from APROBA-SANK systematically mapped vegetative, land use, and political units from May-September 2005. This 5 member team, equipped with GPS technology, compasses, and 1:10000 scale topographical maps, georeferenced each communities territorial polygon and the parcels of all farmers. This work was carried out in conjunction with all community members and their respective coordinating land commissions. In doing so, other biophysical features such as springs, ephemeral streams, caves, mineral deposits, and archaeological sites were identified. This work required the mapping technicians to survey all lands within the Sierra. Operations were based in adjacent communities, and together with local parcel owners, the technicians traversed the reserve recording land use information.

Additionally, a series of soil profiles were dug in the vegetation plots established in the forest inventory (Chapter 5) and in identified 'physiographic units' (Chapter 3), or sub landscape categories, delineated according to topographic commonalities. These soil profiles were used to assess land use potentials, which are consequently presented in cartographic form. Soil sampling was required for the technical study and was based on a method designed by the Guatemalan Institute of Forests (INAB, 2000). The results of this work are presented in soils, land use, and cadastral maps generated by ArcView software (See appendices).

Socioeconomic Census

A complete census of all inhabitants in the 18 communities in Sierra Chinajá was made in June 2005. However, only in the 9 'oldest communities' were socioeconomic surveys administered, as the political climate in the 8 newer communities made it impossible.. This work was carried out by individuals from each community who were elected by community members. They received one week of training in interviewing and recording data. The major focus of the questionnaire was on the use of forest products and basic demographic information. This work was facilitated by the method design, which is novel in that interviewers and subject were neighbors and local citizens, which generally promotes an attitude of trust (A. Stocks, director of Idaho State University, Department of Anthropology pers. com.). Nevertheless, not all neighbors 'like' or 'trust' one another, though this method controls for bias due to 'outsider error'. Data were summarized at community and regional levels to provide a holistic perspective of the region. The community of San Franscisco del Rio was excluded from the study due to the fact that they had previously attained legal title to lands in the Sierra.

Analysis of Management Strategies

The last chapters propose a potential strategy for protected areas management in the Sierra Chinajá based on published sources and frameworks of protected areas management (APROBA-SANK, 2004, CONAP, 1989, IUCN, 1994, ProPeten, 2000). I identify threats to forest conservation and strategies that might provide for conservation and development in the Sierra Chinajá. The conservation and development strategies are bounded by CONAP regulations which are based on current conventional protected areas management models espoused by The World Conservation Union (IUCN), Conservation International (CI), and The Nature Conservancy (TNC). A unique proposal by the Guatemalan conservation and development organizations, ProPeten and APROBA-SANK, for a new protected areas management category and form of land management which incorporates communities as central figures in decision making is also considered as a possible step toward conservation of Sierra Chinajá.

Part II Biodiversity

Chapter 3. Geomorphology

Geographic Location

The Sierra Chinajá is located in the municipality of Chisec at the northern limit of the Department of Alta Verapaz with Peten (Appendix 1)

Proposed Geographic Coordinates of Territory:
North 15° 53'30" 16 02'20", West 90° 05'13" 90 18'40".

Length and Form of Sierra de Chinajá

Sierra Chinajá is a chain of low lying mountains and "karst towers" that range from 200 to 840 m. The Sierra is the last mountain massif of the Verapaz highlands (i.e. Sierra Chama) before entering the limestone plateau of the Peten. It is a zone of montane habitat totally isolated from other mountainous systems. This is due largely to its geographic isolation at the Front Range of the highlands, but also because of the recent large scale habitat conversion of surrounding valleys to cattle pastures that occupy the prime farm land.

The total area of Sierra Chinajá is approximately 13,500ha in an elongated rectangle directed from northwest to southeast. The northwest end is wider and tapers to a pointed end in the southeast. The total length of the mountain range is 20km and its average width is 4km. Even though the asphalt highway going to Flores, Peten bisects the eastern point of the mountain range, its boundary is considered to include the hills that lie on the eastern side of the highway (Appendix 2).

The land is cragged and pockmarked, punctuated by small, but deep valleys and peaks. There are many ways to visualize this terrain; some think of it as like the indentations of an egg carton. Technically this area is called "haystack" karst referring to the hills, or "cockpit" karst, (i.e. the small deep valleys occurring within the hills) (Juberthie, 2000, Kueny et al., 2002). Locally the word "cerro" is used to describe the steep hill formations unique to karst lands and "joya" or "rejoya" (literally "hole") to describe the micro valleys that form at the base. The degree of karstification is highly developed as evidenced by the formation of large underground caverns and the presence of "karst towers" or sheer limestone cliffs. The rows of E to W stacked limestone hills or "cerros" makes the interior recesses of this mountain massif difficult to reach on foot.

Geomorphology

The Sierra Chinajá is the last mountain massif remnant in the greater geological region of the Sedimentary Highlands (Instituto de Incidencia Ambiental (IIA), 2004). The Sierra is located at the northern limits of this zone, and borders the southern portion of the geologic region of the Peten Lowlands (IIA, 2004). The geologic uplift of cretaceous limestone parent material is typical of the highlands. However, the geologic processes of weathering responsible for the formation of the soils and geomorphology of this mountain range have affinity to the lowlands. This is evidenced by the highly leached, iron oxide laden soils and steep sloped, white "karst towers" that dominate the landscape (Juberthie, 2000).

High average temperatures and precipitation result in the rapid formation of these unique geologic formations (Peiro, 1999). Another element of highly developed karst landscapes is the abundance of caves and subterranean river systems. The limestone of this area is highly jointed and faulted creating many fissures and conduits, which facilitate rapid runoff of precipitation into underground channels, rivers, and aquifers (Fernandez, 1999). Due to rapid subterranean drainage, much of the area experiences water deficit during the dry season, while in the lowest parts of the landscape (at the foot of the mountains or in the plains of larger valleys), wetlands form.

The Sierra Chinajá region is a system of highly folded Mesozoic and Tertiary limestone strata overlying Cretaceous dolomite rocks (Centro de Estudios Superiores de Energia (CESEM), 2000). The thickness of these limestone layers allows for extensive development of karst formations through chemical and mechanical dissolution of the relatively soft rock by the constant flow of water over its surface (G. Veni, hydrogeologist specializing in cave and karst terrain, pers. com.).

The Sierra Chinajá rises steeply and folds into a series of small isolated valleys. It is punctuated by two distinct uplifts with peaks above 700 m. These uplifts form numerous sub watersheds. However, because of the complex hydrology, it is difficult to delineate these catchments. The tallest peaks are in the northwest along the border between the communities of Tzulul Qeqchi and Sesaltul at 838 m. The lowest elevations are along its base at ~200 m. The highest peaks of the range are part of a more gradual increase in elevation that gives a rounded appearance to the ridges. Unique mineral formations of quartz and calcite in interstitial spaces of the limestone matrix have been exposed at ridges as well as road cuts. On few high elevation ridges natural quartz conglomerate outcrops occur. This rare parent rock could cause for the formation of unique edaphic characters, which could influence the development of local vegetative communities.

Physiographic Units

In order to understand the Sierra Chinaja as a landscape it is important to identify the components which comprise it. Eighty percent of the lands of the Sierra have greater than 32% slope; and half of the remaining lands, or 10% of the total, have slopes between 16-32% (Table 1).

Natural Region	Natural Province	Life zone	Major Landscape	Landscape	Sub-Landscape	Slope %	Depth of soil (cm)	Ha	% Total
Northern Limestone Lowlands	Sedimentary Highlands	Very humid sub-tropical hot	Sierra Chinajá	Zone of undulating hills 1	Lightly 1.1	4-8	> 90	842	6
					Strongly 1.2	8-16	50 – 90	348	2.5
				Karst Mountains 2	Cragged 2.1	16-32	20 – 50	1,407	10
					Very Cragged 2.2	> 32	< 20	10,970	80
					TOTAL	**13,567**	**100**		

Table 1. Physiographic Regions of the Sierra Chinajá, Chisec, Alta Verapaz. September 2005

The Sierra can be characterized into 4 physiographic regions (Appendix 3) including: Cragged Karst Mountains, Very Cragged Karst Mountains, Zone of Lightly Undulating Hills and Zone of Strongly Undulating Hills. These regions can be thought of as sub landscape units which possess distinct variations on the themes common to all (ie. karstic hills and valleys, with abrupt rock outcrops, rocky, shallow, clay soils, and varying degrees of slope). Within this range of characteristics other common landforms are apparent as well such as parallel rows of hills, sink holes, and steep anticlinal and synclinal hills (Veni et al. 2003). The formation of these features is influenced by the folds, faults, and the process of erosion through dissolution. A summary of the composition and distribution of each physiographic unit in the Sierra Chinajá is presented in the following descriptions:

1. Very Cragged Karst Mountains

Lands with steep slopes >32% and shallow soils <20 cm deep, representing 80% of the total surface area of the Sierra Chinajá.

2. Cragged Karst Mountains

These lands occupy 10% of the surface area of the Sierra and are characterized by slopes ranging between 16-32% with soil depths between 20-50 cm.

3. Zone of Lightly Undulating Hills

This area is 6 % of the total surface area of the Sierra and is characterized by slopes ranging from 4-8% and soils with depths of >90 cm.

4. Zone of Strongly Undulating Hills

This zone accounts for 2.5% of the total area that is characterized by slopes ranging from 8-16% and soils with depths of 50-90cm.

Soils

A study of the physical properties of the soils of the Sierra Chinajá was undertaken to complement the data gathered in the land use mapping exercise (see Chapter 7). One soil pit of 1 X 1 meters was dug down to parent rock in each of the 21 Whittaker plots established in the forest inventory (see Chapter 5). A total of 5 pits were also dug in each physiographic unit described previously. The depth of the soil to rock was recorded in each one of these samples and was averaged in order to characterize the soil depth within each of the physiographic units of the Sierra Chinajá (Appendix 4).

The soils of the Chinajá are developed over limestone parent rock. According to the FAO-UNESCO system of soil classification, the soils of the Sierra Chinajá are considered Ferric Luvisoles. The USDA equivalent is the Ultisol, which is characterized by the presence of a clay pan. These soils belong to the Tamahu series according to the Guatemalan national system of soil classification and are characterized by an impermeable argilic horizon due to high clay content. The soils are generally dark brown friable loamy clays that range from ~5cm to ~90cm of depth. The high degree of leaching and oxidation is evident in their red oxide color. According to Alvarado et al (1998) these soils are slightly alkaline ranging from pH 6.5-7.3 and have low Phosphorous (P) and Potassium (K) levels that limit productivity.

Slope

A topographic map was used to preliminarily define the range of slope in each physiographic unit. Measurements in each of the 21 Whittaker plots and in all the physiographic units (Table 1) were later made in the field with a clinometer. Results are summarized in a map of slopes (Appendix 5).

Due to the steep craggy slopes, soil erosion is a serious problem in this area. The intense rainfall, steep slopes, and impermeable clay horizon makes bare soil highly susceptible to erosion. The fissures and conduits in the highly folded and faulted limestone rock also results in water and soil loss to subterranean reservoirs. Soil loss is a major constraint to agricultural development in this area and slope is a primary factor in determining the suitability of land use (INAB, 2000, INFUEP, 1984).

Land Use Capacity

The average soil depth and percent slope was summarized on a physiographic unit basis and used to derive a map of land use capacity (Appendix 6). This methodology was adapted from the protocol designed by the National Forest Institute of Guatemala (INAB, 2000), which classifies land according to production capacity. The land use capacity categories are self-explanatory and present a spectrum from extensive to intensive land uses. These uses are based on biophysical limitations to sustainable production. Under this system, the majority of lands of the Sierra (80%) are considered suitable for forest protection and management, while the rest of the Sierra is suitable for agroforestry systems or limited agriculture. Current agricultural plots within the

Sierra Chinajá do not coincide with these guidelines. This incongruity highlights the unsustainable development of current land uses.

Hydrology

The Sierra Chinajá is split into two drainage systems. The eastern half contributes to the much larger Salinas river drainage and the western half is part of the Passion River watershed (IIA, 2004). Both are part of the much larger Usumacinta watershed which drains much of lowland Mesoamerica and ends in the Gulf of Mexico (IIA, 2004).

The hydrology of Sierra Chinajá is characterized by subterranean aquifers and temporal rivers and springs. The lack of a major body of water within the interior or immediately adjacent areas of the Sierra is further evidence of the subterranean watersheds. The Sierra is bordered on the south by the River Tzululsechaj and the River Chaquirocjá, the headwaters of the San Pablo River. Both of these rivers originate from large cave openings at the base of the mountains. Numerous ephemeral streams (locally known as "arroyos") are found on the northern side of the mountains, but they yield little water. The most significant of these are Arroyo Chinajá and Quebrada Raxrujá. There also are other small ephemeral rivers and springs within the mountains. This includes a three hectare wetland area on the southeastern corner of the range as well as a small river in the perched valley of the community of Tzulul Qeqchi. During the rainy season many small springs run, but limited water during the dry season constrains development in the region.

Life Zones

According to the Holdridge system, which is still commonly used in Guatemala to classify habitat based on annual precipitation and temperature; the region is characterized by hot, subtropical, humid forest (Barrios,1995 and De la Cruz,). Though there are many ways to characterize ecosystems, this system provides a useful, albeit at times flawed, but universal standard. Key climatic variables according to INSIVUMEH (Institute for Seismology, Vulcanology, and Meterology) at the closest weather station in San Augustin Chixoy are summarized in Table 2 and Figures 2 and 3:

Table 2 Climatic variables of Sierra de Chinajá, Annual averages from 1990 to 1998. San Agustín Station at 140 m Source: INSIVUMEH

Temp. Med °C	Temp. Max-Min °C	HumR* Med**	Hum Max.-Min**.	Insolation*** Hours	PPT mm
26.3	31.1-19.4	83%	95 – 63 %	159	2252

* Annual average Relative Humidity
** Annual average from 1990 to 1993
*** Average from 1990-1992

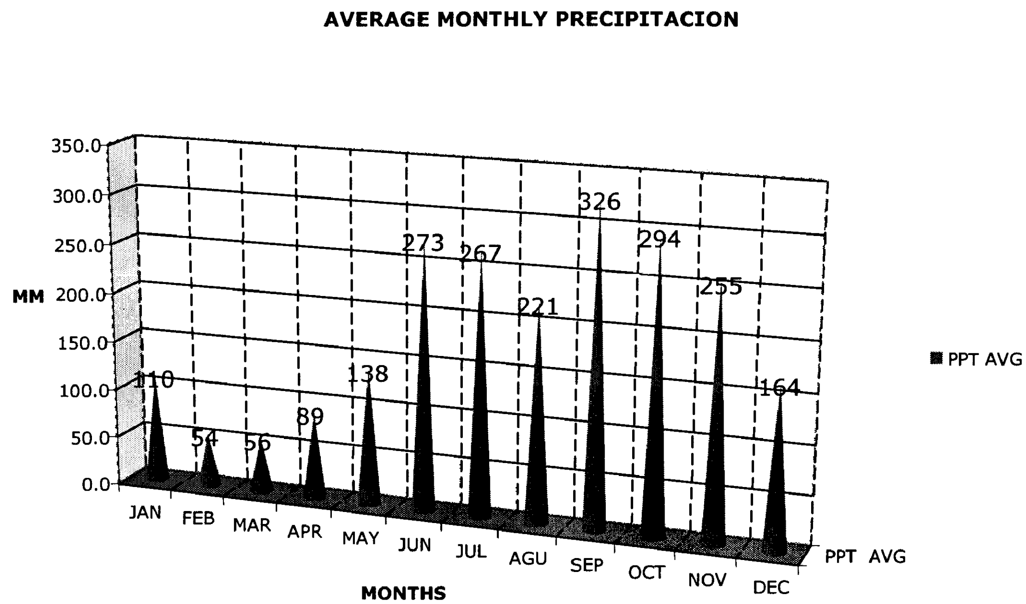


Figure 2 Monthly Precipitacion Monthly averages from 1990 to 1998, Station San Agustín, Source: INSIVUMEH

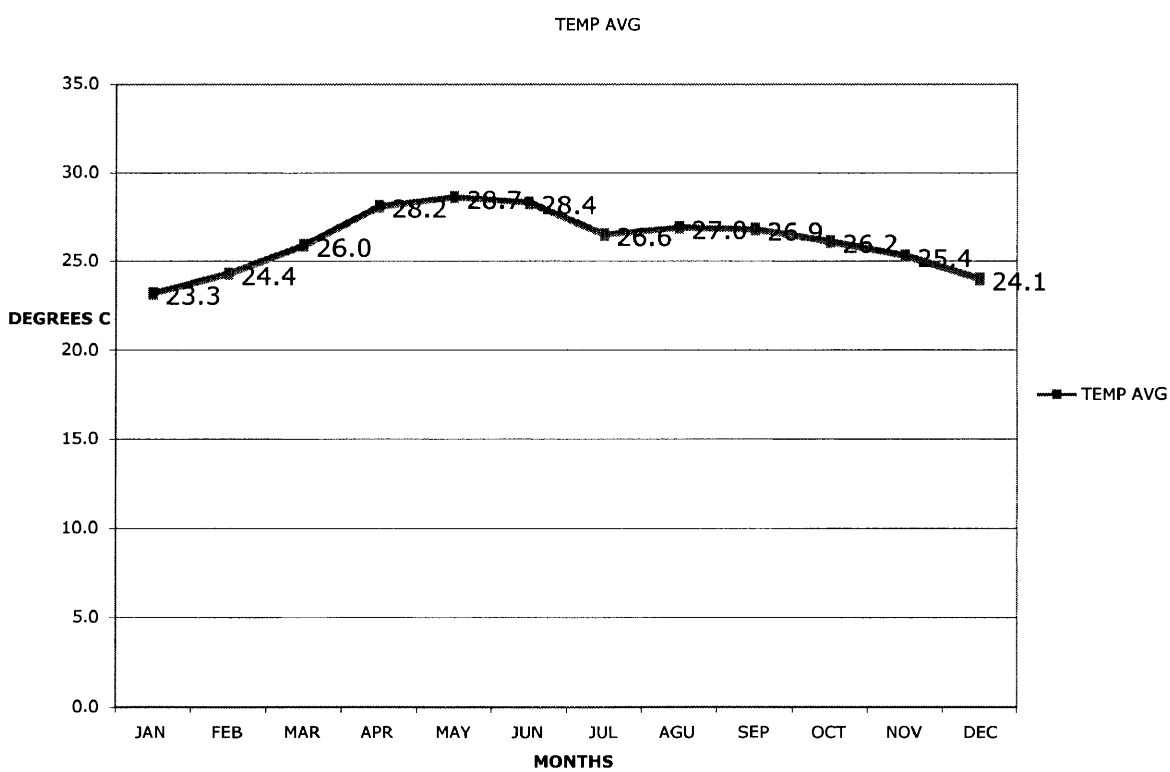


Figure 3 Average Temperature Monthly averages from 1990 to 1998. Station San Agustín, Source: INSIVUMEH

Access

The Sierra Chinajá is accessed from Guatemala City by taking highway CA-9N to El Rancho, Progresso. From there national highway No. 5 is taken to the city of Cobán, Alta Verapaz. From Cobán the recently asphalted highway to Chisec is taken and after Chisec the FTN road is found. From here depending on one's destination the FTN can be taken west toward Ixcan or east to the crossroads with Sayaxche. Taking the highway north to Sayaxche one can enter the Sierra by unpaved roads leading to the south or can park at the side of the highway to enter adjacent areas. The Sierra can be circumnavigated by roads that lead between the many small towns (Yalmachac, El Sauce, Yalicaar, Linterna II, El Eden) that lie at the edge of the roads. By traveling these roads one passes through southern Peten and returns to Alta Verapaz. It is thus possible to enter the Sierra from any angle although some areas are more accessible than others. Those areas of easiest access include the communities which have adjacency to highways including: Tzulul Qeqchi, Belen, Nueva Palestina, Mucbilhal l, Nuevo Cerro Lindo, Nueva Chinaja, Nueva Esperanza, and Valle Verde.

Chapter 4. Fauna of the Sierra Chinajá

A number of taxonomic groups were surveyed in this preliminary assessment, specifically: birds, dung beetles, bats, reptiles, and amphibians. The survey revealed 128 bird species, 24 reptile species, 15 amphibian species, 25 bat species, and 20 dung beetle species. The sampling methods used and survey results are reviewed by taxonomic group.

Avifauna (Birds)

From June to September 2005 observations were made of the resident avian communities in the Sierra Chinajá to generate a preliminary list of species richness. This was accomplished through the use of Point Count methodology and the use of mist nets (USFS, 2002). The point counts were located along trails and roads in three communities (Nueva Esperanza, Tzulul Qeqchi, and Mucbilha II). Two Point Count transects were established in each community and were surveyed at 10 points. Each point was separated by 250m and 10 minutes was spent at each point to identify birds present whether through audio or visual means. All transects were begun at 5:30am, at approximately the time of sunrise, and ended no later than 10:00am.

In addition, six mist nets, 7 x 2 m were used to sample the understory avian community in 26-29 June and 19-25 September. This method was also effective for sampling hummingbirds (Trochilidae).

At Tzulul Qeqchi (700 m), a diverse community of hummingbirds was found that included these seven species: *Amazilia candida, Amazilia tzacatl,* *Phaethornis superciliosus, Phaethornis longumareus, Campylopteris curvipennis, Eupherusa eximia, and Phaeocroa cuvierrii.* Although the mist netting was carried out in a non-systematic manner, it suggests potentially high diversity in all sites. The Point Count data was random and systematic allowing for comparisons across sites. Based on the number of species and number of endemic species, Tzulul Qeqchi was the most important site (Table 3). The species center of abundance refers to the elevational range at which a particular species is most abundant (Stotz et al., 1996). This site also exhibits the greatest number of montane species. This is most likely due to the fact that this site occupies the highest parts of the Sierra and has maintained a large degree of forest integrity.

Table 3. Comparison of Avian Species Distribution across Sites for Point Count Data only

Site	Species Richness	Endemic Species*	Center of Abundance #Species>LT**
Nueva Esperanza	46	6	3
Tzulul Qeqchi	57	7	8
Mucbilha II	32	4	2
Total Point Counts	86	10	9
Total Gross	128	15	16

*species with ranges limited to the South Eastern Atlantic Forests (Howell and Webb, 1995).
** species with centers of abundance at elevations greater than 500m (according Stotz et. al. 1996)

The methods recorded 128 species; 86 through Point Counts, and 42 through mist nets and other non-systematic advantageous sightings (Appendix 7, 8).

The majority of species in the Sierra Chinajá are characteristic of the tropical lowlands of the Peten as evidenced by individuals typical of lowland families such as Furnariidae, Formicariidae, Cotingidae, Thraupinae (Stotz et al, 1996, Howell and Webb, 1995). Nevertheless, 16 species were characteristic of upland tropical forest avian communities. This likely reflects changes in habitat type due to the orographic uplift in this isolated mountain chain. In isolated tropical mountain masses ecological zones are often compressed resulting in the distribution of high montane species at lower elevations (Whitmore, 1998). This uplift has in essence isolated these 16 montane species as if they were on an island. It also represents the northern most distribution of many species and may be cause to change the known elevational distributions of several species. The beautifully distinct song of the Slate colored Solitaire, *Myadestes unicolor*, is just one of the signs of the uniquely montane nature of this isolated mountain remnant.

Six migratory species were recorded and more are expected to be using the area as a wintering ground. Among those recorded were: Streaked Flycatcher, Northern Waterthrush, Black-and-white Warbler, Kentucky Warbler, Canadian Warbler, and Baltimore Oriole. More research into the seasonal movements and viability of local populations should be undertaken to assess the importance of the Sierra Chinajá for Neotropical migrants.

It is worth mentioning that local residents recognized the horn-billed guan from illustrations presented to them and claimed it is distributed in the highest parts of the mountains. Similar results were recorded by Jolon (1999) in nearby Candelaria Caves National Park. Additional bird surveys should explore these claims and other uncertainties.

Entomofauna (Dung beetles)

Dung beetles from the family Scarabinae are considered good ecological indicators because they are commonly found in distinct assemblages that have specific biogeographical distributions (E.Cano, Entomologist, Laboratory of Entomology, Universidad del Valle, pers. com., Halffter and Fávila, 1997). Dung beetles are also easily sampled through the use of baited pitfall traps. Their ubiquitous, highly speciose nature as a group is also a reason which makes them good subjects for biodiversity study. In each study site two randomly placed transects were located along foot trails. Each transect was 200m long and had pitfall traps consisting of a 16 oz. plastic container (11cm tall x 11cm diameter at the opening) placed every 20m. The traps were dug into the ground, baited with dirt and horse dung, and partially covered with a lid that had a wedge, about ¼ of the surface area, removed, to allow entry, but to complicate exit of any individual lured into the trap. In order to avoid confusion, flagging tape was used to mark the location of the traps. Traps were left for 24hrs and generally recollected at about 9am.

The Dung beetles sampled (Table 4) suggests that the Sierra Chinajá is an ecotone or area of transition between two biogeographic areas: The Highlands of Coban and the The Lowlands of the Peten. The presence of *Copris laeviceps* and *Copris nubilosus* suggest that Sierra Chinajá is an ecotone because these species are characteristic of distinct habitats. *Copris nubilosus* is a new species described in 2003 (Kohlmann, Cano y Delgado, 2003) and until now was only reported from cloud forests between 1350-1800 m, in the Sierra

Cuchumatanes and Sierra de las Minas. The species epithet "nubilosus" refers to the exclusive distribution of this species in cloud forests (nube=cloud). *Copris laeviceps* is a characteristic lowland dung beetle recorded from sites in the Atlantic lowland forests of Izabal as well as the Péten Plateau to the north (Kohlmann, Cano y Delgado, 2003).

Table 4. Dung beeltles (Scarabaeinae) of Sierra Chinajá

	ELEVATION (meters above sea level) / Site			Relative Abundance
	N			
SCIENTIFIC NAME	382 / Mucbilha II	400 / Nueva Esperanza	750 / Tzulul Qeqchi	
Copris laeviceps	9	31	30	37.04
Bdeliropsis bowditchi	50	4		28.57
Dichotomius satanas	1	8	6	7.94
Ateuchus sp.			8	4.23
Eurysternus angustulus	8			4.23
Deltochilum bowditchi			6	3.17
Dichotomius agenor	3	3		3.17
Canthydium nueva sp.		3		1.59
Copris nubilosus			3	1.59
Uroxys boneti		3		1.59
Ontherus mexicanus			2	1.06
Onthophagus sp.1	2			1.06
Uroxys micro	2			1.06
Canthon montanus			1	.53
Deltochilum pseudoparile			1	.53
Eurysternus caribaeus			1	.53
Onthophagus nueva sp.	1			.53
Onthophagus sp.2	1			.53
Onthophagus sp.3	1			.53
Phanaeus endymium		1		.53
Total	78	53	58	n=189

Also, two new species of the genera *Canthydium* and *Onthophagus* were found as well as at least one new species of Passalid bettle (Passalidae) (Schuster, Director, Laboratory of Entomology, Universidad del Valle, pers. com.). Thus the Sierra Chinajá may already have given rise to speciation and raises the question, to what extent the Sierra has served as a refuge through epochs of geologic and climate change.

Chiroptera (Bats)

Three distinct habitats were selected and sampled during 7 days of nocturnal mist netting from Sept.19-25. The trapping configuration consisted of five mist nets each 12m long and 1 harp trap. These nets were opened shortly after sunset (6:30pm) and closed 4 hours later (11:00pm), so as to be operable during peak bat feeding activity. Immediately after each capture the identification and reproductive condition was determined using commonly used guides for Mesoamerica (Medellín et al., 1997, Reid, 1997). Each animal was released and the time of capture was noted.

Twenty-five species were recorded, *Carollia sowelli* being the most abundant (Appendix 9). The composition of the bat community of the Sierra Chinajá is similar to that of the bat communities of the Atlantic lowlands. Despite the majority of these species being of lowland affinity, several species were characteristic of highland bat communities. *Dermanura tolteca* is a species that commonly inhabits mountains of medium elevation. At higher elevations in the cooler mountains it is often replaced by *Dermanura azteca* (S. Peréz, Director of Vertebrate Collections, University of San Carlos Museum of Natural History, pers.com.). This pattern was also observed in Sierra Chinaja as well.

D. tolteca shares the Sierra with two other species from the genus *Dermanura*, both of which are characteristic of the lowlands *D.phaeotis* and

D.watsoni. This may suggest a relatively complex system of niche partitioning worthy of further study.

Another indicator that Chinajá consists of elements of mountains of medium elevation is the presence of *Sturnira ludovici*. This species, representative of medium sized mountains was found sympatrically with *S. lilium*, the sister species more typical of the lowlands (Perez et. al, 2005).

It appears that other bat species characteristic of the highlands are absent, as all the other bats are typical of hot, humid lowland climates. Nevertheless, this is only a preliminary look at the bat communities of the Sierra Chinajá; additional surveys are required to fully understand this complex and speciose group. Appendix 9 summarizes the the bats observed in Mucbilha II, Tzulul Queqchi and Nueva Chinajá. The last two sites represent the highest and most well conserved forests of the Sierra, and the species richness at these sites is considerably higher. The presence of several unique species such as, *Mimon cozumelae*, *Trachops cirrhosus* (frog-eating bat), and *Tonatia saurophila*, which are restricted to well developed mature lowland forests, is also an indicator of the healthy state of forests there (Fenton et al, 1992). Due to their habitat specificity, these species have been proposed as ecological indicators. (Fenton et al., 1992)

It is important to mention that *Diphylla ecaudata*, a species of vampire bat, is an uncommon species because it feeds on the blood of other animals (Uieda, 1992). It is believed that it prefers the blood of birds because, unlike *Desmodus rotundus*, which is a common bovine and farm animal parasite, it lacks the ability to walk on ground (Uieda, 1992).

In Mucbilha II the presence of vampire bat species, and the common widespread species *Sturnira lilium* underscores the degree of environmental perturbation that is evident. These species are commonly associated with zones of forest regeneration or areas that have been managed for agriculture (Fenton et al, 1992). Thus it is not surprising to find these species as well as *D. rotundus*, often associated with ranching, occurring sympatrically.

Herpetofauna (Amphibians and Reptiles)

The amphibian and reptile community was sampled in one week between 19-25 September. Two sites were surveyed, Mucbilha II at 300 m and Nueva Chinajá at 615 m, representing lower and upper elevational forest communities, respectively. Sites were surveyed through nonsystematic diurnal and nocturnal walks in forest patches and along foot trails. Twenty-four reptile species and 15 amphibian species were observed (see tables 5 and 6).

The majority of the Sierra Chinajá is generally below 600 m, thus the predominant herpetofaunal species are widely distributed in the Carribean lowlands of Mesoamerica. The species diversity of amphibians is constant from elevations of 0 – 1,500 m; above this level it decreases steadily (Campbell and Vannini, 1989). The number of species of reptile and amphibian species reportedly increases between 1,200-1,700 m, possibly due to the overlap in the vertical distribution of lowland and highland habitats (Campbell and Vaninini, 1989). The herpetofaunal communities in the Sierra Chinaja could be a reflection of not only the relatively high number of medium-elevation restricted endemic species, but also the diversity of habitats found at these zones of transition between lowlands and highlands.

Table 5. Reptiles of Sierra Chinajá, Sept. 2005. CONAP Red List: 1= Almost extinct, 2= Endangered, 3= Special management; CITES Apendices: I= in danger of extinction, II= Potentially in danger.

Scientific Name	Location			CONAP Red List, CITES Apendices
	Mucbilha II	Nueva Chinajá	Total	
Ameiva festiva		5	5	
Ameiva undulata	4		4	
Atropoides nummifer		3	3	3
Basiliscus vitattus	1		1	3
Boa constrictor		1	1	3, II
Bothriechis schlegelii		1	1	3
Coniophanes fissidens	1		1	3
Dryadophis melanolomus		1	1	
Drymobius margaritiferus		1	1	
Eumeces sumicrasti		1	1	3
Eumeces schwartzei		1	1	3
Imantodes cenchoa	2	2	4	
Leptodeira septentrionalis		1	1	
Leptophis aheatulla	1		1	
Ninia sebae		2	2	
Norops biporcatus		3	3	
Norops capito		1	1	3
Norops uniformis	7	4	11	3
Pliocercus elapoides	1		1	
Rhadinaea decorata		1	1	3
Sceloporus teapensis		4	4	
Sibon sanniola	2		2	3
Sphenomorphus cherriei		3	3	
Xenodon rabdocephalus	2		2	3
Total	21	35	56	
Total Species Richness	n= 9 sp.	n= 17 sp.	n=24sp.	

A more intensive study is needed to determine the degree of endemism in the Sierra Chinajá. For example, the presence of *Agalychnis moreletii* and *Eleutherodactylus xucanebi* could be evidence of endemicity in the Sierra. According to Campbell and Vannini (1989) *A. moreletii* and *E. xucanebi* range between 500-1500 m. Thus, biogeographic isolation could be occurring in the Sierra since it is an island of montane habitat surrounded by lowland forest habitat unlikely to support these species.

The forests of the Sierra Chinajá provide habitat for many species dependent upon mature forests. The need for high humidity and microhabitat niches (ie. tank bromeliads, deep leaf litter) characteristic of mature forest limit the distributional range of amphibian species, particularly tree and leaf frogs, to forest habitat (C. Vasquez, herpetologist, Museum of Natural History, University of San Carlos). Amphibians are sensitive to habitat alteration and degradation due to climate change (Young et al., 2001). Therefore these species may serve as ecological indicators (Pearman, 1997). Furthermore, some amphians are confined to a home range near their place of birth and therefore can be good indicator of local site conditions (Campbell and Vannini, 1989).

The herpetofaunal region of the Peten is characterized by species of wide distribution, distributed over a large geographic space (Lee, 2000). The possibility that these species represent an ecological complex of subpopulations unique to the Sierra Chinajá could be investigated by DNA testing. The genetic fragmentation of geographically disperse populations is a common phenomenon with amphibians. Low dispersal capacity and fidelity to home ranges leads to specialization and population isolation (Parra-Olea, et al 2004).

A total of 29 species of amphibians and reptiles were collected in this study. This is likely to be only a fraction of the total herpetofaunal diversity in the area. The overlap of the highlands of the Verapaces and the northern lowlands of the Peten make this an area of high biological diversity that warrants further study to better understand its importance biogeographically.

Table 6. Amphibians of Sierra Chinajá. Sept. 2005. CONAP Red List: 1= Almost extinct, 2= Endangered, 3= Special Management; CITES Apendices: I= in danger of extinction, II= Potentially in danger.

Scientific Name	Location			CONAP Red List, CITES Appendices
	Mucbilha II	Nueva Chinajá	Grand Total	
Agalychnis callidryas		1	1	
Agalychnis morelleti		1	1	
Bufo valliceps	17	3	20	
Eleutherodactylus alfredi		1		2
Eleutherodactylus chac		3	3	3
Eleutherodactylus laticeps		2	2	3
Eleutherodactylus psephosypharus		4	4	3
Eleutherodactylus xucanebi		6	6	3
Hyla microcephala		2	2	
Leptodactylus labialis	1		1	
Leptodactylus melanonotus	2		2	
Rana berlandieri	1		1	
Rana vaillanti	1		1	
Smilisca baudini	3	3	6	
Total	25	26	51	
Species Richness	N= 7 sp.	n= 10 sp.	n= 15 sp.	

Threatened and Endangered Species

The Sierra Chinajá is habitat for at least 35 species found on the Red List of the Guatemalan Council of Protected Areas (CONAP) and the Appendices of the Convention on Internacional Trade in Endangered Species (CITES) (Table 7). Although no direct observations of felines were made through the course of this study, the Sierra Chinajá likely provides habitat for several of the lesser felines including: Jaguarundi, *Herpailurus yaguaroundi*, Ocelot, *Leopardus* *pardalis* and Margay, *Leopardus wiedii*. These species are of special interest because of the trade in pelts (CONAP 2001). The presence of Jaguar, *Pantera onca* and Mountain Lion, *Felis concolor*, has been reported by local residents, but it is doubtful the Sierra is sufficiently large to sustain viable populations of these large cats. It is possible, however, that Sierra Chinajá provides ecological linkage between Laguna Lachuá National Park and the Community Conservation Corredor (Tzuul Taqa) (see Appendix 10). It is also likely that Jaguar and other feline species use this area as part of their home ranges or areas of juvenile dispersal.

Two ungulate species, Brocket deer, *Masama americana* and White-tailed deer, *Odocoileus virginianus*, were said to reside in the area according to local residents. Red brocket deer (*M. americana*) were seen in the field and it is assumed that small numbers of White-tailed deer (*O. viginianus*) also persist in remote parts of the Sierra. However, the population levels of both species are likely to be stressed by local hunters. The same can be said for the two species of Peccary that are said to occur according to local residents. Neither Collared peccary, (*Tayassu tajacu*) nor White-lipped peccary, (*Dycotyles pecari*) were observed.

Table 7. Total list of fauna on the CONAP Red List and the CITES Appendices. CONAP Red List: 1= Almost extinct, 2= Endangered, 3= Special management; CITES Appendices: I= in danger of extinction, II= Potentially in danger.

Scientifc Name	Family	CONAP Red List, CITES Appendices
Allouata paliata	Cebidae	2, I
Ateles geoffroyi	Cebidae	2,II
Atropoides nummifer	Viperidae	3
Basiliscus vitattus	Corytophanidae	3
Boa constrictor	Boidae	3,II
Bothriechis schlegelii	Viperidae	3
Coniophanes fissidens	Colubridae	3
Eumeces sumicrasti	Scincidae	3
Eumeces schwartzei	Scincidae	3
Norops capito	Polichrotidae	3
Norops uniformis	Polichrotidae	3
Rhadinaea decorate	Colubridae	3
Xenodon rabdocephalus	Colubridae	3
Eleutherodactylus alfredi	Leptodactylidae	2
Eleutherodactylus chac	Leptodactylidae	3
Eleutherodactylus laticeps	Leptodactylidae	3
Eleutherodactylus psephosypharus	Leptodactylidae	3
Eleutherodactylus xucanebi	Leptodactylidae	3
Amazilia candida	Trochilidae	3,II
Amazilia tzacatl	Trochilidae	3,II
Amazona autumnales	Pstacidae	3,II
Campylopterus curvipenis	Trochilidae	3,II
Crypturellus boucardi	Tinamidae	3
Eupherusa e.eximia	Trochilidae	3,II
Falco rufigularis	Falconidae	3,II
Leucopternis albicollis	Acciptridae	3,II
Phaethornis superciliosus	Trochilidae	3,II
Pteroglossus torquatus	Ramphastidae	3
Pygmornis longemareus	Trochilidae	3,II
Ramphastos sulfuratus	Ramphastidae	3,II
Agouti paca	Agoutidae	3
Masama sp.	Cervidae	3,III
Odocoileus virginianus	Cervidae	3,III
Tayassu tajacu	Tayassuidae	3
Dycotyles pecari	Tayassuidae	3,II

CONCLUSION (Biogeographic Importance of Sierra Chinajá)

The Sierra Chinajá illustrates an important ecological principal about the permeability of ecological boundaries and its effect on species distribution. The ecotone or zone of transition from predominantly tropical lowlands to a mix of montane environments is an enigma, and remains poorly understood by ecologists (Whitmore, 1998). In the Sierra Chinajá, species assemblages change as one penetrates the interior of the mountain massif. The change in distributions between lowland and highland communities creates regions with habitat suitable for both lowland and highland species. Instead of increased competition leading to the exclusion of certain species, this data suggests that increased biodiversity results. This balance of species ranges and distributions is not only important for biodiversity conservation, but it might be particularly sensitive to shifting climate conditions. It is also possible that the highland forest species observed in the forests of Sierra Chinajá are isolated remnants that are in the process of speciation and the development of "new" endemism.

It is apparent that some characteristic highland species are distributed at the upper elevational sites (>600m) of Tzulul Qeqchi and Nueva Chinajá. These areas of lowland and highland faunal community overlap are of primary conservation importance. The presence of 16 avian species suggests a highland affinity of the avian community at upper elevational sites. Not only in birds is this pattern evident, but also with dung beetles where *Copris nubilosus*, a species previously reported in Alta Verapaz only from Purulha, a cloud forest habitat at approximately (1,200m). The presence of this species in Sierra Chinajá is not only a new record, but also suggests the ecological importance of this unique mountain chain. The same is true for the Chiropterans, sucha as *Dermanura tolteca* and *Sturnira ludovici*, typical inhabitants of upland forests (Perez et al., 2005). The records of the leaf frog, *Agalychnis moreletii*, and *Eleutherodactylus xucanebi* is additional evidence of the highland nature of the faunal communities of Sierra Chinajá.

All these species are reportedly found only above 500m thus restricted to habitat that corresponds to less than 30% of the area of Sierra Chinajá. It may be however that habitat zones are compressed according to the Massenerhebung effect and suitable habitat may be available at lower elevations. It is noteworthy that although these species exist in an isolated highland community in a sea of lowland ecosystems, they persisted since the mountainous areas of the Sierra Chama to the south were connected habitats. This would suggest that speciation has been occurring for some time now due to the isolation of these specialized montane communities, and existence of endemic species. It also suggests that some highland species may be able to migrate through or seasonally occupy lowland habitat while some lowland species can utilize highland habitat. The study of the degree of 'permeability' or ability of species to freely pass from one side to the other of this ecotone warrants further study and could contribute discoveries in biogeographic theory.

This faunal survey underscores the importance of the Sierra Chinajá as a "mountainous island" where biogeographic speciation may be occurring and as an ecotone between the Verapaz highlands and Péten lowlands. The upper elevational range of the Sierra Chinajá, where many of these interactions occur, occupies very little area. Consequently, forest conservation of the highest slopes of the Sierra Chinajá should be made a top priority.

Chapter 5. Flora of Sierra Chinajá

From June to September 2005 vegetation sampling was carried out throughout the Sierra Chinajá. These months are the rainiest part of the year when few species are flowering. Unfortunately, the grant and project schedule did not correspond to more favorable seasonal plant phenology and collecting times. Nonetheless, at any one time many species in the tropical forest are in flower. Thus collection is possible throughout the year with peak flowering occurring from Feb - May and Nov - Dec. (A. de McVean, ethnobotanist at Universidad del Valle, pers. com.) Three primary sites of study were selected and systematically sampled around the communities of Mucbilha II, Tzulul Qeqchi, and Nueva Esperanza. Other sub sites were sampled non-systematically as opportunity arose. Thus, two methods were used to assess the flora: one systematic, the other non systematic.

The composition of the forest cover of the Sierra Chinajá was preliminarily inventoried through a system of randomly located transects, with Whittaker parcels of 20 x 50 meters established every 500m (Comiskey et al., 1999). In total, 21 parcels were established to assess the diversity and abundance of mature forest systems at upper elevations (400+ m). In every parcel, the identification, height, form, and diameter at breast height (DBH) of all trees greater than 10cm DBH were recorded. These parameters were analyzed to estimate species frequency, density, basal area, and volume on a per hectare basis. A 5 x 5 m sub-parcel was established in every parcel and all individuals of three dominant species of xate (*Chamadorea spp.*), an ornamental palm of economic value, were counted.

The sub canopy, herbaceous, and epiphytic plant species were sampled non-systematically through a series of non-random transects in various habitats at different sites across the Sierra Chinajá. All flowering and fruiting species were collected, catalogued, preserved, identified and deposited in the Herbarium at the University of San Carlos and the National Museum of Natural History in Guatemala City. Unknown species, encountered in the forest inventory, were collected whether they did or did not possess reproductive structures. Many epiphytes, especially orchids and bromeliads, were identified in the field by experts and samples were only taken when they filled gaps in existing collection material at national herbaria.

Preliminary Forest Inventory

Sample sites were selected based on accessibility, presence of primary forest, and elevation so that the greatest amount of distinct habitats could be sampled. The communities and adjacent zones included in this sampling effort were Mucbilha II, Tzulul Qeqchi, Nueva Esperanza, Sesaltul, and Seraxtzucl (figure 4)

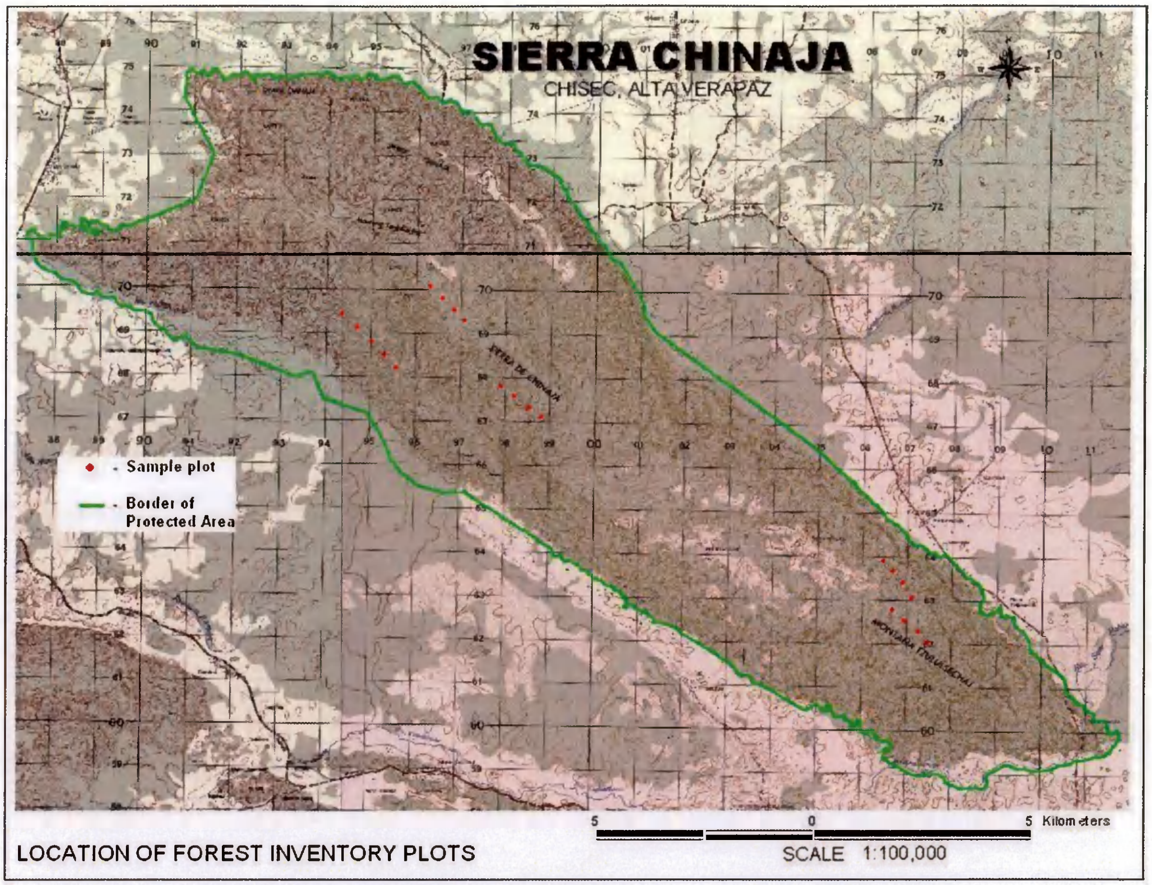


Figure 4. Location of forest inventory plots in the Sierra Chinajá

Forest composition

In the forest inventory, 72 species of trees were recorded of which 65 were identified (Appendix 11). The most important species observed in this preliminary analysis were: *Terminalia amazonia, Bursera simaruba, Manilkara zapota, Pouteria amygdalina, Blomia pisca, Pouteria sp., Psidium sartorianum, Desmopsis stenopetala, Pseudobombax ellipticum, Lonchocarpus guatemalensis.*

An importance value for each species was calculated based on the frequency, density, and basal area per Orellana et al. (2001).

$$Dr + Fr + BAr = IV$$

Dr=Relative Density
Fr=Relative Frequency
BAr= Relative Basal Area
IV=Importance Value

Appendix 12 summarizes the more important structural elements of the forest based on this formula. Because of limitations inherent in any rapid assessment of biodiversity, it is important to incorporate vegetation descriptions by previous botanists working in the area.

According to Miranda (1952) the Sierra Chinajá ecosystem could fall under the biogeographic region of Chiapas, Mexico known as Tall Evergreen Jungle (Selva Alta Perennifolia). There is floristic similarity between the Sierra Chinajá ecoregion and the Eastern Highlands of Southern Mexico, which is formed by mountains ranging from 200-1500 m (Veliz, botanist and Director of University of San Carlos BIGU Herbarium, pers.com.).

According Breedlove (1973), the vegetative associations in the Sierra Chinajá are continuous with those of the Peten and both regions share endemic species. Based on this floristic similarity and following Breedlove's system of vegetational formation, it is posible that the Sierra Chinajá is comprised of Low Montane Tropical Rainforest with elements of Lowland Tropical Rainforest. (Miranda 1952, 1963; Gómez Pompa, 1965, Breedlove, 1981)

The Low Montane Rainforest described by Breedlove (1973) is common in the majority of mountains of the Eastern Higlands of Chiapas. This formation is structurally similar to Tropical Rainforest, but lacks the third (tallest) level of forest trees that extend up to 50-60 m in height. The tallest stratum of trees in the

Sierra Chinajá is composed of individuals only 25-45 m in height. This stunted growth is likely caused by the presence of shallow rocky soils and steep slopes, characteristic of the karstic terrain. The understory is largely composed of dense, spiny thickets of palms and cycads.

The species most commonly reported by Breedlove (1968) for Tropical Rainforests are: *Aspidosperma megalocarpon, Brosimum alicastrum, Dialum guianense, Erblichia xylocarpa, Guatteria anomala, Manilkara achras, Poulsenia armata, Swietenia macrophylla, Terminalia amazonia*. The most abundant trees of the subcanopy are: *Alchornea latifolia, Alibertia edulis, Belotia cambellii, Bumelia perimilis, Bursera simaruba, Cassia grandis, Blepharidium mexicanum, Gaurea excelsa, Hasseltia dioica, Licaria peckii, Orthion subsessile, Phitecelobium arboreum, Quararibea funebris, Sickingia salvadorensis, Wimmeria bartletii, Zuelania guidonia*.

The species reported by Breedlove for Low Montane Rainforest are: *Belotia mexicana, Callophyllum brasiliense, Chaetoptelea (Ulmus) mexicana, Licania platypus, Nectandra sinuata, Ocotea rubriflora, Quercus oleoides, Quercus skinneri, Sebastiana longicuspis, Talauma mexicana,* and *Vochysia hondurensis*. Common subcanopy tree species of Lowland Rainforest include: *Chrysophyllum mexicanum, Cleidion oblongifolium, Cymbopetalum penduliflorum, Faramea occidentalis, Pseudolmedia spuria, Sloanea terniflora, Stemmadenia donnell-smithii*, and *Trophis racemosa*. Many of these species listed for Chiapas are also recorded in the preliminary forest inventory of the Sierra Chinajá presented in Appendix 11 and 12. The florisitic similarity between the Sierra Chinajá and the mountains of southern Chiapas suggests they may share other biological elements as well.

The Chinajá ecosystem also has elements of upland forest developed over limestone rock similar to that found in the Maya Mountains of Belize. (Meerman, 1997). Species shared between these areas include: *Terminalia amazonia, Chamaedorea tepejilote, Calophyllum brasiliense, Vochysia hondurensis, Stemmadenia donnel-smithii, Protium copal, Nectandra spp., Trichilia moschata, Pouteria campechiana, Coccoloba tuerckheimii,* and *Alseis yucatanensis.*

The species composition of Sierra Chinajá forests is somewhat homogenous, as no group or species seems to be range restricted or dominant in a particular area. However, it is important to point out several other distinct vegetation formations. These formations warrant further investigation in order to understand factors involved in their formation, distribution, and species composition.

<u>Subtropical semideciduous forest</u>

The forests of Chinajá display characteristics of subtropical semideciduous forests as evidenced by the periodic loss of leaves in various Sapotaceae, Meliaceae, and Bombaceae species. This formation is found on the ridges and portions of the southwestern slopes around Mucbilha II. The presence of this forest type in distinct locales suggests that site specific climatic and edaphic conditions may be important. Detailed studies need to be carried out to determine whether these forests are a reflection of rain shadow effects or site specific drainage patterns. The lack of orographic uplift on a grand scale would seem to discredit a rain shadow effect, but the elevational compression of ecological zones, known as the Massenerheubung effect, could account for this variation (Whitmore, 1998). Because of the large quantity of rain that is received here annually, it is hard to imagine drought conditions play a significant role either. However, despite the abundant quantity of precipitation that the area receives the subterranean drainage system of the underlying soil carries water away rapidly, which can cause a water defecit in some areas during the hottest months. The lack of water holding capacity of these soils and the seasonal distribution of rainfall also play large roles in the formation of this vegetation type.

Dwarf forest

Evidence of the elevational compression described by the Massenerheubung effect is the presence of Dwarf forest in the Sierra Chinajá. Dwarf forests are found on the exposed ridges and peaks of mountains primarily above 600 m elevation. The strong winds, high humidity, frequent storms, and unstable slopes create a dense thicket of epiphytes and stunted trees in this area. The species composition is similar to the contiguous montane forests, but individuals are smaller and more densely branched. Characteristic arboreal species are from the Clusiaceae family especially, *Clusia guatemalensis*, but also *Plumeria rubra*, *Miconia spp.*, and *Oreopanax spp.* An abundance of ferns and epiphytes, such as orchids and bromeliads, is also commonly associated with this vegetation type.

Pine savanna

A pine savanna vegetation association exists in a small region of the major valley adjacent to the southern slopes of Sierra Chinajá. This association forms around the bluffs above the wetlands and seasonally inundated low parts of the Candelaria valley, and is primarily open grassland with patches of trees. Principal tree species include Peten Pine, *Pinus caribaea* and the Corozo or Cohune Palm, *Orbignya cohune*.

Vegetation Stratification and Phenology

Canopy Trees (T)

This stratum consists of the dominant trees of maximum size (ie. height and diameter). Often these trees have well developed buttressed roots and range from 25-45 m in height. The most common trees fruiting or flowering during the 4 month period of collection were from the Tiliaceae, Araliaceae, and Sapotaceae families. This includes 15 genera and more than 20 species. Various individuals of *Oreopanax* and *Dendropanax* were found on steep slopes or in unstable cliff areas. The genera *Luehea*, *Heliocarpus*, and *Trichospermum* of the Tiliaceae family represent fast growing colonizing tree species. While the Sapotaceae family represented by the genera *Manilkara*, *Chrysophylla*, and *Pouteria spp.* are slow growing species characteristic of mature forest. Other important genera represented in this sample were *Clusia*, *Plumeria*, and *Draecaena* species characteristic of the low montane forest ridges.

Subcanopy Trees (B)

The Subcanopy stratum is composed of small trees and bushes between 5-20 m in height. This layer of vegetation is often very dense, especially on steep hillsides. Subcanopy vegetation was less dense on level sites and in the micro valleys between steep karst hills possibly due to lower light levels. As can be seen in Appendix 13, the Subcanopy strata (see profile column, letter B) was dominated by species from the genera *Psychotria* of the Rubiaceae family and the genera *Acalypha* and *Croton* from the Euphobiaceae family. The genera *Miconia*, *Topobea* and *Clidema* of the Melastomataceae family occurred at approximately the same densities. Other interesting species that occur in this stratum are: species of Cacao, *Theobroma spp.* as well as various armed palms (*Astrocaryum mexicanum*, *Crysophila argentea, Chamaedorea spp.*) and cycads (*Zamia spp., Ceratozamia spp.*).

Herbaceous Vegetation (H)

A feature characteristic of all parts of the Sierra is the great variety and abundance of species from the genera *Begonia*. *Begonia*, which consists of at least 6 species, were common in rocky areas or growing in humus in areas of indirect or shaded light and rapid drainage. The family Araceae was also well represented by species in the genus *Anthurium.*

The genus *Chamaedorea* of the Arecaceae family is one of the most diverse palm genera of the neotropics and is most diverse in parts of Guatemala and Costa Rica (Castillo, 1999). Three species in this group are of particular interest for their value as non timber forest products (NTFPs). The abundance of these three species of *Chamaedorea* or Xate, as its known locally, was calculated from sample plot data, (based on the 21 independent 5 x 5 m plots (Table 8).

Table 8. Xate Abundance per Hectare in the Sierra Chinajá

Common Name	Scientific Name	Plants/ Ha.	Relative Density
Hembra	*Chamaedorea elegans*	112	25.9
Cola de pescado	*Chamaedorea ernestii-augustii*	156	36.1
Jade	*Chamaedorea oblongata*	164	37.9
	TOTAL	432	111.9

Observed Xate densities are considerably lower in comparison to studies in the adjacent geographic province of Sayaxche, in the southern Peten (Orellana et al. 2001). However, these numbers are similar to those cited by Ceballos (1995) for sites in the northern Peten. The low density may result from significant pressure exerted by xate collectors on local populations. Nevertheless, xate collection remains a viable economic activity, and requires management to avoid depletion of stocks. While there are many varieties of *Chamaedorea*, it is *Chamaedorea ernestii-augustii*, or the fish tail xate (cola xate) that is of particular economic importance in the Sierra Chinajá.

Epiphytes (E)

Epiphytes include all plants whose habitat obligates them to other species for structural support. Despite the ubiquoutous presence of mosses and liverworts, this study was limited to vascular plants and trachaeophytes, and bryophyte classification was beyond the scope of this investigation. This stratum is largely composed of the Bromeliaceae and Orchidaceae families. Several species of Ferns (*Trachaeophyta*) and Aroids (*Araceae*) were also observed. The abundance and diversity of the epiphytic strata is an important reflection of the degree of disturbance of a vegetative community as well as the relative humidity of the habitat (M.Dix, former Director of Biology Department, Universidad del Valle, pers com). Because of the attractive nature of many epiphytes they are subject to national and international trade. A large number of the species found in the Sierra appear on the CONAP's Red List or in the CITES Appendices. Appendix 14 lists the orchids found in the Sierra Chinaja and their status under federal and international conservation frameworks.

Conclusion

The Sierra Chinajá represents an area of relatively homogeneous low montane forest intermixed with more humid forests in the northeast and more deciduous forests in the southwest. It is a region of extremely high biodiversity (Mittermeier, et al., 1998). The Sierra Chinajá a phytogeographic region that blends the highlands of Alta Verapaz with the lowlands of the Peten. It is structurally and floristically similar to both the limestone mountains to the east in

Belize and to the west in Chiapas, Mexico (Breedlove,1981, Meerman, 1997). Because of the interface between lowland and montane habitats many species that are commonly separated, exist together in the Sierra Chinajá. The suitability of the habitat provided by the Sierra Chinajá to both lowland and highland species, explains the species richness of the area. The biogeographic isolation of this mountain range is another factor that makes this mountainous forest likely habitat for endemic sub populations, which further contributes to the potential species richness of the area.

One notable endemic subpopulation is that of *Ceratozamia robusta* (a member of the cycad family). This neotropical genus is distributed in mountainous parts of Mexico, Belize, and Guatemala (Jones, 1993). This particular species reaches its southern most distribution in Guatemala and perhaps in the Sierra Chinajá (Jones, 1993). It is also a rare and highly sought after ornamental species (The World Conservation Union (IUCN), 2000). The conservation of rare endemics of market value is of principal importance in conservation and land management efforts (CITES, 2000).

The Sierra Chinajá also contains many valuable timber and nontimber forest resources (Salafsky et al., 1993). The exploitation of forest species has a long history in the lowlands of the Peten (Schwartz, 1990). Timber species such as *Swietenia macrophylla* and *Cedrela odorata* have been selectively logged from these areas since colonial times (Snook, 1999). For this reason and the current global market for high value tropical timber, these species are threatened throughout much of their range (Snook, 1999). The Sierra Chinajá provides habitat to many of these well-known non timber forest products such as: chicle (*Manilkara sapota*), all spice (*Pimienta dioica*), xate (*Chamaedorea spp.*), Ramon (*Brosimium alicastrum*), Sarsaparilla (*Smilax sp.*), and medicinal plants. The high value of non timber forest products in this region is reason to assess development and conservation plans that take advantage of these species.

This preliminary investigation provides just a glimpse into the floristic diversity of the Sierra Chinajá. The region may contain as many as 4,000 plant species (Martinez et al. 1994). This wealth of biodiversity has both global, "existence value", and local "use value". The local value and importance of these and other species is considered in the following section.

PART III Conservation

Chapter 6. Socioeconomic Characterization

Uncontrolled human settlement in the Sierra Chinajá has led to widespread occupation of the edges (ie. the small areas of adjacent valley) of this landscape. Recently, newly arrived communities have migrated to the interior lands of the Sierra. This fact has drawn the attention of government, conservation, and human rights groups because of the conflicts that arise due to public policies regarding encroachment of agriculture on protected areas lands. The role of human settlement is central to forest conservation in the Sierra Chinajá.

To understand the pressure that local people exert on natural resources and the ways in which they utilize resources of the Sierra Chinajá a socioeconomic study of the 9 oldest communities was carried out in June 2005. Due to financial, political, and time constraints it was not possible to survey households in newly arrived communities (age 17 years or less). Therefore, the data reflect the household conditions and resource use by established communities only. This included the administration of surveys in 9 communities comprising 369 households and aproximately 2,000 people. A census of all households in the newly arrived communities (i.e. an additional ~200 householeds) was carried out to document total population size and potential land needs in these communities. On-going political conflict over lands in newer communities made more detailed surveys impossible at the time of study.

A complete census of all inhabitants in and adjacent to the Sierra Chinajá protected area lands was made. This list was compiled at the community level using the number of households as the base organizational unit. Information regarding land use practices was later compiled for the 9 oldest communities. The methodology utilized was a modification of Participatory Rural Appraisal (PRA) and Rapid Rural Appraisal (RRA) techniques in which a variety of structured and semi structured interviews, focus groups, general meetings and community mapping were used to gather data (Eghenter, 2000, Hellier et al., 1999, Stocks, 2002). This survey was conducted by individuals selected by the community members themselves, who then received one week of training in interviewing, recording, and tabulating data. The focus of the questionnaire was on land use practice, use of forest products, and basic demographic information. This work was facilitated by the fact that the interviewers and respondents were neighbors and local citizens which can promote trust and reduce outside investigator error (Stocks, 2002). The potential limitations of this method are obvious due to the simple fact that even neighbors have personal reasons for embellishing or understating certain responses. The process of gathering socioeconomic information through survey data is imperfect. Therefore it is important to keep in mind that these data are merely estimates. Nevertheless, the overarching patterns are relevant to the discussion of land management in the Sierra Chinajá.

Local Populations

Approximately 600 families live in and around the Sierra Chinajá and use it as their main source of economic production. This amounts to more than 3,000 people spread out in 18 communities. The largest and oldest extant community is Tzulul Qeqchi, with over 100 families. The smallest and among the newest is Lagunita, a community with only 13 families. The degree to which local communities are able to exploit local natural resources is influenced by the time of establishment of each community (Appendix 16). The oldest and largest communities have been able to more effectively use local natural resources and have higher per capita income than younger, smaller communities (Figure 5).

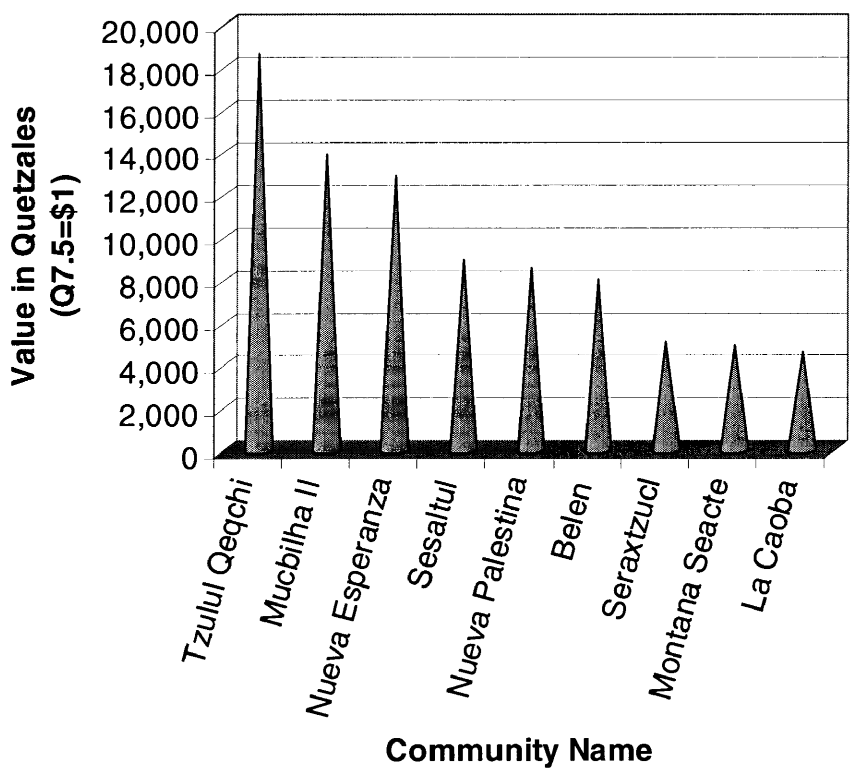
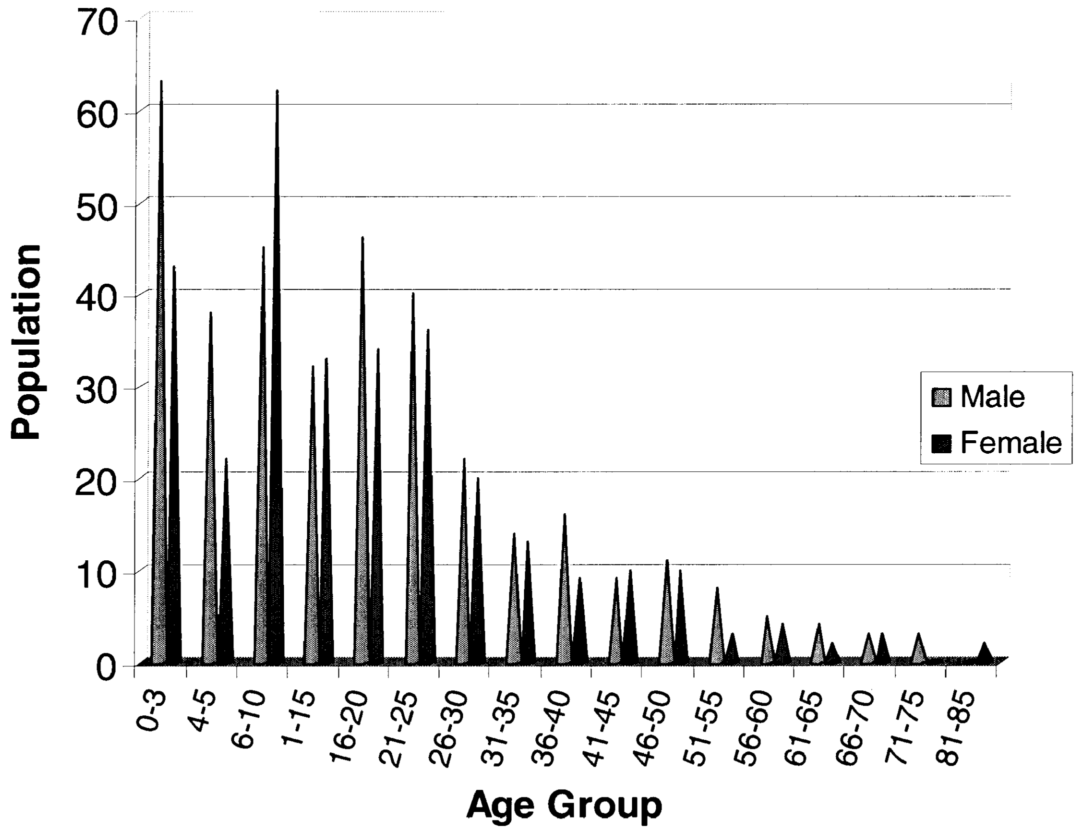


Figure 5. Comparison of per capita income of 9 communities of Sierra Chinajá

An average of 75% of the population is under the age of 25 in all nine communities surveyed. As evidenced by Tzulul Qeqchi, the large population aged 6-10 and 16-20 could be sign of a future population increase even if immigration and survival rates remain stable (Figure 6). The lower population size in the 0-3 group and 4-5 age group, may suggest high infant mortality.

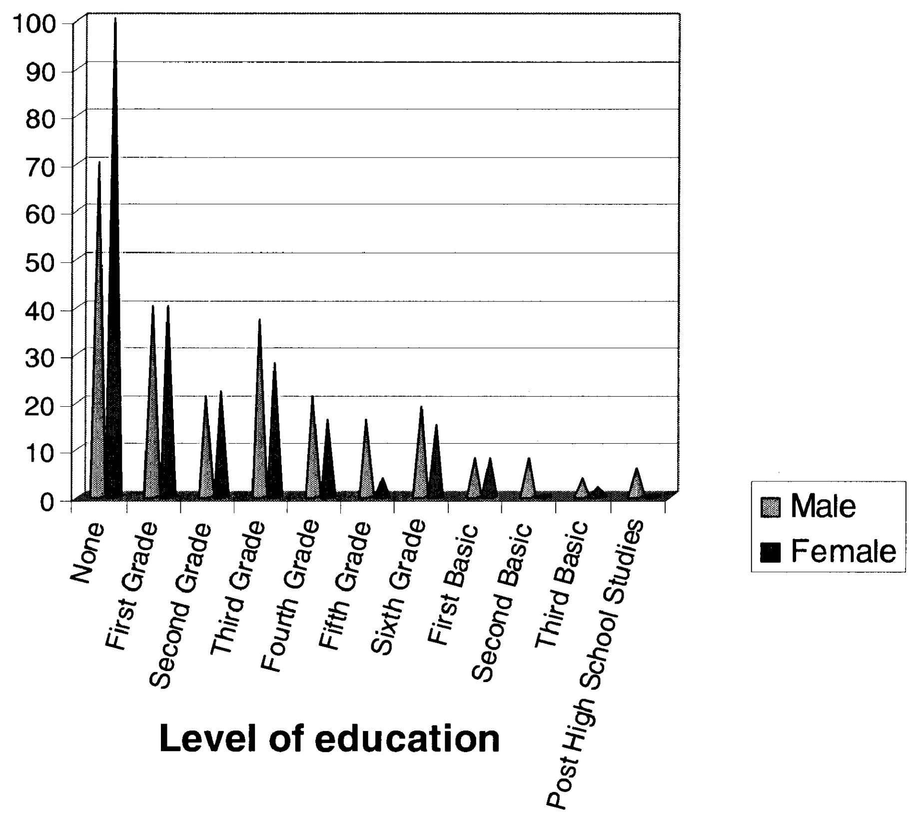
Figure 6. Population age group distribution for male and female residents of Tzulul Qeqchi, Sierra Chinajá, Chisec, Alta Verapaz, Guatemala. Sept. 2005.



Education

The level of education in campesino (peasant) societies is usually low because of historic inequities in access to educational opportunities and cultural biases of curricula which limit the success of students from marginalized ethnic groups (Siebers, 1998). This is certainly the case in Guatemala, which has more than 24 distinct ethnic groups (Wilson, 2000). Lack of disposable income and high demand for labor in agricultural production also contribute to low education levels (Wilson, 1994). Figure 7 shows the level of education among men and women in Tzulul Qeqchi. More than 50% of residents have less than a second grade education. Consequences of low levels of education include: lack of social mobility, reliance on traditional economic practices (often of low profitability), and lack of economic diversification. Many youth now receive more education and are the first bilingual generation in their families and societies historically. Qeqchi is the first language and is typically spoken at home.

Figure 7. The level of education of residents of the community of Tzulul Qeqchi, Sierra Chinajá, Chisec, Alta Verapaz, Guatemala. Sept. 2005.



Forest Product Use

A total of 28 species of common non-timber forest products (NTFPs) were reported by survey respondents as economically important. Many more species are known to be used by residents of the Sierra Chinajá. A list of plants and their reported uses and market values are presented in Tables 10, 11, and 12.

The collection of Xate (*Chamaedorea spp.*) is an important local activity. Xate is an ornamental understory palm that is collected by cutting the mature leaves while leaving the plant itself intact. The leaves are gathered, sorted, and shipped to markets in the United States and Europe. The demand for this product is great, garners good prices, and there is an active regional trade in the Sierra Chinajá. Federal law prohibits unlicensed collection of Xate. Calculating the quantity of Xate collected is difficult because much is clandestinely extracted. Nevertheless, regulated Xate collection could potentially supplement traditional agricultural livelihoods and facilitate management of xate populations. The abundance of xate plants observed in this study (Table 8) suggests that harvesting these wild populations could remain abundant. However, reportedly, higher productivity sites in adjacent lands of Sayaxche, Peten (Orellana et al., 2001) may suggest a need to incorporate xate species in a cultivated agroforestry-type setting. The cultivation of xate has been attempted with success in parts of the northern Peten through Wildlife Conservation Society (WCS) conservation projects. Actual populations of xate in Sierra Chinajá could provide a source of raw materials to establish forest gardens.

The collection of chicle sap to make chewing gum from the Chico Zapote tree, *Manilkara sapota*, was historically practiced in this region. Although Chico is abundant in the area, today this activity is not economically important due to lack of formal market channels. This is also true of an emerging market for

Bread Nut from the Ramon tree, *Brosimum alicastrum*, and Vanilla (*Vainilla planifolia*). Despite limitations to some forest grown crops, production of other native, forest dependent, species such as Cacao (*Theobroma cacao*) is practiced extensively by local farmers. The contribution of total income from Cacao production can be significant in some Qeqchi communities (ie. Department of Cahabon), however in Sierra Chinajá production is largely destined for consumption. The importance of Cacao to the local economy reflects its spiritual importance and use in Qeqchi ceremony.

Medicinal plants are important in local communities of the Sierra Chinajá (table 9). Local medicine men are the keepers of specialized knowledge, but many plant remedies are widely known. For example, Tres Puntas, *Neurolanea lobata*, is widely known and available, and is used to treat malaria. Tubers from, Cuculmeca and Sarsaparilla (*Smilax spp.*), are prime components in many tonics used for a variety of purposes including rheumatism and prostate cancer. Another plant of both ecological interest and local medicinal importance is *Zygocactus sp.*, an epiphyte from the cactus family used in the treatment of bone fractures.

Table 9. Common medicinal plants used by communities in and around the Sierra Chinajá.

Local Name	Scientific Name	Description	Typical Use*	Cost/Unit**
Medicinal Plants				
Pens k'aam		Bark and root of vine	Added to Coffee	Q1.00 Q1.00
Pens Che	*Pimienta dioica*	Fruits and leaves	Added to Coffee	Q1.00
Palo de Jiote	*Bursera simaruba*	Fruits	Fungus, Sore throat	Q0.50
Tres Puntas	*Neurolanea lobata*	Leaves	Malaria Diarrea	Q1.00
Roq Wakax	*Bauhinia divaricata*	Leaves	Gastritis	Q1.25
Guava	*Psidium guajavum*	Bark	Amoebas	Q2.00
Tiq'ilb'aaq	*Zygocactus spp.*	Leaves	Fractures	Q1.25
Cuculmeca	*Smilax cordifolia*	Root of vine	Arthritis	Q1.00
Sarsaparilla	*Smilax ornate*	Root of vine	Anemia	Q1.00
Cedar	*Cedrela odorata*	Bark	Amoebas	Q1.00
Mahogany	*Swieetenia macrophylla*	Bark	Amoebas	Q1.00

*Determined by the most popular responses recorded in socioeconomic questionnaire
**Unit defined as the smallest quantity sold, usually accounting for a single dosage.
Cost is in Quetzales (Q), exchange rate at the time of this study was aprox. Q7.5 = $1

Wild foods, although of little economic importance are important in the diet of local residents. A list of common wild foods indicates that a variety of plants are utilized by Sierra Chinajá communities (see Table 10). Wild foods provide important nutrients for people whose diets are otherwise composed largely of corn, beans, chili and eggs. This 'subsidy of nature' is an important contributor to the overall economy of local peoples. Of particular importance is Mak'uy (*Solanum americanum*) an herb found on forest edges and agricultural plots which is eaten (boiled or fried) as a meal or side dish. The importance of this plant to local people is evident by its cultivation in small household gardens and its prevalence in local markets. Another wild food crop of seasonal importance is the 'pacaya' or 'k'ib' in Qeqchi, which are the infloresences of an understory palm (*Chamaedorea tepejilote*). The domestication of this species has led to a large local market and is especially popular during Easter. Other species of wild pacaya (*Chamaedorea spp.*) are collected as are the inflorescences of the palm *Crysophila argentea*.

Table 10. Species of wild food plants utilized by local communities

Local Name	Scientific Name	Description	Cost/Unit*
Wild Foods			
k'ib' re k'iche	*Chamaedorea tepejilote*	infloresence	Q2.00
K'ib' acte'	*Crysophila argentea*	infloresence	Q2.00
Mak'uy	*Solanum americanum*	Herb	Q1.50
Cho'nte'	*Witheringia spp.*	Herb	Q1.00
Saqi okox	*Pleurotus spp.*	Mushroom	Q1.00
Saltul	*Pouteria sapota*	Fruit	Q1.00
Sunsa	*Licania platypus*	Fruit	Q1.00
Granadillo	*Pasiflora spp.*	Fruit	Q1.00
Xik tzi'		Mushroom	
Tib' tz'i			Q1.50
Holob'oob'			Q1.00

*Unit defined as the smallest quantity sold, usually accounting for a single dosage. Cost is in Quetzales (Q), exchange rate at the time of this study was aprox. Q7.5 = $1

In addition to Xate, several other palms and vines are important components in the NTFP trade (Table 11). *Orbignya cohune* known locally as 'corozo' is a large palm tree commonly used as roof thatch and is often the only tree species left standing in pastures after they are cleared and prepared for cattle grazing. This species grows in deep well drained soils and is rarely found in the mountains of the Sierra. It is therefore relatively scarce to residents and must be acquired in adjacent lowland plains.

Table 11. Other Non-timber Forest Products (NTFPs) collected by local residents of the Sierra Chinajá

Local Name	Scientific Name	Description	Typical use	Cost/Unit*
Other NTFPs				
Cola	*Chamaedorea ernestii-augustii*	Palm Leaf	Export	Q10.00
Kumun	*Astrocaryum mexicanum*	Palm Leaf	Roofing	Q20.00
Corozo	*Orbignya cohune*	Palm Leaf	Roofing	Q0.25
Guano	*Sabal mexincanus*	Palm Leaf	Roofing	Q0.25
Saqik'aam		Vine	Fastening	Q20.00
Talquetzal			Roofing	Q20.00

*Unit defined as the smallest quantity sold, usually accounting for a single dosage.
Cost is in Quetzales (Q), exchange rate at the time of this study was aprox. Q7.5 = $1

Wood Products (Timber/firewood)

Wood products are the principal forest resources that are exploited by local residents. To assess the degree of exploitation of timber species a detailed list was made at the household level, which quantifies wood products extracted in the last year. Thirty-six species of trees and shrubs were reported to be used by survey respondents. The approximate volume and extracted value per year of each species is presented in table 12. The high quantity of tree species utilized as timber and firewood is evidence of the great diversity and high value that characterize these forests. These data should be considered estimates only due to the error associated with recall responses which require detailed recollection of common day events over a long period of time. However, the salient trends associated with these responses illustrate important patterns of resource use.

Most timber harvested in Sierra Chinajá is used locally or sold regionally to carpenters in larger towns. Boards are rough cut in the field with chainsaws and removed on the backs of the logger and his beasts of burden. Due to the severely karstic terrain mechanized extraction methods are impossible. Timber harvest is ultimately limited by the residents that can afford the investment of purchasing a chainsaw. Nevertheless land tenure insecurity has caused the mining of timber resources, including the high grading and virtual extinction of precious woods like Mahogony and Cedar. Chico Zapote (*Manilkara sapota*) and Canxan (*Terminalia amazonia*), are the two most important species based upon volume, accounting for 18% and 14% of the total, respectively. The combined volume of their extraction still accounts for less than half of the total volume of wood products extracted. The rest of wood product extraction is based on more than 10 species each of which accounts for less than 10% of the total wood extraction by local residents. This highlights the importance of biodiversity to local users that equally exploit a variety of timber species. The level of Chico Zapote extraction is particularly high, which may reflect a shift in markets from traditional high value timbers such as Mahogany, to lesser quality wood because of resource scarcity. It could also be evidence of the abundance of Chico in this area, which is rather high (see Chapter 5). A study of seedling recruitment should be undertaken to investigate whether current extraction levels can be sustained.

Common Name	Scientific Name	Volume Timber (ft^3)	Volume Firewood (ft^3)	Total Value*
Chico Zapote	*Manilkara zapota*	62,644	60,564	128,255
Canxan	*Terminalia amazonia*	45,332	48,576	97,956
Ichte (Chechen)	*Sebastiania longicuspis*	1,054	61,997	83,175
Santa Maria	*Calophyllum brasiliense*	64,512	6,564	71,623
Cedar	*Cedrela odorata*	53,329	4,104	57,775
Choochok	*Paterna spp.*	18,425	-	55,275
Mahogany(Caoba)	*Sweetenia macrophylla*	-	50,580	54,795
Amapola (okok)	*Pseudobombax ellipticum*	8,938	-	44,690
Valerio (Chokop)	*Aspidosperma megalocarpon*	36,944	6,624	44,120
Chilacayote	*Sapium spp.*	672	25,260	28,037
Cacaote	*Desmopsis stenopetala*	14,050	7,200	21,850
Palo Lagarto	*Zanthoxylum*	-	17,040	18,460
Saqsi	*Licaria spp.*	-	14,508	15,717
Rajatebien		11,264	2,592	14,072
Tem	*Sideroxylon capirii*	12,225	-	12,225
Medallo	*Vatairea lundellii*	7,570	1,080	8,740
Suj	*Pithecelobium arboretum*	4,810	-	4,810
Ceiba (Inup)	*Ceiba pentandra*	4,650	-	4,650
Zapote (Saltul)	*Pouteria sapota*	300	3,744	4,356
Laurel (Suuchaj)	*Cordia glabra*	600	3,240	4,110
Tamarindo	*Dialium guianense*	3,200	-	3,200
Irayol (Yaxte)	*Genipa Americana*	620	1,992	2,778
Cacho de Toro		-	2,244	2,431
San Juan	*Vochysia hondurensis*	2,340	-	2,340
Ichmalay		-	1,752	1,898
Cedrillo	*Guarea glabra*	1,400	-	1,400
Bolb		1,350	-	1,350
Ramon (Anx)	*Brosimium alicastrum*	-	1,152	1,248
Palo Hormigo	*Platymiscium dimorphandrum*	1,200	-	1,200
Kolay	*Sickingia salvadorensis*	-	876	949
Kukte (Plumajillo)	*Schizolobium parahybum*	940	-	940
Palo Sangre	*Virola koschnyi*	797	-	797
Jocote Fraile	*Astronium graveolens*	600	-	600
Jocote	*Spondias mombin*	-	372	403
Atzamte		-	240	260
Amate	*Ficus radula*	-	120	130

* in Quetzales (Q 7.5 to a $1)

Table 12. Tree species and the gross value of their extraction in the Sierra Chinajá. Sept. 2005.

Game Species

Through the questionnaire information was sought about hunting by local residents. However, because of the sensitive nature of such information, these calculations of estimated meat harvest levels are tentative only (Table 13). Tzulul Qeqchi, Mucbilha II and Sesaltul, the three most populous communities probably exert the most pressure on wild game. The species most commonly hunted are: Tepescuintle (*Agouti paca*), Coatimundi (*Nasua narica*), and Peccary (*Tayassu* and *Dycotyles*). Only in the community of Tzulul Qeqchí was it possible to obtain data about the scale of white-tailed deer (*Odocoileus virginianus*) hunting activity.

These data reflect the importance of this resource to local production systems and the abundance of some game species in the area. This may however be a reflection of local scarcity due to declining game populations over years of hunting pressure. Because of the relative ease of access (ie. presence of adjacent roads) to the core areas of the reserve it is a traditional favored hunting ground of both local subsistence hunters and regional market hunters.

Table 13. Game animals of Sierra Chinajá and harvest levels in 7 communities 2005.

	Community							
Species	Belén	La Caoba	Mucbilha II	Montana Seacté	Seraxtzucl	Sesaltul	Tzulul Qeqchi	Total (lbs.)*
Armadillo		6				102	16	124
Brocket Deer			175	30			145	350
Chachalaca		6				32		38
Peccary	150		850	150	125	285	225	1785
Oppossum	10							10
Parrots		1						1
Tinamous						27		27
Raccoons	8		120	2				130
Pigeons/Doves	5	2						7
Great Currassow	32	8				57	134	231
Coatimundi	192	7	256	88	136	750	470	1899
Taltuza						26		26
Tepescuintle	600	60	765	380	360	570	1769	4504
White-tailed Deer							380	380
Total (lbs.)	997	90	2166	650	621	1849	3139	9512

* based on recall estimates from survey data

Distribution of Economic Income

Annual household income can indicate the viability of land use practices as well as the value of land currently under use. Qeqchi Maya farmers traditionally cultivate maize in a short fallow (i.e. 1-5 yrs, depending on local site conditions affecting production and transportation) shifting cultivation system known as "milpa". Although maize production accounts for only 12% of total income (Table 14) it is of primary importance to the sustenance of local communities. Maize is a staple product consumed at each meal, and most of the maize produced is for domestic consumption not for sale. The spiritual importance of maize cultivation is also significant among Maya farmers (Hatse and De Ceuster, 2001).

In terms of total income, the most important crop to Sierra Chinajá farmers is cardamom (*Eletarria cardamomum*). This introduced crop is produced entirely for export and a large regional infrastructure has developed around it involving value added processing, including drying and sorting. The production of cardamom accounts for 86% of total income received by farmers of the Chinajá (Table 14). The large scale investment by farmers in a perennial crop that takes 3 years to mature is a testament to both the degree of their integration into the regional/global economy of local farmers and the suitability of this crop to marginal upland lands in the Sierra. The income generated by this activity provides the liquid capital used to purchase maize, which may be underproduced because of the

Beans (*Phaseolus spp.)* are also of importance largely for subsistence use and to a lesser extent for sale. Beans and a variety of other traditional lowland agricultural crops comprise the balance of crops cultivated by farmers in the area.

Table 14. Annual income generated through agricultural activity by crop in 9 communities of the Sierra Chinajá Sept. 2005.

Crop	Annual Income	% of total
Corn	Q318,940	12.1
Bean	Q29,523	1.1
Cardamom	Q2,261,110	86.0
Coffee	Q925	0.0
Banana	Q3,460	0.1
Achiote (*Bixa orellana)*	Q1,360	0.1
Cacao	Q617	0.0
Peanut	Q1,000	0.0
Pineapple	Q9,100	0.3
All Spice	Q2,400	0.1
Coconut	Q2,000	0.1
Chili	Q200	0.0
Total	Q2,630,635	99.9

The agricultural sector accounts for more than half of the total income of resident families of Sierra Chinajá (Table 15). The extraction of forest products including timber and hunting accounts for almost 30% of all annual income. Thus, the economy of Sierra Chinajá is intimately connected to forest and land resources and local livelihoods are dependent upon access to and use of these lands. The total value of forest resources extracted on an annual basis by local communities should be assessed under various land use management scenarios to optimize return from market and non-market values.

Table 15. Distribution of economic income of resident families in 9 communities of the Sierra Chinajá. Sept. 2005.

Income Sector	Annual Income	% of Total
Agricultural	Q1,988,440	49.0
Forest Products	Q938,537	23.1
Animal Sales	Q423,760	10.4
Hunting	Q124,571	3.1
Non-agricultural Work	Q375,536	9.3
Day Labor	Q205,164	5.1
Total	Q4,056,008	100.0

The amount of land needed for a family to satisfy its needs on a sustainable basis under current land use systems of milpa agriculture and cardamom cash cropping, is at least 5.45 ha (Alvarado et al., 1998). This estimate incorporated annual expenses of an average family and calculated the amount of land needed to meet those expenses based on the productivity of the land and the price of the commodities produced, as well as subsistence non-market production. The average parcel size of farmers of the Sierra Chinajá is 6.01 ha, with parcels ranging from 1.4 -10.5 ha (Appendix 16). In light of the estimate by Alvarado et al (1998), it would appear that some households in the Sierra Chinajá have sufficient quantity of land to subsist. Nevertheless, if this estimate is compared across communities, it is clear that some communities are unable to meet subsistence needs through agricultural production alone. How then do these local farmers support families? One way is to rely on the extended family unit to provide necessary supplements (ie. access to rentable land, surplus food crops, pay for labor, etc...). The difficulty in assessing this issue stems from the fact that farmers are not isolated units in closed economic systems

Chapter 7. Land Use and Land Tenure

Land use maps were prepared to assess the distribution and intensity of local farmers' resource use of the Sierra Chinajá. The methods used to develop these maps were adapted from other similar participatory mapping efforts (Eghenter, 2000, Stocks, 2002). Locally trained technicians from APROBA-SANK systematically mapped cadastral and current land use conditions from May-September 2005. A five member team equipped with GPS technology, compasses, and 1:10000 scale topographical maps georeferenced each community's territory (polygon) and all parcels reported by farmers. This work was carried out in conjunction with all community members and their respective coordinating land commissions. The results of this work are presented in the following land use, and cadastral maps generated by Arc View software (see Appendix 17, 18, 19, 20).

The current state of land use of the Sierra Chinajá and actual distribution of agricultural plots was compared with maps of 'accepted land use capacity' as defined by the Guatemalan forest service (INAB) to determine the degree to which 'ideal' land use coincides with actual resource use (see Appendix 20 and 6). 'Ideal' land use is determined by assessing and landscape and soil characteristics including composition, depth, and slope in order to prescribe suitable agricultural production systems (INAB, 200).

Land Use Categories

Land use categories were designed to reflect all local land use practices and agroecological systems. This required understanding local farming systems and annual cultivation cycles as well as natural patterns of forest formation and development. The following 6 categories attempt to simplify the array of land use and vegetation types.

Primary Forest (PF)

A forest type consisting of large diameter "emergent" species, often with buttressed trunks, typically from the Meliaceae and Sapotaceae families. This forest is more than ~50 years old and exhibits little recent anthropogenic disturbance such as selective logging and extraction of non-timber forest products. The diversity of plant and animal species is highest in this forest type. It is characterized by abundant biomass typical of lowland tropical rain forest. The structure of this forest is characterized by several levels of vegetation (~3 or more). It is also recognized by an abundance of lianas and epiphytes, which create dense vegetation, high humidity, and low light levels at the forest floor.

Secondary Forest (SF)

Species composition is similar to Primary Forest, but forest structure is simplified due disturbance, including fire, wind throw from hurricanes, selective harvesting of large diameter tree species, and natural flood/drought cycles. A large portion of the Sierra >30% was burned during the drought that occurred during the el Nino and Hurricane Mitch year of 1998. The forest structure is less complex with fewer strata of vegetation than primary forest. As a consequence, dense thickets of woody shrubs and small trees dominate the undergrowth.

Guamil (Agricultural fallow) (G)

This land use type refers to customary fallowing of agricultural lands throughout much of Latin America. It is part of a system of rotating or shifting cultivation in which parcels are rested or "fallowed" for 1-15 years after harvest. Lands are cleared, dried, burned and planted in a methodical way without tilling the soil. Planting is carried out by hand with dibble sticks and clearing is done with machete. When fallowed, the vegetation varies from young pioneer "forests" of fast growing early successional species (ie. *Cecropia peltata, Heliocarpus donnel smithii, Schizolobium parahybum, Trichospermum galliothi, and Spondias mombin*) to low scrub vegetation (*Psychotria spp., Clidemia spp.,* and *Piper spp.*). These areas normally occupy the small valleys with deeper soils.

Milpa (M)

This refers to lands under the production of corn or maize (*Zea maiz*) during the time of the study (June 2005 – January 2006). The vegetation type can range from monocultures of maize with occasional herbaceous weed species at field edges, or more commonly interplanted with ayote (*Cucurbita ficifolia*), a squash, and beans (*Phaseolus spp.*). This land use category commonly rotates into the Guamil category and vice versa.

Permanent Cultivation (PC)

This land use type is synonymous with Cardamom (*Eletarria cardamomum*) and entails perennial crop cultivation in a forest like environment. In the Sierra Chinajá cardamom is commonly cultivated beneath native trees grown to provide shade. A variety of tree species are utilized for this function, and are often simultaneously managed for timber, food, medicine, and other materials used in daily life. The recent practice of cultivating monocultures of Cardamom is similar to monocultures of maize and involves the complete removal of all overstory trees. Cardamom, an exotic species from Asia, begins producing about 3 years after planting and parcels are often rotated on a 7-10 yr cycle.

Burned (B)

This category characterizes lands that have recently been burned by escaped fires or lands previously degraded by fire. It is not uncommon that fires "escape" or unintentionally spread to adjacent lands causing damage to both forested and cultivated areas. The height of the dry season (May) corresponds with the burning of fields, thus the risk is high as fuels are very dry. Due to the intensity of large fires that have passed through the Sierra Chinajá, some areas, particularly hilltops, have little vegetation. In some hilltop areas burned in the 1998 fires, soils are still forming and vegetation has yet to reestablish. The permanence of such conditions and restoration possibilities warrant further study.

The Forest Mosaic

An important pattern appears from these land use and forest maps. Small patches of cultivated lands exist within a larger matrix of distinct seral stages of forest development ranging from pioneer to primary forests (Appendix 19). Small (<3 ha) parcels of arable land are distributed within primarily steep unarable slopes. The value that farmers place on the small valleys that lie between the hill tops is evident in that many agricultural parcels are great distances from residences. The most prevalent type of land use in the Sierra Chinajá is primary forest with a total of 6,030 ha, followed by secondary forest (3,854 ha), and permanent cultivation (1,155ha) (table 16).

Table 16. Land use in the Sierra Chinajá. Sept. 2005.

Type	Area (ha)	%
Primary Forest	6,030.00	44.8
Secondary Forest	3,854.93	28.7
Permanent Cultivation	1,155.64	8.6
Guamil	985.15	7.3
Milpa	948.86	7.1
Burned	347.06	2.6
Pasture	94.92	<1

The largest amount of contiguous forest in the Sierra Chinajá is located on the western end of the Sierra along the ridges that border Tzulul Qeqchi, Sesaltul, Mucbilha, and La Caoba. There is also a large contiguous forest in the east above the recent settlements of Nuevo Cerro Lindo and Valle Verde.

Biophysical limitations of agricultural development have maintained a large degree of forest cover by default. High value forest habitat on hill tops is available to mobile species such as primates, birds, bats, and other forest dwelling species. Despite highly fragmented habitat, the land supports populations of forest dwelling animals. Given the topographic limits to human development, it is conceivable to view traditional small scale agricultural practices co-existing with forest conservation.

Cardamom Production in Sierra Chinajá

The introduction of cardamom, *Elatteria cardamomum*, by German immigrants caused a revolution in agriculture which permitted the successful settlement of previously uninhabited lands in northern Alta Verapaz (Universidad Rafael Landivar, 1994). This diversification of agriculture changed a plantation economy based solely on coffee production to one dominated by cardamom and created a cash crop which encouraged the internal Qeqchi migration (Wilson, 1995). The spread of this crop is also partly responsible for the large degree of forest integrity that exists today in northern Alta Verapaz. Because cardamom was until recently grown in a shade of a forest and planted in small patches normally less than 2ha in size, forests are not disrupted as much as in other forms of agricultural production. Over story trees provide shade for cardamom and habitat for various species similar to that found in rustic coffee cultivation. The greater ecological value of rustic, shade coffee plantations in comparison to more intensive land uses is well documented (Calvo and Blake, 1998 and Perfecto et al, 1996). The importance of Cardamom to the regional economy is evident in the presence of cardamom dryers in even the Sierra's most remote areas (i.e. Tzulul Qeqchi and Sesaltul). While some of this money goes to independent growers it is often the case that cardamom dryers are financed by larger cardamom producers who then take a cut of the yield.

Land Tenure Systems

The Sierra Chinajá is located at the northern border of the department of Alta Verapaz with Péten. It is an area that encompasses approximately 13,500 hectares that was declared in 1989 an Area of Special Protection according to the Guatemalan law of protected areas, article 4-89. According to this law, CONAP, the protected areas management agency, is the administrator of these lands, and it is part of the state system of protected areas (SIGAP). Before CONAP was granted authority, the lands were uninhabited. When first settled in the 1970's, these lands were administered by the Institute of Agrarian Transformation (INTA). This government agency was responsible for organizing, designing, and titling frontier lands recently opened to settlement. The process of land settlement was not well organized (Jones, 1990). Widespread land grabs occurred in the region, and many landless people arrived to search for land in the furthest corners of the region, when they realized that many of the prime productive agricultural lands had already been occupied. INTA was phased out in the early 1980's and replaced by FONTIERRA, which currently administers all state lands available for titling. Due to lack of institutional coordination among CONAP and FONTIERRA and institutional changes from INTA to FONTIERRA, the status of land entitlement in the Sierra remains unresolved.

Many communities established before the proclamation of protected areas law do not own lands they have resided on for over 3 decades. In the late 1990's agreements were reached between the 9 older communities, CONAP, and CONDEG, (the Council of Displaced Persons of Guatemala; el Consejo Nacional de Desplazados de Guatemala), a peasant land organization. CONDEG, one of many non-governmental organizations (NGOs), was formed by former guerillas as part of the transformation from armed resistance to political negotiation. This group represents landless peasants and works at the political level to acquire land titles for them. The territories of the 9 oldest communities were surveyed by engineers as a result of these agreements. According to this agreement, a certain portion of the lands of the Sierra were to be administered by the resident communities, while another part was to be left as a reserve (i.e. nuclear zone) or 'exceso', literally 'excess' (Appendix 17).

Recently, additional households arrived and established newcommunities in these "open lands". These new communities have begun to fill in the 'excess' lands and at times have come into conflict with the older communities. Without formal authorization and support from local authorities, the older communities have been unable to exclude the recent settlers. Since the new communities arrived after the agreements between CONAP and the older communities, CONDEG has been politically unable to represent them and CONAP has sought to remove them. However, a different peasant organization, the Union of Peasant Organizations of the Verapaces (UVOC), has taken the place of CONDEG, and represents the newly arrived communities. The presence of two NGOs representing peasants pursuing land titles and unclear government policies and procedures creates an extremely complicated management environment.

Despite recent formal agreements by both CONAP, and FONTIERRA to settle displaced populations, no results of their commitment are evident. Several meetings have taken place between government entities, NGOs, and local communities which have established the directions to be taken by each party involved. However, little has been accomplished with respect to the solidification of land management in the Sierra due to myriad political complexities. It is unlikely that local communities will voluntarily re-establish themselves outside the reserve without viable land alternatives. The involvement of the peasant organization UVOC, which has the reputation of being combative and skeptical of government intervention, decreases the likelihood of voluntary resettlement by newly arrived communities.

As of Feb 2005 there were 18 communities residing within the protected area zone as demarcated by CONAP (Table 17). Nine of these communities have a history of establishment that precedes the proclamation of the law of protected areas and one community (i.e. San Francisco del Rio) has already been granted title to lands. The other communities arrived more recently, in some cases less than a year ago. The increasing rate at which landless farmers are migrating to the Sierra is cause for alarm. Within the last year, six new communities have established themselves in or adjacent to the Sierra Chinajá (see Appendix 19).

Table 17. Land distribution among resident communities of the Sierra Chinajá and their. Sept. 2005

Community	Year of Arrival	No. Of families	Population	Families Landless	Size (ha) AC	AF
Tzulul Q'eqchi	1973	104	665	4	683.63	3,328.25
Muqbilha II	1975	58	305	8	1,757.36	-
Sesaltul	1975	63	312	15	2,430.22	2,652.16
Belén	1981	34	213	4	579.86	317.98
Nueva Palestina	1982	29	134	14	332.94	317.90
Nueva Esperanza	1984	21	139	9	568.78	405.99
Montaña Se'acte	1984	20	109	6	522.61	339.81
Se'raxtzuc	1987	20	120	2	386.74	396.68
La Caoba	1987	20	125	5	452.25	-
Nueva Jerusalén	1989	30	173*	-	-	-
Valle Verde	1998	35	201*	-	-	669.51
La Bendición	1999	16	92*	-	-	-
Serranía Los Mayas	1999	20	115*	-	-	-
Lagunita	2004	13	75*	-	-	-
Cerro Lindo	2004	18	104*	-	-	-
Chibeenitzul	2005	27	155*	-	-	-
Nueva Chinajá	2005	37	213*	17	-	-
Grand Total**	-	565	3250	84	8,914.66	8,371.44

AC-According to Community Mapping
AF-According to FONTIERRA Mapping
*based on the average number of individuals in a family derived from census of 9 oldest communities (5.75)
**this does not account for the approximately 35 families of San Francisco del Rio who occupy an estimated 1,143.34 ha

All residents consider the acquisition of title extremely important. A principal motive behind the initiation of this project was to facilitate the process of regularization of land titles for local communities, as well as to develop a framework of conservation agreements with local communities. Without a clear understanding of the nature of land claims, the problem of insecure land tenure cannot be solved. For this reason community mapping was utilized to analyze the perceptions residents have of the size of their communities.

Points delineating community territories were georeferenced in the field in coordination with community members at agreed upon sites, often demarcated by physical land marks including trees, cement blocks, and natural land forms. Due to financial and political constraints community mapping was only possible in the nine old communities. These polygons were overlaid on official preliminary maps composed by FONTIERRA engineers and are presented in Appendix 18.

The results of this comparison are largely inconclusive because of the variability between perceptions, although in some cases the 'fit' is 'tight' as communities and government have similar perceptions of the size and location of identified territories. In most cases the local perception was that community territories were larger than indicated on preliminary maps composed by FONTIERRA. This is likely due to misconceptions of the legal status of the 'excess' lands and the fear of the loss of their rights to these adjacent lands (where they have traditionally planted cardamom and collected forest products).

The lack of congruence between community-perceived territory and government-designated territory in the Sierra Chinajá demonstrated in table 17 and the aforementioned appendices 18 and 19 is evidence of the poorly defined and disseminated land tenure strategy developed in past agreements between local communities, government agencies, and NGO's. While all local communities recognize the presence of a 'core' or 'nuclear' zone they have still penetrated these intact areas of forest to plant crops and the nuclear zone is also the target of settlement by newly arrived colonizers. Due to confusion and conflict resulting from a poorly implemented government land tenure system, there is a need to re-negotiate the terms of the arrangement and develop a more realistic and effective strategy.

Chapter 8. The Political History of the Sierra Chinajá and Northern Alta Verapaz

The preceding chapters have discussed mainly the biophysical details of the Sierra Chinajá. The following chapter considers the importance of politics, economics, and society from an historical perspective. These elements are addressed as they relate to land management in northern Alta Verapaz and the Sierra Chinajá. The underlying structures that exert influence upon land use decision making are highlighted and begins with a consideration of the mechanisms that have influenced settlement in the area.

Detailed documentation of settlement in Northern Alta Verapaz is lacking due to the limited written history of humans on this landscape. However, the history of "prehistoric man" in the Sierra Chinajá is likely long and textured as we know from archaeological studies in lowland Mesoamerica, especially the Péten. The lowland portion of northern Alta Verapaz gave rise to one of the most sophisticated new world civilizations: The Maya. The ubiquitous signs of past settlement are evidenced in the architecture and art discovered at local and regional sites. Some of the more important sites in the region include Cancuen, a city at the headwaters of the Passion River and the Candelaria Caves, among the longest subterranean river systems in Tropical America. These sites were important commercial and religious centers where archaeologists today are making important discoveries that explain the rise and abrupt decline of the Maya (Woodfill 2005, Demarest 2002).

The archaeological sites in the Sierra Chinajá have their own story and attest to a time when this area was far from the frontier land it is today. Recent discoveries by local people highlight significant examples of the influence of the ancient Maya on their environment. Ceremonial ceramics found in the inner recesses of cave systems and large limestone blocks sculpted with hieroglyphs (Figure 8) are evidence of the rich prehistory of the Sierra Chinajá.

Figure 8. Carved Maya hieroglyph on Chinajá limestone. Linterna II, Alta Verapaz

The extent to which the Maya inhabited the interior and immediate vicinity of this mountain range is unknown. However, due to the presence of elevated stone platforms and burial tombs it would appear that there was at one time permanent human settlement of at least the edges of the Sierra. Since the collapse of the Mayan civilization around 800-900 A.D. the Sierra Chinajá remained virtually uninhabited, except for seasonal migrations of nomadic peoples such as the Lacandon, who now reside in the state of Chiapas in southern Mexico (Woodfill, 2005). Spanish colonization in the 15th and 16th centuries, and the immigration and subsequent large land entitlements given to German migrants in Alta Verapaz in the early 20th century restructured the social order and had major effects on land use which are still evident today (Wilson, 1995).

The influence of colonial powers on the settlement of Guatemala and specifically on Alta Verapaz, was felt most intensely in the temperate highlands where Spaniards could escape the heat and deadly malaria common in lowland tropical such as northern Alta Verapaz and Sierra Chinajá. The lowland areas, like much of the Peten, were considered inhospitable by Europeans and thus saw relatively little economic activity, except for occasional timber extraction of particularly valuable species such as Mahogany (*Swetenia macrophylla)*, and Tropical Cedar (*Cedrela odorata)*. The collection of Chicle sap from the Sapodilla tree (*Manilkara zapota)* contributed to economic development in the region following rising international demand for chewing gum took on large scales in the 1920's (Schwartz, 1990).

However inhospitable and remote these marginal areas were, they were not uninhabited. The Qeqchi, a Maya group of which there are over 23 separate groups of modern Mayan descendents in Guatemala alone are native to Alta Verapaz and had been there long before Spanish colonization (Wilson, 1995). The territory of the Qeqchi, now known as the Verapaces, was the only area that resisted European domination "by the sword" due to the remote and difficult terrain and the ferocity of Qeqchi warriors (Wilson, 1995). This provoked the

King of Spain to allow the settlement of the area by pacific means through the work of Dominican friars (Wilson, 1995). This is one reason why Qeqchi culture and language persist today. Qeqchi also continues to be the fastest growing Mayan dialect spoken in Central America, largely due to their migration from Alta Verapaz to Peten and Belize, which has occurred since the 1940's (Wilson, 1995). For centuries the Qeqchi have lived in parts of northern Alta Verapaz in disperse agricultural communities of small family groups on traditional land holdings (Siebers, 2001). Due to colonization practices many were forced to become tenants on large foreign land holdings (Wilson, 1994).

During the 1960's, national policies began to have wide ranging impacts on the politics and economics of this remote region. It was at this time that the Guatemalan government, faced with an ongoing civil war over demands for land reform opened for settlement what is known as the Franja Transversal del Norte. This area, composed of the upper quarter of the departments of Quiche, Alta Verapaz, and Izabal, is a region of humid sub tropical karstic terrain. A major constraint to agriculture in the area are the clayey infertile soils that overlie steep craggy limestone mountains. High annual precipitation, frequent storms, and subterranean drainage typical of karst, render most of the FTN unfit for permanent agriculture (INFUEP, 1982).

Instead of true land reform, the Guatemalan government chose to colonize this marginal area of northern Alta Verapaz and Peten to relieve population pressure and social upheaval in the highlands (Wilson, 1994). In the 1940's and 1950's expropriated German farms (expropriated because of their connections with the Third Reich) and state lands in the FTN were redistributed under government colonization programs by the Institute for Agrarian Transformation (INTA). Despite the lack of infrastructure (ie. there were no roads in the area, the only means of communication was by foot from Coban and by boat from Sebol) and poor quality of land, lack of access to lands or livelihood prompted a great internal movement of Qeqchi migrants looking to acquire land and escape the indentured sharecropping characteristic of the coffee plantations of highland Alta Verapaz. However, many high-ranking military officials and their associates also received vast acreages of arable land causing the colonization programs to be largely ineffective in securing land tenure for the majority of the new migrants (Jones, 1990).

At about the same time the government began promoting lowland tropical colonization in the FTN. The first exploratory petroleum companies began to arrive at this time as well. By 1959 the Ohio Oil Company had sunk test wells in the Sierra Chinajá (Figure 9) prompting enough interest to build several wells at the end of a 9km road in the deepest forests of the Sierra Chinajá.

Figure 9. Sign marking presence of Ohio Oil Company in the Sierra Chinajá

The wells in the Sierra are all tapped today and new wells have been established on the adjacent lowlands at the base of the mountains, but the road, along which 2 local communities have sprung up in their place, is a testament to the influence oil exploitation has had on the area. It was also during this time that Basic Resources, the transnational conglomerate of several American petroleum companies (including Halliburton) built an oil pipeline to transport oil directly to Puerto Barrios, on the Caribbean coast. It was largely for this reason (ie. to service the pipeline) that the FTN road from Quiche to Izabal was built. Chinajá was also the site of a geopolitical military build-up (Solano, 2004). During the late 50's the airstrip at Chinaja was the largest in the country. After the Cuban revolution, US trained anti-Castro troops were stationed in the region along with scores of US bombers (Solano, 2004).

By the 1970's colonization projects and communities began to fill in what was considered "baldío", or state land open for settlement, in the Chisec bloc of the FTN. The plantation distribution hub at Sebol played a large role in the settlement of the area, for it was the highest navigable point on a network of rivers that covered the area. The large agricultural parcelization of Raxruja, which is adjacent to the Sierra Chinajá, was established down stream from Sebol. Between 1975-1979 the FTN road was constructed by the U.S. Army Corps of Engineers, the INTA, and Shenandoah Oil, which facilitated oil extraction, colonization, and communication between Cobán and the FTN (Solano, 2004). The construction of this road was a crucial development of the region and allowed for a new wave of settlement. In the early 1980's a shift in strategy by the guerrilla fighters brought the civil war to a new front: the FTN and Chisec, Alta Verapaz (Solano, 2004).

War had significant effects on development efforts in the FTN. Access to and control over land changed hands repeatedly through military action by military, paramilitary, and guerilla groups. The military campaign strategy of "scorched earth" resulted in the destruction and subsequent concentration of disperse settlements into "poles of development" (Jones, 1990). The oil pipeline became a favorite target of revolutionary groups and was bombed several times in an attempt to cripple the economy of Guatemala. This policy left lasting marks on the environment as evidenced by the oil stained walls visible on some caves in the area.

Local residents report that the insurgency and military activity in northern Alta Verapaz was heaviest during the years 1980-82 when the municipal capital of Chisec was captured by guerrillas and razed. It was also at this time that guerrillas dynamited the GUATEL radio transmitter on a ridge of the Chinajá. The radio tower has been reinstalled, along with 2 other towers, on a ridge accessed by the road built long ago by the Ohio Oil Company. The tallest summit of the Sierra is occupied by the historic, now non-functional transmitter, of General Lucas Garcia, one of the major "caudillos", or military strong men, of the time. From this location, it is believed that General Lucas was able to evade prosecution after the coup led by the new government of Erain Rios Montt.

The land acquisition pattern in the FTN is complicated by the policy of not assigning parcels to farmers, but instead assigning land to a group of farmers, within which each farmer establishes his own work area (Jones, 1990). This communal pattern of development is similar to the 'ejido' concept in Mexico. However, the settlement of large tracts of land, including the Sierra Chinajá, was poorly organized and resulted in an unmanaged "land grab" (Jones, 1990). Before a community could be officially recognized and provided title to land, a threshold number of families had to have improved the site and constructed homes. Still today, few people have gained official titles to their lands despite having lived in and staked claims for over three decades.

Modern day settlement of the mountains of the Sierra Chinajá began with the translocation of the first residents of the town of Tzulul Qeqchi in 1973 by gubernatorial decree (Macario Xo, former mayor of community of Tzulul Qeqchi, pers. com.). This community had resided on a plantation in San Pedro Carcha in highland Alta Verapaz before it was removed and provided transportation to the present day site. Two years later the communities of Mucbilha II (settlers from the Cahabon area) and Sesaltul (settlers from Carcha) were formed. These three communities are the oldest, have the largest populations, and the largest land holdings in the Sierra Chinajá.

A second wave of settlement occurred on the heels of the first which added 7 more communities during the 1980's. In the late 1990's and the early 2000's a third wave of settlement occurred adding seven more communities to the slopes of the Sierra. In several cases the new settlers were the sons and daughters of the previous waves of settlers (Ignacio Caal, Mayor of Nueva Palestina, pers. com.). However, within each group there are also lands speculators that are seeking to expand their land base for sale later.

Several important events occurred during these years in the Sierra. One of particular interest because of its implications on present day land management occurred in Sesaltul. In the mid 1980's a group of squatters arrived in the area and conflicts broke out between the new arrivals and existing inhabitants. This was brought to a head when a machete fight over land resulted in one death and numerous injuries. This unfortunate incident reflects the inability of the government to establish secure tenure for people in this frontier zone. It shows the lack of effective governance by formal government institutions; it also casts light onto the viability of community protected nature reserves in comparison to federally protected nature reserves. Based on this case, it would appear that local communities could be more effective in controlling land management practices in the Sierra than the Guatemalan government. Landless settlers are probably more likely to settle on state owned lands (with no de facto control) than on lands controlled by local communities. This is because of the threat posed by local residents, who quickly and powerfully respond to the usurpation of their lands. Where the government is unable to effectively administer or control land use, it seems that land entitlement of local peoples could be an alternative to stem forest conversion and degradation. Skirmishes such as these are not uncommon in Chisec due to the history of land acquisition via the open access land grab settlement process.

In 1989 the National Law of Protected Areas was created, which for the first time established a system of protected lands to be administered by the federal agency (CONAP). Sierra Chinajá was declared an "Area of Special Protection" at this time. This officially created an area where settlement and resource extraction are illegal and which was to be further categorized pending technical study. A technical study commissioned by CONAP through FONAPAZ (a social projects trust fund) was written in 1999 by Gaitan et al., but was rejected by CONAP because it lacked detailed information on local socioeconomic conditions, soil capacity, and community awareness and support for the plan. A second study was commissioned by the association APROBA-SANK in 2005 through FONACON (an environmental conservation trust fund), which I directed. The present document is based upon the results of this study. This study is still pending official approval by CONAP and subsequent approval by the Guatemalan Congress.

Chapter 9. Land Management in the Sierra Chinajá

This final section incorporates frameworks of protected areas management as informed by CONAP regulations and the World Conservation Union (IUCN) to propose a potential strategy for conservation and sustainable use in the Sierra Chinajá. I discuss a variety of management perspectives, particularly focusing on a current proposal by ProPéten, an NGO in the Péten, for an Indigenous Reserve category within the Guatemalan system of Protected Areas. The political and administrative ramifications of management are discussed and avenues for development recommended.

Land management in the Sierra Chinajá in the last three decades can be characterized as an “open access regime” in which settlers have come and gone under a “tragedy of the commons” mentality. This situation and Guatemala’s limited capacity for enforcement, has led to the widespread perception that all uninhabited public land is open for settlement, even if settlement is prohibited by law, such as the Sierra Chinajá. This has led to agricultural occupation of marginal hill sides and extensive forest conversion. Although geographically and ecologically isolated, the Sierra Chinajá is economically and politically embedded within a regional development context and therefore is strongly influenced by land uses surrounding it. The lack of institutional presence on the part of both CONAP and the land regularization agency (FONTIERRA) has resulted in widespread competition by many actors for public lands.

The Guatemalan protected areas agency (CONAP) is modeled on modern 'western' approaches which largely exclude utilitarian human use (i.e., farming and forest resource extraction). The system is also based on strategies espoused by the World Conservation Union (IUCN). The approach focuses on classifying forest areas based on land use suitability as a means of regulating and managing resource use (table 16).

It is important to note that the current classification of the Sierra Chinajá does not appear in this table because it is awaiting a formal categorization by CONAP which requires the official consent of the Guatemalan Congress. It is currently decreed an "área de protección especial" or "specially protected area", which in reality means that it is a "paper park" or a protected area that has no formal land management implementation on the ground and exists only on the books. The purpose of this document is to set into motion the transformation of this area from "paper park" to "functional protected area"; by providing baseline data from which to establish management goals and federal budgetary allocations to on the ground projects. The Sierra Chinajá would likely be a category III or IV (in IUCN system) protected area because of the degree of integration of local people in the environment. This would be expected to translate into at least a partial focus on socioeconomic benefits from conservation and to some degree of respect for local customary land use.

Due to the high rate of land invasion and forest conversion currently occurring in the Sierra it appears existing models of simplistic top-down driven protected areas management cannot address the full array of factors affecting forest conservation and local development. Thus it is necessary to consider alternative management strategies within the local context. A combination of federal institutional support and participatory policies of community collaboration need to be incorporated by CONAP and other NGOs due to the uniquely complex ecological and social problems outlined in the following section.

Table 18. Summary of Guatemala's and the IUCN's protected areas management strategies

Management Category	CONAP (Guatemala) Category	World Conservation Union (IUCN) Category	Description of Category
I	Parque Nacional/ Nacional Park	Strict Nature Reserve	Outstanding uninhabited, representative ecosystem. Available primarily for scientific research or environmental monitoring
	Reserva Biológica/ Biological Preserve	Wilderness Area	
	Zona de Veda/ Zone of prohibition		
II	Biotopo Protegido/ Protected Biotope	National Park	Natural area managed to protect ecological integrity, recreation, spiritual, and educational value
	Monumento Cultural/ Cultural Monument		
III	Área de Uso Múltiple/ Area of Multiple Use	Natural Monument	Area managed to protect significant but unique natural/cultural features
	Manantial/Watershed		
IV	Parque Regional/ Regional Park	Habitat/ Species Management Area	Area subject to active intervention for management purposes so as to ensure the maintenance of habitats and/or to meet the requirements of specific species.
	Reserva de Vida Silvestre/ Wildlife Reserve		
V	Reserva Natural Privada/Private Nature Reserve	Protected Landscape/Seascape	Area managed so as to assure the integrity of the traditional interaction between local peoples and natural resources
VI	Reserva de Biosfera/Biosphere Reserve	Managed Resource Protected Area	Area managed to ensure long term protection and maintenance of biological diversity, while providing a sustainable yield of natural products and services to local peoples

*Summarized from Guatemala protected areas law and IUCN documents found on the web.

Threats to Biodiversity Management

This section summarizes and assesses the problems facing conservation in the Sierra Chinajá, taking into account the unique context within which each problem is embedded. Proximate threats to forest conservation include, but are not limited to: land invasion, forest conversion, timber/firewood extraction, forest fires, erosion and sedimentation, illegal hunting and other non timber resource extraction, and oil and telecommunications development. These activities are most commonly cited as the causes of biodiversity loss in tropical forests, probably because they are the most apparently destructive. However, destructive land use practices are just the last link in a chain of causation that includes structural relationships which influence access and control over resources (J. Belsky, Director of the Bolles Center for People and Forests, pers. com). The intersection of these activities constitute underlying driving forces of forest degradation and conversion and include: land concentration, lack of institutional legitimacy, and tenure insecurity. The interrelated nature of many of these problems suggests the need for a holistic approach. Addressing only one problem, or only the symptomatic proximate causes of the underlying driving forces of forest conversion (Geist and Lambin, 2002), will not likely resolve challenges to biodiversity conservation. Therefore, I analyze these problems from an integrated perspective and identify underlying driving forces of forest conversion (Geist and Lambin, 2002).

Land Invasion

The large number of landless farmers in Alta Verapaz is one of the reasons this area (Franja Transversal del Norte) and the Péten were opened for settlement in the 1970's. Historical land distribution inequity and the concentration of lands in vast plantation estates in more productive agricultural areas like highland Alta Verapaz have been determining factors in the conflicts over land tenure for decades. The inequitable access to land and other resources was a driving cause behind Guatemala's 36-yr civil war and a pillar on which the 1996 Peace Accords was founded. Thus, access to land and secure land tenure are central themes that motivate all actors involved. Due to underlying political, economic, and social complexities and conflict, the issue of tenure has yet to be dealt with in a meaningful way (Jones, 1990).

Land insecurity tends to encourage mismanagement of forest lands in the pursuit of short term gains (Godoy et al., 1998). This is largely because the long term investments needed for sustainable forest management are absent for farmers with insecure land claims. The government's weak role in the regulation of public lands is an underlying cause of this insecurity. The lack of governance legitimacy complicates protected areas management by traditional means and may point to the need for the empowerment of local communities (Clark, 1998). It is for this reason that community land titling may represent a potential means to maintain forest cover and establish a sense of stewardship among local residents. In situations like the Sierra Chinajá, where many groups vie for control over areas of open access lands, the entitlement of certain groups can assist the effort of forest conservation (Godoy et al., 1998).

Land entitlement alone will not assure the maintenance of forest cover in the Sierra. Projects and policies (i.e. Integrated Conservation Development Projects or ICDPs) designed to improve the standard of living and promote alternatives to the expansion of the agricultural frontiers are also needed to facilitate this transition. In a paper by Ostrom et al. (1999) a policy of 'exclusion' and 'creating incentives' is suggested to effectively manage lands under insecure tenure regimes. It is argued that by restricting access to resources to certain groups, through the assignment of rights to other groups, resource degradation can be avoided, as long as there are incentives to sustainable use of natural resources.

Currently 18 communities as well as other adjacent communities (see Alvarado et al., 1998, Gaitan, 2002) and individual property owners are situated in and around the Sierra. Because of spontaneous migration to the Sierra, conflicts exist not only between various government agencies and settlers, but between previously established communities and newly arriving 'invaders'. Due to the land claims of newly arrived communities, older land claims have been solidified and legitimized by government agencies in an attempt to stem the uncontrolled migration of new colonizers. Nevertheless, the disorganized implementation of a seemingly ever-changing government policy and the characteristic impunity to law that exists in Guatemala has undermined the effectiveness of government intervention. Confusion over rights of access to land resources, worsened by recently enacted protected areas policy, has prompted forest conversion by creating a commons that is managed, de facto, by resident colonizers.

In some cases newly arrived communities are the sons and daughters of adjacent communities that are "defending" their interests in lands they have traditionally protected from fire and utilized in less intensive ways such as the collection of firewood and non timber forest products. Due to recent arrival of new settlers, these communities are attempting to 'appropriate the commons' before outsiders can. Many recent arrivals appear unlikely to improve newly acquired lands due to lack of capital, limited desire to create permanent agricultural systems, or to reside in the region and because many of these lands are marginal (i.e. reserved for NTFPs because of their unsuitability for more intensive uses). Instead, many are looking to acquire lands they can later resell at a profit (Ernesto Tzi, President APROBA-SANK, pers. com.).

Nevertheless, the acquisition of secure title may be the leverage needed to achieve community compromise on conservation issues.

Forest Conversion/Expansion of agricultural frontier

The most obvious proximate threat to ecosystem integrity is the 'expansion of the agricultural frontier', which refers to the change in forest cover from native forest vegetation to agriculture usually involving the cutting and burning of previously forested areas. This activity reduces biodiversity, simplifies habitat structure, increases erosion, and depletes soil fertility (Pimentel et al., 1992). Local communities are often held responsible for this destruction and they are certainly the active proximate causes. However, underlying, driving factors that force communities onto marginal agricultural lands are often ignored or simply said to be caused by population growth (Geist and Lambin, 2002). The reality in the Sierra Chinajá and many other regions in Latin America is that land concentration and government policies (i.e. perverse incentives) also play large roles.

From a topographic, soils, and production potential perspective, one has to question why colonizers would choose to farm distant, rocky, steep lands. The answer is that these are the only lands that have not been formally or forcefully appropriated by other people. The lowlands that surround the Sierra are already settled by communities and large land holders that own vast cattle ranches and oil palm plantations. These 'prime' lands for development have already been appropriated, either legally or corruptly. The inequitable distribution and intensive management of adjacent lands influences forest conversion in the Sierra. By forcing landless farmers onto marginal mountainous lands, a cycle of land degradation is initiated which compromises both biodiversity conservation and the sustainable development efforts.

Deforestation has been traditionally used in the region as a tool to claim territory (Schwartz, 1990); thus, without land title, deforestation is perceived as a rational course of action. Land rights are conveyed upon a particular area by using it in a productive manner and not allowing it to become idle or 'tierra ociosa' (Ley de reforma agrarian Decreto 900 de la Constitucion de Guatemala June 17, 1952). The government has also utilized this notion of 'idle' land to expropriate lands considered 'idle'. These government policies have fueled widespread deforestation in lowland areas of Guatemala.

Alternatives or incentives could be created to encourage more sustainable agricultural and land use practices, like shade grown cardamom cultivation and

NTFP harvesting, (i.e. Xate collection). Unfortunately, maximization of short term benefits of land use is currently the norm because of lack of secure land tenure. Reforestation and land restoration are long term propositions that will only gain support from individuals or communities that have a reason to invest in the future. At present, investing in reforestation is unlikely due to government policy and resource competition. Policies and programs that allow agrarian societies to stabilize and diversify incomes while providing for ecological sustainability are one means to address the problem of forest conversion. However, underlying, driving forces, specifically inequitable access to 'prime' agricultural lands, will likely have to be addressed if forest conversion is to be effectively controlled. Although this structural change may be impossible without extensive agrarian reform efforts, it is nevertheless important to consider land use practices which ameliorate unsustainable resource use.

Timber/Firewood extraction

Large scale timber extraction does not occur in Sierra Chinajá due to the cratered topography which makes mechanized extraction virtually impossible. Sustainable forestry practices are also not attractive due to low site productivity and access limitations. Despite the difficulty of timber extraction, the Sierra has already been largely high graded for Mahogany (*Swietenia macrophylla*) and Cedar (*Cedrela odorata*). Currently local timber extraction is centered on Chico Zapote (*Manilkara sapota*) for both dimensional lumber and firewood. The intensity of current extraction could lead to depletion of these and other species if harvest controls are not enacted. Most firewood collection is used to dry cardamom in communities with industrial dryers (i.e. Sesaltul and Tzulul Qeqchi). The impact of these dryers on local forests is unclear, but likely significant due to the large quantity of fire wood required (Figure 10).

Figure 10. Pile of firewood destined for use in cardamom dryer, Chisec, Alta Verapaz

All resident families of Sierra Chinajá also rely on firewood as their primary source of energy for cooking. The demand for firewood and its impacts on local resources warrants further study. The designation of certain areas of the Sierra Chinajá for the production of 'energetic forests' or plantations composed of fast growing fuel wood species could mitigate firewood harvesting impacts.

Chapter six identifies many tree species which are utilized by the residents of the 9 oldest communities. Wood and timber products represent the largest component of income derived from forest resources. Land insecurity may provoke over harvesting of timber and firewood by local communities due to the presence of open access land tenure regimes and doubt over continued control over resources. Local and regional markets also exert an increasingly large pressure on Sierra Chinajá forests because of their proximity to newly opened transportation networks. Residents of 'old communities' noted that Sierra Chinajá lands have been widely used by adjacent, wealthy land owners and communities, for poles, fence posts, firewood, and timber.

Forest fires

Large scale forest fires, although rare, have historically occurred in the Sierra Chinajá. Fires were especially widespread from 1998-2000. In 1998, a strong El Niño provoked both a drought and fire, which burned a large portion of the lower slopes of the Sierra. Most fires are started by farmers whose fires "escape" and damage adjacent forest lands. Fire damage can be minor or severe depending upon the intensity and duration of the burn. Steep hill slopes above agricultural fields are especially vulnerable due to the threat of fire climbing fuel ladders of downed trees. Large fires that climb hill slopes and reach ridges are especially devastating as they can spread to other ridges. They also cause lasting damage to forest ecosystems because shallow soils and rocky terrain are worsened. Stunted forest regeneration on post fire ridges is still evident decades later (Figure 11).

Figure 11. Stunted vegetation on ridges, ~8yrs after fire, Serrania de Los Mayas, Sierra Chinajá

Because seasonal burning corresponds with the height of the dry season, fires often spread to adjacent vegetation. Small scale, low intensity brush fires set annually by local farmers appear to cause little damage and facilitate land management. Fire is an integral part of the agricultural system currently practiced by local farmers. It is also of spiritual and cultural importance as well as an agricultural tool for local farmers (Hatse and De Ceuster, 2001).

Erosion and sedimentation

Soils perched on steep slopes are highly susceptible to erosion when vegetation is removed and they are exposed to heavy rains. The soils of the Sierra Chinajá are susceptible to degradation because the highly jointed, fissured nature of the limestone bedrock facilitates water and suspended soil movement into subterranean reservoirs (Juberthie, 2000). Soil erosion is accelerated by forest conversion and surface vegetation removal, which is commonly associated with the 'expansion of the agricultural frontier'. Agricultural systems which promote less frequent disturbance of soil, such as agroforestry systems (i.e. cardamom, cacao, vanilla) generally cause less erosion (Universidad Rafael Landivar, 1994). Despite high rates of erosion, contour planting, terracing, and green belts are rarely used to mitigate this problem.

In extreme environments such as the Sierra Chinajá, the economic viability of soil conservation practices may be debatable, especially due to land tenure insecurity of resident farmers. Farmers are unlikely to invest in long term maintenance of soil fertility when future access to land is still insecure. The orientation of agricultural plots within small valleys or low spots provides catchment areas which take advantage of erosion off the upper slopes. The predominant form of agriculture (i.e. shade grown cardamom) causes little disturbance to soil structure due to the permanent establishment of plots and maintenance of ground cover. This land use causes less alteration to forest structure and biodiversity than 'milpa' agriculture because of the maintenance of shade providing canopy trees. With the revenue earned through cardamom sales, staple crops like maize and beans are purchased. Accordingly, the need to produce these staple crops through traditional intensive annual cropping systems is greatly reduced. Thus it would seem possible to reconcile forest conservation and agricultural production through shade grown crop production (Perfecto et al., 1996). Nevertheless any economy based solely on cash crop production is at risk from global market instability, which can rapidly send the price of commodities like cardamom into steep decline. The implications of market decline could cause accelerated forest conversion, thus the volatility of international markets for this spice should be assessed to reduce the risk of such repercussions.

Illegal hunting and resource extraction

Wild game populations are reported to be declining by local resident hunters although actual data on hunting rates and species populations do not exist. Wildlife species hunted by local populations are detailed in Chapter six and there are five species of primary interest. Fragmentation of habitat and reduced prey for top level predators, particularly jaguar and puma, not local hunting pressure, may pose the major threat to these species in the Sierra Chinajá. Nevertheless, the populations of top-level carnivores were not surveyed in this study and the degree to which this area is utilized by these species is unknown. Large felines could be using the Sierra Chinajá as part of their home range or while moving from areas with known jaguar and puma populations (Laguna Lachua National Park, Tzuultaqa Forest Reserve, Candelaria Caves National Park). Thus, Sierra Chinajá may provide connectivity between other core forest areas.

Customary use and collection of flora and fauna by resident settlers is similar among Qeqchi in most areas adjoining the Sierra. However, these "every-day" (from the Qeqchi perspective) activities are prohibited according to the 1989 law of protected areas. In essence this law converted law abiding citizens into criminals over night. One particularly problematic element of this law made collection of the ornamental palm Xate (*Chamaedorea spp.*) illegal. When harvested properly, Xate extraction can be ecologically sustainable and economically productive (Salafsky et al, 1999, Orellana et al. 2001). However, current Xate harvest practices do not assure sustainability. Due to the lack of secure access and control over Xate resources in the Sierra Chinajá, collectors may optimize short term economic production over long term sustained yield. The doubt of whether resources will be available in the future likely causes collectors to manage resource extraction for short term benefits, which may cause resource degradation. Xate extraction and commercialization should be investigated and managed in order to sustain yields and profits over the long term, while minimizing adverse ecological effects.

Oil and Telecommunications Development

The opening of vast acreages of land to development through the construction of roads and other transportation networks to extract oil facilitated the settlement of formerly uninhabited lands in Guatemala (Solano, 2005). Roads provide a means to extract not only oil, but also forestry and agricultural commodities. The result was an influx of migrants looking to earn a living off the land. This has traditionally involved the conversion of forests into farms, the removal of valuable timber species, and hunting wild game populations.

Today, oil extraction has moved to the sidelines of the Sierra, but the cement caps of abandoned wells and approximately 4km of road in the community of Tzulul Qeqchi are testament to a time when oil extraction was pursued well inside the Sierra. The current extent of oil exploration activities is unknown. However, petroleum exploration and extraction will likely increase due to increasing global demand. New platforms and pumping rigs have sprung up along the sides of the Sierra. Oil extraction in protected areas is illegal according to Guatemalan law, but did not stop oil development in the core zones of the largest protected area in Guatemala, Laguna del Tigre (R. Reyes, former Secretary General of CONAP, pers. com.).

Another transnational development threat is the construction of radio communications infrastructure within the core areas or highest points of Sierra Chinajá. The advent of radio technology stimulated the construction of telecommunications infrastructure in Guatemala. The construction of large antennas and roads to access remote sites exacts a toll on flora and fauna. Currently there are three transmitters on the central ridge of the Sierra and a recent extension of the energy grid from the community below, has led to forest clearing to erect poles and power lines. The impact of the periodical clearing of otherwise forested habitat for the maintenance of these power lines and antennae is cumulative and likely fragments habitat for many interior forest dwelling species.

Biodiversity Conservation in the Developing World

Protected areas management in the Sierra Chinajá must address factors that are absent in North America. Inequitable land and resource concentration, large rural impoverished populations, intensive small-scale agriculture, and uncontrolled resource extraction are factors that have far ranging repercussions for protected areas management. The role of the state in regulating land use inside protected areas is often tenuous due to a history of extractive enterprises, dependence of local people on land inside parks, and the lack of funding that is characteristic of protected areas management agencies in developing nations (Bruner et al., 2001). For these reasons it is important that protected areas management efforts in developing nations adapt policies to local conditions and diverge from coercive, ineffective, and unjust policies (Peluso, 1993, Zerner, 1996).

A recent change in exclusive models of protected areas management has shifted the focus from United States-based models, in which humans are removed from the land, to one emphasizing local communities as possible conservation stewards (Brosius, 2003). This movement towards what is known as Community Based Conservation (CBC) or Community Based Natural Resource Management (CBNRM) seeks to decentralize land use decision making, particularly with respect to natural resources, by devolving power to local institutions comprised of resident peoples (Brosius, 2003).

This transition is often facilitated through Integrated Conservation Development Projects (ICDPs) that attempt to create links between livelihoods and forest/resource conservation through education and community development initiatives (Stallings, 2001). The conservation and development effectiveness of ICDPs has been questioned (Hughes and Flintan, 2001), but continues to be the principal way protected areas management is pursued throughout much of the tropics, including Guatemala (Stallings, 2001).

In the Sierra Chinajá land tenure is of paramount conservation importance and could be a means to engage all actors and facilitate the transformation of resident people from 'squatters' to 'stewards'. Without security of ownership, it is unlikely that farmers will invest in long term land management (Godoy et al., 1998), instead they will likely continue short rotation agricultural cropping systems that are unsustainable on the majority of the region's land. Without land security, residents of the Sierra Chinajá, are unlikely to adopt or participate in many activities (ie. ecotourism, agroforestry, reforestation) promoted by ICDPs, whether they improve environmental health or stimulate economic development.

The challenge of creating management strategies to address the realities of dynamic and diverse ecosystems such as those found in tropical Latin America are well recognized (Putz et al., 2001, West and Brechin, 1991) Instead of repeating the management mistakes that have served to alienate resident peoples and fracture natural landscapes in an attempt to 'extract a protected park' from its surroundings, it may be more useful to imbed protection within the context of community based land management.

The data compiled in this study provide an overview of an area that possesses unique and valuable biodiversity and forest resources that deserve protection for their global existence values. It also documents the scale of dependence that local communities have on the natural resources of the Sierra. The high degree of integration of resident people in the Sierra Chinajá requires a novel approach to management which addresses the many opportunities and constraints to forest conservation in the area.

The traditional zoning strategies inherent in many large land reserves (i.e. biosphere, national parks, and extractive reserves) may not be suitable for lands under varying degrees of use by local residents, unless these zones are identified and corroborated by locals (Zerner, 1996, Brosius, 2003). Unrealistic land conservation agreements can lead to the failure of conservation planning, unless management plans are tailored to local conditions, including agricultural dynamics and the seasonal nature of many activities. The overlapping patchwork of agricultural cultivation (Zimmerer, 1999) and the extraction of NTFPs in forested patches (Salafsky et al., 1993) that characterize land use in Latin America suggests the need for dynamic management regimes that incorporate trade-offs between development and environmental preservation. A recent proposal by the conservation organization ProPeten for a new category of protected areas management is a potential step in this direction (ProPeten, 2003).

The ProPeten proposal calls for a new management category (Indigenous Reserve). Current protected areas management legislation in Guatemala does not recognize the rights of indigenous peoples and their proposal addresses that deficiency (ProPeten, 2003). In light of the significance of the Indigenous population in Guatemala (i.e. accounting for 65% of total population of approx. 13M), this omission has caused a glaring deficiency in protected areas management and resulted in unresolved conflicts, such as in the Sierra Chinajá. Without formal mechanisms to reconcile the interests of the state and local peoples, land tenure conflicts in protected areas have worsened. The creation of an Indigenous Reserve category could be the mechanism to bridge this gap.

The details of what constitute an Indigenous reserve and how one should be managed remains undefined. The language parallels that used in the International Labor Organization's (ILO) Indigenous and Tribal People's Convention ILO #169 (1989). This document focuses on the need to maintain customary rights or "usos consuetudinarios". In essence, these documents argue that there are certain inalienable rights, among them traditional use and access to land and natural resources for indigenous people. Whether or not the residents of Sierra Chinajá qualify as 'customary' or 'traditional' residents, deserving of the rights potentially granted by these documents after having lived in this area for less than two generations, is a question warranting further analysis. It would be necessary to identify to what degree current land use practices are of a 'customary nature'. It is also important to recognize that although some agricultural practices may be of a 'customary' nature it doesn't mean they are the most sustainable or suitable to land capacity and market demand. The development of alternative non-traditional agricultural systems could be more sustainable, profitable, and acceptable to local land managers; and should not be overshadowed by this proposal's focus on 'customary uses'. Nevertheless, the lack of an alternative protected areas management category, which addresses conditions specific to Guatemalan realities is an important move towards the implementation of the federal protected areas system.

Toward Management Strategies to Conserve Biodiversity

Current human population growth in the Sierra Chinajá is unsustainable, largely because of new migration to the area, which has doubled the number of resident households in the last ten years. Even if this growth was stopped today it is debatable whether agricultural production systems used by current residents would be sustainable on these marginal lands under current levels of use.

Traditional protected areas management has failed to achieve the goals of biodiversity conservation. The incompatibility of traditional protected areas management models is evident in the unprecedented rate at which forest conversion and expansion of the agricultural frontier is occurring today in the Sierra. The prospect of forced resettlement of local peoples within the context of Guatemalan reality is, at best, likely to cause extreme hardship to an already marginalized population barely surviving, and at worst it could spark civil insurrection that could be the impetus to another civil war. The lack of institutional legitimacy, land tenure insecurity, and land concentration are the underlying driving forces for biodiversity loss in the Sierra Chinajá and the reasons for the failure of top-down government driven command and control protected areas management policies.

The ProPeten proposal for an Indigenous Reserve category is yet another call for conservation from the "bottom-up". It is based on the recognition that land management needs to promote both local (use) and global (existence) values of biodiversity, without privileging a particular side. This model of protected areas management, and others put forth by APROBA-SANK (2004), come from experiences in the field, at the point where conservation theory meets reality. They recommend an inclusive approach that involves working with local communities, takes into account the realities of local agricultural production systems, and places responsibility of upholding conservation commitments in the hands of local institutions. The short falls of 'top-down' management, such as externally determined protectionist agendas that ignore local people in the name of biodiversity, are neither affordable nor effective in the Sierra Chinajá. In contrast, an Indigenous Reserve represents an important first step to involving and empowering resident people in conservation efforts. While community co-management is a step, it alone is not a solution.

A combination of government support and local co-management of protected areas could effectively ensure forest conservation in the Sierra. The current rate of biodiversity loss is a symptom of greater problems that underlie land management in the Sierra. Integration of governmental protected areas management models and community based management elements could provide the institutional backing and the on-the-ground empowerment of land users that is needed to effectively manage forest resources that are being exploited as open-access resources. By creating a union of currently polarized groups (i.e. CONAP and local communities) certain weaknesses inherent to each group could be overcome. The formal creation of the Indigenous Reserve category within the system developed by CONAP could create the permanent mechanisms which allow integration between community-based and institutionally-based land management efforts. Due to the institutional discordance between FONTIERRA and CONAP a confusing mosaic of land tenure regimes exists in the Sierra, which is contentious not only between neighboring communities, but also within communities as well. This confusion is highlighted by the community mapping exercise presented in Chapter 7, which shows great divergence over accepted boundaries by FONTIERRA and the local communities. This perception of land use rights is further complicated when maps of territorial boundaries are compared with maps of actual land use by local farmers. It would seem that local farmers pay little regard to political boundaries and instead emphasize the exploitation of favorable agricultural lands; even those distributed a great distance from the urban center. Confusion over land tenure and ineffective enforcement of law (due to the history of civil war, institutional turnover of land titling agencies, under funded national police force, corrupt local government, and a military limited by the 1996 Peace Accords) makes state control alone impossible. In addition, the inability of FONTIERRA to compensate displaced communities and the institutional policy of CONAP, which limits resettlement of indigenous communities in Alta Verapaz in effect transfer the de facto right to establishment of land tenure regimes from institutional agencies (i.e. government) to local residents. Thus institutional mechanisms which grant secure land title to local residents (i.e. the de facto land managers) strengthen control over land use and empower local people to defend their own lands from newly arrived land 'invaders', something the government has failed to do since the declaration of protected areas in 1989. This arrangement could lead to less indiscriminate invasion of protected areas (ex. in the case of San Francisco, the only community that has already been granted formal land title, no new communities have invaded their lands and they have not sold their rights) which subsequently could reduce the conversion of forest cover. Although this study does not provide documentation proving that the acquisition of land title leads directly to forest conservation, some anecdotal evidence reported by residents of San Francisco suggests that blocks of historically intact forest have been maintained since the community received definitive land title in 2004.

Communal land claims, as currently organized by FONTIERRA, may be the proper tenure arrangement to facilitate the change from land 'squatter' to 'steward'. However, as evidenced by the *ejidos* of Mexico, these tenure arrangements have had varying effects depending on federal policies and local socioeconomic, political, and ecological conditions (Taylor, 2006). Although, the definitive privatization of land conveys certain benefits upon its owner, including more easily defensible lands, it can also be dangerous because it can facilitate land concentration through the sale of newly acquired lands to wealthy land owners and cattle ranchers. Non-transferable rights act to safeguard long term land access to title holders, but also limit the likelihood of acquiring all-important bank loans, necessary to jump start the livelihoods of capital deficient impoverished farmers of the area (B. Marie, Director of Chisec Project of NGO Veterinarians Without Frontiers, pers. com.). Rights conveyed upon title holders in the Sierra Chinajá need to consider these risks. A form of 'limited title' which restricts sales and defines certain land use norms should be developed in conjunction with local communities.

Inherent weaknesses are likely in whatever conservation agreements are made, especially because of pressure exerted by powerful national elite and multi-national interests such as oil companies. However risky the prospect of land titling of protected areas may seem to staunch environmentalists, to follow the current course, which has been dictated by "one-size-fits-all" international models of protected areas management, would result in continued settlement and forest conversion in the Sierra Chinajá.

The community of San Francisco highlights the importance of land title in excluding outside settlers and forest users and could provide an indicator to the viability of community conservation without intervention. Through unknown processes and channels San Francisco acquired land title and has subsequently not had problems with invaders, despite the fact that two new communities have established themselves nearby of their border, and within the territories of other well established communities (i.e. Tzulul Qeqchi and Mucbilha II) that lack titles. How an Indigenous Reserve could be integrated with CONAP and IUCN policies remains to be considered. However, if approved, the ProPeten proposal would make the Sierra Chinajá a likely candidate to become one of the first ever Indigenous Reserves in Guatemala. The integration of community based management strategies and federal protected areas management categories is the combination of state and local management that is key in order to legitimize protected areas policies in areas of land insecurity. Without proper legal land tenure documentation and financial investment provided by the state, local residents are unable to take responsibility for the management or develop a sense of ownership of protected areas lands. While without support and participation from local people any top-down forest management strategy is likely to receive resistance or opposition. The implications of an integrative designation which combines government support with community management should identify ways to facilitate community well being and biological conservation. One way to contemplate the reconciliation of these two goals is through the identification of land use practices that serve to both promote forest conservation and agricultural production systems.

The role of agricultural practices in influencing vegetation dynamics suggests ways to integrate protected areas management with 'customary uses' (i.e. agricultural production). Patchworks of agricultural development are key factors that determine landscape integrity as well as agrobiodiversity (Perfecto et al., 1996 and Zimmerer, 1994). The degree of integration of agricultural systems with the native forest matrix can be manipulated to facilitate the maintenance of ecological processes (R. Senanayake, Senior scientist of Analog Forestry Program for Counterpart International, pers. com.). The widespread cultivation of cardamom may be an opportunity for forest conservation in the Sierra Chinajá. Strategic planting of cardamom to link patches of forest could reconcile conservation of forest integrity and agricultural production. Due to its high market value and relatively low impact on forest ecosystems (excluding firewood extraction for drying), it is conceivable to imagine cardamom cultivation and other shade grown crops as ways to integrate forest conservation with productive agriculture. Nevertheless commercialization of any cash crop should be done in a way which protects the producer, as the pressure of global market demands could create perverse incentives. This pressure could result in accelerated forest conversion, especially when producers are not diversified and dependent upon the production of only one crop. Regardless of the risk of linking conservation efforts to agricultural practices the importance of the agricultural matrix in maintaining biodiversity in the Sierra Chinajá cannot be understated.

Agricultural practices in Sierra Chinajá have been limited to valleys between steep hills. The inherent physical limitations to farming in karst terrain render steep slopes and hill tops unusable. The premium farmers place on inter-hill valleys is a constraint to traditional protected areas management techniques which create swaths of 'intangible' area, which are invariably utilized, despite laws prohibiting use. However, a natural limitation on the ability of a farmer to cultivate lands below a certain soil depth and above a threshold percentage slope, 'naturally' conserves montane habitat, and mosaic forest patterns that link forested hilltops together. Instead of the arbitrary assignment of simplistic management zones, land use plans should consider policies which combine ‘laws’ of agricultural limitation (i.e. threshold soil depth and percentage slope) with conservation theory.

Instead of traditional ‘horizontal zoning’ of concentric circles, the concept of ‘vertical zoning’, limiting use based on slope, soil depth, and elevation may be more acceptable under customary land use systems in the Sierra Chinajá. These concepts, coupled with shade grown agricultural systems could facilitate ecological connectivity and suggests a more viable protected areas conservation strategy.

Land management in the Sierra Chinajá should be a blend of adaptive conservation strategies. The recognition of the need to institutionalize locally based co-management models for protected areas has been made in other parts of Latin America with high populations of indigenous people such as Bolivia (Kaimowitz et.al., 1998). The promotion of new conservation incentives diverges from exclusionary policies imported from developed countries. Guatemala and other Latin American countries would be well advised to explore conservation models based on their unique local, site specific social and ecological conditions. The ProPeten proposal may be the sort of innovation that is required to balance forest conservation with human development in areas characterized by land insecurity and marginalized populations. Nevertheless, traditional protected areas management is useful in establishing baseline concepts from which modifications, like the ProPeten proposal can be made, allowing for the evolution of protected areas management that adapts to unique and changing environments. By looking at conservation from a regional perspective that incorporates social, economic, political, and historical realities a more realistic and viable forest conservation is possible.

A regional conservation strategy values networks of natural and low intensity use areas of differing sizes and management regimes to preserve overall ecological connectivity and viability. From this perspective, Sierra Chinajá is a cornerstone in an ecoregional conservation network that extends from Laguna Lachua National Park to the Tzuultaqa Reserve (Appendix 10). This ecoregional foundation should be promoted as a way to foster forest stewardship among local Qeqchi Maya communities and invite investment from conservation and development financing programs. The future of the Sierra Chinajá and reserves like it, lie not in preservationist policies that remove forests or people from their local contexts, but in the integration of forest conservation with local socioeconomic well being, and in the development of institutionally supported, collaborative, locally-based co-management approaches.

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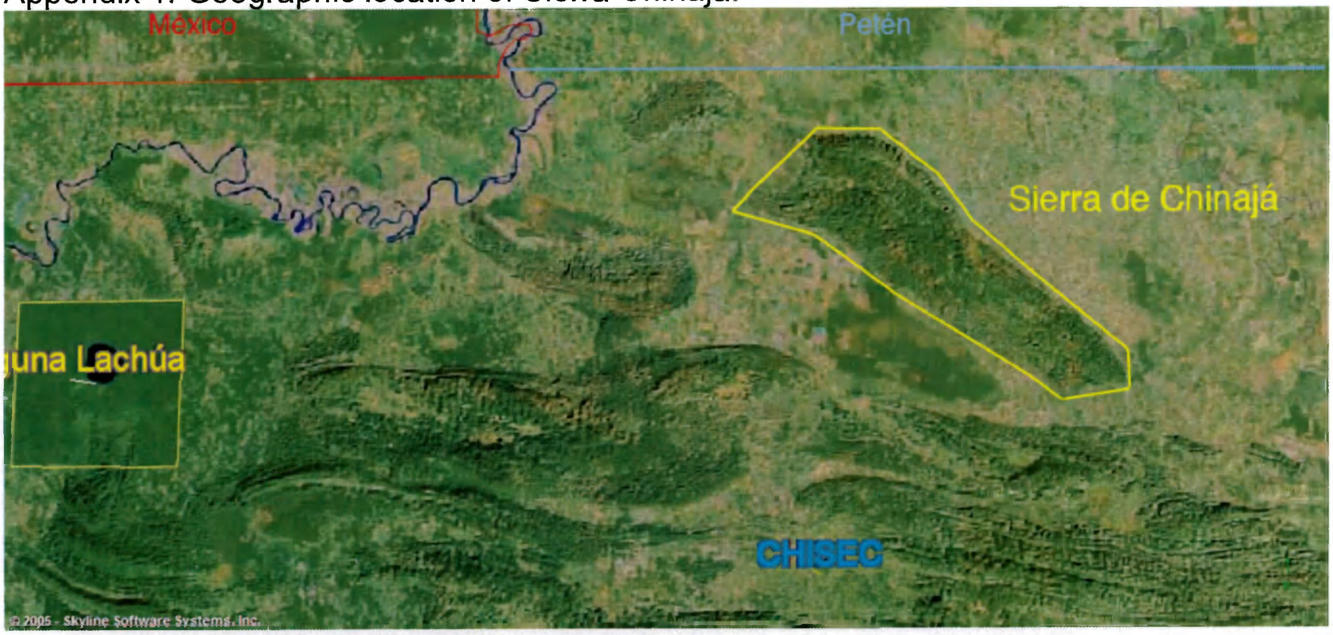
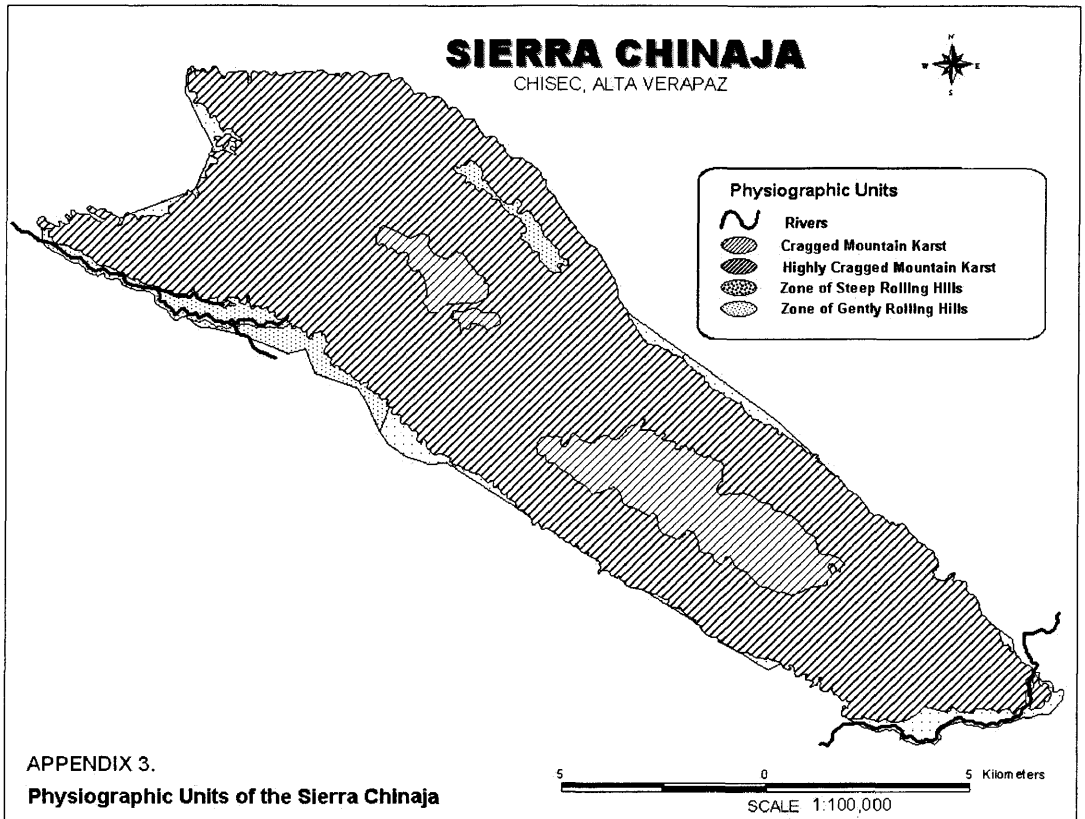
APPENDICES

Appendix 1. Geographic location of Sierra Chinajá.



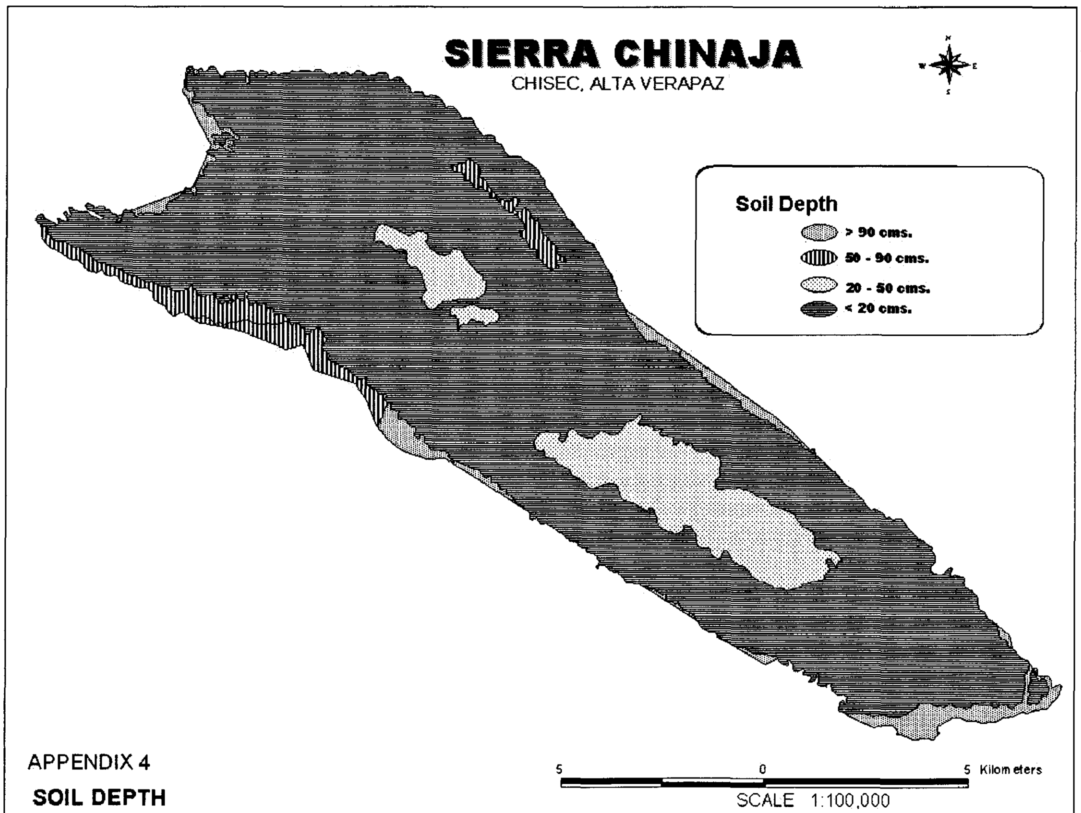
APPENDIX 2
CARTOGRAPHIC DELIMITATION OF SIERRA CHINAJA

5 0 5 Kilometers
SCALE 1:100,000



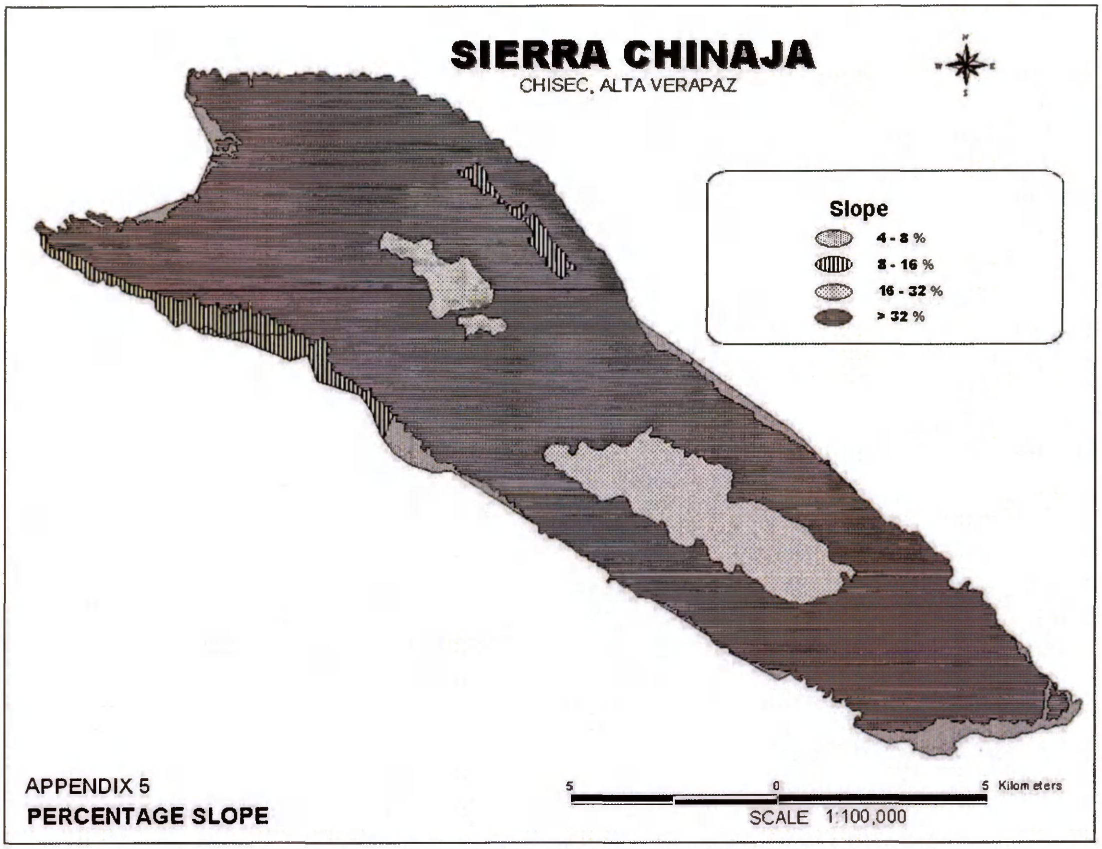
APPENDIX 3.

Physiographic Units of the Sierra Chinaja



APPENDIX 4

SOIL DEPTH



APPENDIX 5
PERCENTAGE SLOPE

APPENDIX 6
LAND USE CAPACITY OF SIERRA CHINAJA

APPENDIX 7. Total list of bird species of Sierra Chinajá recorded from June 2005 – Sept. 2005

CONAP Red List: 1=Almost extinct, 2=Endangered,3=Special Management; CITES Appendix: I=endangered, II=Potentially at risk

	Family	Scientific Name	CONAP	CITES	Migratory
1	Accipitridae	*Buteo (Asturina) nitidus*			
2	Accipitridae	*Buteo magnirostris*			
3	Accipitridae	*Elanus leucurus (caeruleus)*			
4	Accipitridae	*Falco rufigularis*	3	2	
5	Accipitridae	*Leucopternis albicollis*			
6	Alcedinidae	*Ceryle torquata*			
7	Alcedinidae	*Chloroceryle americana*			
8	Apodidae	*Streptoprocne zonaris*			
9	Ardeidae	*Bubulcus (Ardeola) ibis*			
10	Ardeidae	*Egretta thula*			
11	Bucconidae	*Malacoptila panamensis*			
12	Caprimulgidae	*Nyctidromus albicollis*			
13	Cardinalinae	*Caryothraustes poliogaster*			
14	Cardinalinae	*Passerina cyanoides*			
15	Cardinalinae	*Saltator atriceps*			
16	Cardinalinae	*Saltator maximus*			
17	Cardinalinae	*Saltator coerulescens*			
18	Cathartidae	*Cathartes aura*			
19	Cathartidae	*Coragyps atratus*			
20	Columbidae	*Columba nigrirostris*			
21	Columbidae	*Columbina talpacoti*			
22	Columbidae	*Geotrygon Montana*			
23	Columbidae	*Leptotila casinii*			
24	Columbidae	*Leptotila verreauxi*			
25	Corvidae	*Psilorhinus morio*			
26	Cotingidae	*Laniocera rufescens*			
27	Cotingidae	*Lipaugus unirufus*			
28	Cotingidae	*Pachyramphus cinnamomeus*			
29	Cotingidae	*Rhytipterna holerythra*			
30	Cotingidae	*Tityra semifasciata*			
31	Cracidae	*Ortalis vetula*	3	3	
32	Cuculidae	*Crotophaga sulcirostris*			
33	Cuculidae	*Piaya cayana*			
34	Cuculidae	*Tapera naevia*			
35	Dendrocolaptidae	*Dendrocincla homochroa*			
36	Dendrocolaptidae	*Dendrocolaptes certhia*			
37	Dendrocolaptidae	*Glyphorprhyncos spirurus*			
38	Dendrocolaptidae	*Lepidocolaptes souleyetti*			
39	Dendrocolaptidae	*Sittasomus griseicapillus*			
40	Dendrocolaptidae	*Xiphorhynchus flavigaster*			
41	Emberizinae	*Arremon aurantiirostris*			
42	Emberizinae	*Arremonops chloronotus*			
43	Emberizinae	*Sporophila torqueola*			
44	Emberizinae	*Tiaris olivacea*			
45	Emberizinae	*Volatinia jacarina*			
46	Formicariidae	*Dysithamnus mentalis*			

47	Formicariidae	*Formicarius analis*			
48	Formicariidae	*Microrhopias quixensis*			
49	Formicariidae	*Thamnophilus doliatus*			
50	Furnariidae	*Automolus ochrolaemus*			
51	Furnariidae	*Sclerurus guatemalensis*			
52	Galbulidae	*Galbula ruficauda*			
53	Icteridae	*Dives dives*			
54	Icteridae	*Icterus dominicensis*			
55	Icteridae	*Icteus galbula*			Yes
56	Icteridae	*Psarocolius montezuma*			
57	Icteridae	*Psarocolius wagleri*			
58	Icteridae	*Quiscalus mexicanus*			
59	Momotidae	*Hylomanes momotula*			
60	Momotidae	*Momotus momota*			
61	Parulinae	*Basileuterus culicivorus*			
62	Parulinae	*Mniotilta varia*			Yes
63	Parulinae	*Oporornis formosus*			Yes
64	Parulinae	*Seiurus noveboracensis*			Yes
65	Parulinae	*Wilsonia Canadensis*			Yes
66	Picidae	*Campephilus guatemalensis*	2		
67	Picidae	*Dryocopus lineatus*			
68	Picidae	*Melanerpes aurifrons*			
69	Picidae	*Melanerpes pucherani*			
70	Picidae	*Veniliornis fumigatus*			
71	Pipridae	*Manacus candei*			
72	Pipridae	*Pipra mentalis*			
73	Psittacidae	*Amazona autumnalis*	3	2	
74	Psittacidae	*Aratinga astec (nana)*	3	2	
75	Psittacidae	*Pionopsitta haematotis*	3	2	
76	Rallidae	*Laterallus rubber*			
77	Ramphastidae	*Aulacorhynchus prasinus*			
78	Ramphastidae	*Pteroglossus torquatus*	3		
79	Ramphastidae	*Ramphastos sulfuratus*	3	2	
80	Strigidae	*Glaucidium brasilianum*	3	2	
81	Sylviidae	*Ramphocaenus melanurus*			
82	Thraupinae	*Chlorophanes spiza*			
83	Thraupinae	*Cyanerpes cyaneus*			
84	Thraupinae	*Euphonia gouldi*			
85	Thraupinae	*Euphonia hirudinacea*			
86	Thraupinae	*Habia fuscicauda*			
87	Thraupinae	*Habia rubica*			
88	Thraupinae	*Lanio aurantius*			
89	Thraupinae	*Piranga leucoptera*			
90	Thraupinae	*Ramphocelus passerinii*			
91	Thraupinae	*Ramphocelus sanguinolentus*			
92	Thraupinae	*Tangara larvata*			
93	Thraupinae	*Thraupis abbas*			
94	Thraupinae	*Thraupis episcopus*			
95	Tinamidae	*Crypturellus boucardi*	3		
96	Trochilidae	*Amazilia candida*	3	2	
97	Trochilidae	*Amazilia tzacatl*	3	2	
98	Trochilidae	*Campylopterus curvipennis*	3	2	
99	Trochilidae	*Campylorhynchus zonatus*			
100	Trochilidae	*Eupherusa eximia*	3	2	

101	Trochilidae	*Heliothryx barroti*	3	2
102	Trochilidae	*Phaeochroa cuvierrii*	3	2
103	Trochilidae	*Phaethornis longuemareus*	3	2
104	Trochilidae	*Phaethornis superciliosus*	3	2
105	Troglodytidae	*Henicorhina leucophrys*		
106	Troglodytidae	*Henicorhina leucosticte*		
107	Troglodytidae	*Microcerculus philomela*		
108	Troglodytidae	*Thryothorus maculipectus*		
109	Trogonidae	*Trogon collaris*		
110	Trogonidae	*Trogon Massena*		
111	Trogonidae	*Trogon violaceus*		
112	Turdidae	*Myadestes unicolor*		
113	Turdidae	*Turdus assimils*		
114	Turdidae	*Turdus grayi*		
115	Tyrannidae	*Attila spadiceus*		
116	Tyrannidae	*Contopus cinereus*		
117	Tyrannidae	*Elaenia flavogaster*		
118	Tyrannidae	*Leptopogon amaurocephalus*		
119	Tyrannidae	*Mionectes oleaginous*		
120	Tyrannidae	*Myiobius sulphureipygius*		
121	Tyrannidae	*Myiozetetes similes*		
122	Tyrannidae	*Myiodynastes maculatus*		
123	Tyrannidae	*Oncostoma cinereigulare*		
124	Tyrannidae	*Onychorhynchus mexicanus*		
125	Tyrannidae	*Pitangus sulphuratus*		
126	Tyrannidae	*Tolmomyias sulphurescens*		
127	Tyrannidae	*Tyrannus melancholicus*		
128	Tyrannidae	*Tyrannus savanna*		

Appendix 8. Bird species detected in Sierra Chinajá

Scientific Name	Common name	Method of Detection	Site	Sensitivity	Relative Abundance	Cntab	Conservation Priority	Endemic	Habitat
Amazilia candida	Whitebellied Emerald	PC, MN	1,2,3	M	C	LT	4		F1,F7
Amazilia tzacatl	Rufoustailed Hummingbird	PC, MN	1,2,3	L	C	LT	4		F1E,F15,F7
Amazona autumnalis	Redlored Parrot	PC	1,2	M	C	LT	3		F1E,F15,F,F8
Aratinga astec	Aztec Parakeet	PC	1,2,3	L	C	LT	4		F1E,F15
Arremon aurantrirostris	Orangebilled Sparrow	PC,MN	2	M	F	LT	4		F1
Arremonops chloronotus	Greenbacked Sparrow	PC	2,3	L	C	LT	4	Y	F1E,F7,F15
Attila spadiceus	Brightrumped Attila	O	-	M	F	LT	4		F1,F7,F4
Aulacorhynchus prasinus	Emerald Toucanet	O	-	M	F	UT	4		F4,F1
Automolus ochrolaemus	Buffthroated Foliagegleaner	PC	1	M	C	LT	4		F1,F2
Basileuterus culicivorus	Goldencrowned Warbler	O	-	M	C	HT	4		F1,F4,F15
Bubulcus (Ardeola) ibis	Cattle Egret	O	-	L	C	LT	4		N13,N6
Buteo (Asturina) nitidus	Grey Hawk	O	-	M	F	LT	4		F8,F7,F1E,F3
Buteo magnirostris	Roadside Hawk	O	-	L	C	LT	4		F1E,F7,F8,F3,
Campephilus guatemalensis	Palebilled Woodpecker	PC	1,2,3	M	F	LT	4		F1E,F8,F15,F7
Campylopterus curvipenis	Wedgetailed Saberwing	MN	-	M	F	LT	4	Y	F1,F15
Campylorhynchus zonatus	Bandbacked Wren	PC	2	L	C	UT	4		F11,F4E,F1E
Caryothraustes poliogaster	Blackfaced Grosbeak	PC	1,3	M	F	LT	4	Y	F1,F15
Cathartes aura	Turkey Vulture	PC	1	L	C	LT	4		N14,F7,F8,F15
Ceryle torquata	Ringed Kingfisher	O	-	L	C	LT	4		A8,A6,A11,F14
Chloroceryle americana	Green Kingfisher	O	-	L	C	LT	4		A9,A6,A8,F14
Chlorophanes spiza	Green Honeycreeper	PC	2	M	F	LT	4		F1,F2,F15,F8
Columba nigrirostris	Shortbilled Pigeon	O	-	M	F	LT	4		F1,F4
Columbina talpacoti	Ruddy Grounddove	PC	3	L	C	LT	4		N14,N11,N1
Contopus cinereus	Tropical Peewee	PC	2	L	F/P	HT	4		F1E,F4E,F7,F8
Coragyps atratus	Black Vulture	O	-	L	C	LT	4		N16,N6,N1,N13
Crotophaga sulcirostris	Groovebilled Ani	PC	1,2,3	L	C	LT	4		N14,N11
Crypturellus boucardi	Slatybreasted Tinmous	PC	1,2,3	M	F	LT	4		F1,F15
Cyanerpes cyaneus	Redlegged Honeycreeper	PC	2,3	L	C/P	LT	4		F1,F15,F8
Dendrocincla homochroa	Ruddy Woodcreeper	MN	2	H	F	LT	4		F1,F4,F7
Dendrocolaptes certhia	Barred Woodcreeper	PC	2	H	F	LT	4		F1
Dives dives	Melodious Blackbird	PC	2	L	C	LT	4		F1E,F15,F8

Dryocopus lineatus	Lineated Woodpecker	O		L	C	LT	4		F3,F8,F15
Dysithamnus mentalis	Plain Antvireo	O	-	M	C	UT	4		F4,F1
Egretta thula	Snowy Egret	O	-	L	C	LT	4		A1,A2
Elaenia flavogaster	Yellowbellied Elaenia	PC	3	L	C	LT	4		N14,N11,F15E
Elanus leucurus	Whitetailed Kite	O	-	L	U/P	LT	4		N13,N14,N6
Eupherusa e.eximia	Stripetailed Hummingbird	MN	2	M	U	UT	4		F1,F15
Euphonia goldi	Olivebacked Euphonia	PC	1,2	M	F	LT	4	Y	F1
Euphonia hirudinacea	Yellowthroated Euphonia	PC	1,3	L	C	LT	4		F1E,F8,F15
Falco rufigularis	Bat Falcon	PC	2,3	L	F	LT	4		F1E,F7E,F8E
Formicarius analis	Blackfaced Antthrush	PC,MN	3	M	C	LT	4	Y	F1,F2
Galbula ruficauda	Rufoustailed Jacamar	PC	2	L	C	LT	4		F1E,F
Geotrygon Montana	Ruddy Quaildove	O	-	M	F	LT	4		F1,F4,F7
Glaucidium brasilianum	Pygmy Owl	O	-	L	C	LT	4		N1,N2,N14
Glyphorprhyncos spirurus	Wedgebilled Woodcreeper	PC	3	M	F	LT	4		F1,F4
Habia fuscicauda	Redthroated Anttanager	PC	1,2	M	F	LT	4		F1E,F2,F15
Habia rubica	Redcrowned Anttanager	O	-	H	F	LT	4		F1
Heliothrix barroti	Purplecrownd Fairy	PC	2	M	U	LT	4		F1,F15
Henicorhina leucoprhrys	Greybreasted Woodwren	O	-	M	C	UT	4		F4
Henicorhina leucosticta	Whitebreasted Woodwren	PC	1,2,3	M	F	HT	4		F1,F4
Hylomanes momotula	Tody Motmot	O	-	H	U	HT	4		F1,F4
Icterus dominicensis prosthemelas	Blackcowled Oriole	PC	2	L	F	LT	4	Y	F1E, F15
Icteus galbula bullockii	Baltimore Oriole	O	-	L	C	UT	4		F8,F7,F15
Lanio aurantius	Blackthroated Shriketanager	O	-	H	F	LT	3	Y	F1
Laniocera rufescens	Speckled Mourner	PC	1	M	U/P	LT	3		F1
Laterallus rubber	Ruddy Crake	PC	2	L	F	LT	4		A1
Lepidocolaptes souleyetti	Streakheaded Woodcreeper	PC	3	L	L	LT	4		F7,F8,F1,
Leptopogon amaurocephalus	Sepiacapped Flyacatcher	PC,MN	3	M	F	LT	4		F1,F15
Leptotila casinii	Greychested Dove	PC	2	M	F	LT	4		F7,F8,F1
Leptotila verreauxi	Whitetipped Dove	PC	2	L	C	UT	4		F7,F8,F15
Leucopternis albicollis	White Hawk	PC	3	H	F	LT	4		F1,F4,F7
Lipaugus unirufus	Rufous Piha	MN	2	M	F	LT	4		F1
Malacoptila panamensis	Whitewhiskered Puffbird	O	-	M	F	LT	4		F1,F15
Manacus candei	Whitecollared Manakin	PC,MN	1,2	M	F	LT	3	Y	FIE,F15

Melanerpes aurifrons	Goldenfronted Woodpecker	PC	1,2,3	L	C	LT	4		N1,N2,F8
Melanerpes pucherani	Blackcheeked Woodpecker	PC	2,3	M	C	LT	4		F1,F15
Microcerculus philomela	Nightingale Wren	O	-	H	F	HT	3	Y	F1
Microrhopias quixensis	Dotwinged Antwren	PC	1,2,3	M	C/P	LT	4		F1
Mionectes oleaginous	Ochrebellied Flycatcher	MN	2	M	F	LT	4		F1,F2,F15
Mniotilta varia	Black and White Warbler	O	-	L	-	MIGRANT	4		F1,F4,F15
Momotus momota	Bluecrowned Motmot	PC	1,2	M	C	LT	4		F1,F4,F15
Myadestes unicolor	Slatecolored Solitaire	PC	2	M	F	UT	3	Y	F4,F11
Myiobius sulphureipygius	Sulphurrumped Flycatcher	PC	2	M	F	LT	4		F1,F8,F15
Myiozetetes similes	Social Flycatcher	O	-	L	C	LT	4		F1E,F7E
Myodinastes maculatus	Streaked Flycatcher	PC	2	L	C	LT	4		F1E,F15
Nyctidromus albicollis	Pauraque	PC	1,2	L	C	LT	4		F1E,F15
Oncostoma cinereigulare	Northern Bentbill	PC,MN	2,3	L	F	LT	4		F1E,F7
Onychorhynchus mexicanus	Royal Flycatcher	PC	1	H	U	LT	4		F1
Oporornis formosus	Kentucky Warbler	O	-	-	-	MIGRANT	-		-
Ortalis vetula	Plain Chachalaca	PC	1,2,3	L	C	LT	4	Y	F1E,F8
Pachyramphus cinnamomeus	Cinnamon Becard	PC	3	L	F	LT	4		F1E,F15
Passerina cyanoides	Blueblack Grosbeak	PC	2	M	F	LT	4		F1,F15
Phaeochroa cuvierrii	Scalybreasted Hummingbird	O	-	L	C	LT	4		F15,F1E
Phaethornis longemareus	Little Hermit	PC,MN	1,2,3	M	F	LT	4		F1,F15
Phaethornis superciliosus	Longtailed Hermit	PC,MN	2,3	H	C	LT	4		F1,F4,F7
Piaya cayana	Squirrel Cuckoo	O	-	L	C	LT	4		F1,F7,F15
Pionopsitta haematotis	Brownhooded Parrot	O	-	M	F	LT	4		F1,F4
Pipra mentalis	Redcapped Manakin	PC	1,2	M	F	LT	4		F1
Piranga leucoptera	Whitewinged Tanager	PC	3	M	F	UT	4		F4,F1,F11
Pitangus sulphuratus	Great Kiskadee	PC	1,2	L	C	LT	4		F15,F8
Psarocolius montezuma	Montezuma Oropendola	O	-	M	C	LT	4	Y	F1,F15
Psarocolius wagleri	Chestnutheaded Oropendola	PC	3	M	F	LT	4		F1,F15
Psilorhinus morio	Brown Jay	PC	1	L	F	LT	4		F8,F15
Pteroglossus torquatus	Collared Aracari	PC	1,2,3	M	C	LT	4		F1,F15
Quiscalus mexicanus	Greattailed Grackle	O	-	L	C	LT	4		N14,N13
Ramphastos sulfuratus	Keelbilled Tucan	PC	1,2,3	M	C	LT	4		F1,F15
Ramphocaenus melanurus	Longbilled Gnatwren	PC	3	L	FP	LT	4		F1E,F15

Ramphocelus paserinii	Scarletrumped Tanager	PC	1,2	L	C	LT	4	Y	F1E,F15,N14
Ramphocelus sanguinolentus	Crimsoncollared Tanager	PC	1	L	F	LT	4	Y	F1E,F15
Rhytipterna holerythra	Rufous Mourner	O	-	M	F	LT	4		F1,F15
Saltator atriceps	Black-headed saltator	PC	1,3	M	F	LT	3		F1E,F15
Saltator coerulescens	Greyish Saltator	PC	1	L	C	LT	4		N14,N12
Saltator maximus	Buffthroated Saltator	PC	2	L	C	LT	4		F1E,F15
Sclerurus guatemalensis	Scalythroated Leaftosser	O	-	H	U	LT	3	Y	F1,F4
Seiurus noveboracensis	Northern Waterthrush	PC	2	M	-	MIGRANT	4		F1,F15,F14
Sittasomus griseicapillus	Olivaceous Woodcreeper	PC	1	M	C	LT	4		F1,F2,F4
Sporophila torqueola	Whitecollared Seedeater	PC,MN	2,3	L	C	LT	4		N14,N1,N11
Streptoprocne zonaris	Whitecollared Swift	PC	1,2	L	F	LT	4		F4,F1,F15
Tangara larvata	Goldenhooded tanager	PC	3	L	C	LT	4		F1E, F15
Tapera naevia	Striped Cuckoo	PC	2	L	C	LT	4		N14,N6,N11
Thamnophilus doliatus	Barred Antshrike	PC	1,3	L	C	LT	4		N4,N11
Thraupis abas	Yellowwinged Tanager	PC	1,2,3	L	C	LT	4		F1E,F15,F8
Thraupis episcopus	Bluegray Tanager	O	-	L	C	LT	4		F1E,F15
Thryothorus maculipectus	Spotbreasted Wren	PC	1	L	F	LT	4		F1E,F15,F7
Tiaris olivacea	Yellowfaced Grassquit	PC	1	L	C	LT	4		N14,N1
Tityra semifasciata	Masked Tatyra	PC	1,2	M	C	LT	4		F1,F4,F15
Tolmomyias sulphurescens	Yellowolive Flycatcher	PC	1	M	F	LT	4		F1,F4,F7
Trogon collaris	Collared Trogon	PC	1,2	M	C	LT	4		F1,F4,F2,F7
Trogon Massena	Slatytailed Trogon	O	-	M	F	LT	4		F1,F15
Trogon violaceus	Viloaceous Trogon	PC	1,2,3	M	F	LT	4		F1,F15
Turdus assimils	Whitethroated Thrush	PC	1,2	M	F	UT	4		F4,F1,F7
Turdus grayi	Claycolored Robin	PC	2	L	C	LT	4		F1E,F7,F15
Tyrannus melancholicus	Tropical Kingbird	PC	2	L	C	LT	4		F15,F8,F3
Tyrannus savanna	Forktailed Flycatcher	O	-	L	C	LT	4		N6,N7,N13
Veniliornis fumigatus	Smokybrown Woodpecker	PC	1,2	L	C	UT	4		F4,F1,F15
Volatinia jacarina	Blueblack Grassquit	PC	1,2,3	L	C	LT	4		N4,N6,N1
Wilsonia Canadensis	Canada Warbler	O	-	M	-	MIGRANT	4		F4,F15,F1
Xiphorhynchus flavigaster	Ivorybilled Woodcreeper	PC	1,2	M	C	LT	4		F1,F4,F7

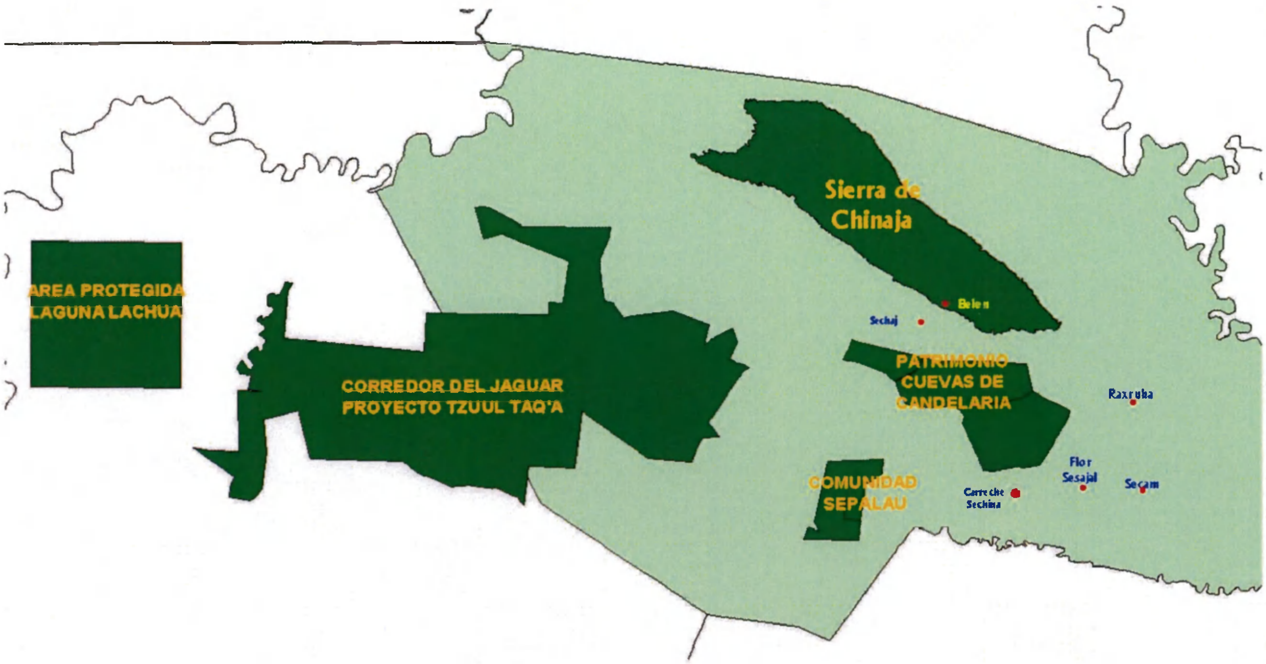
Center of Abundance: LT-Lower tropical(<500m), LS-Lower subtropical(<500m), HT-Hill tropical(500-900m), UT-Upper tropical(900-1600m), US-Upper subtropical (500-1600m), MM-Middle montane(1600-2600m), UM-Upper montane(>2600m)
Conservation Priority: 1-Urgent, 2-High, 3-Medium, 4-Low

Habitats: F1-Tropical lowland evergreen forest, F2-Flooded tropical evergreen forest, F3 River-edge forest, F4-Montane evergreen forest, F5-Elfin forest, F7-Tropical deciduous forest, F8 Gallery forest, F11-Pine-oak forest, F15-Secondary forest, N1-Arid lowland scrub, N2-Arid montane scrub, N3-Semihumid/humid montane scrub, N13-Pastures/agricultural lands, N14- Second-growth scrub, A1-Freshwater marshes, A8-Rivers, A9-Streams, E-Edge
Relative Abundance: R-Rare,U-Uncommon,F-Fairly comon, C-Common, P-Patchily distributed
Sensitivity: L-Low, M-Medium, H-High
Method of Detection: PC-Point Count, MN-Mist Net, O-Other random sighting
Site: 1=Nueva Esperanza, 2=Tzulul Qeqchi, 3=Mucbilhall, MN-Mist Nets
(According Stotz et. al. 1996 Neotropical Birds: Ecology and Conservation)

Appendix 9 Species of bats of Sierra Chinajá and their relative abundance

No	Scientific Name	Location				
		Mucbilha II	Nueva Chinajá	Tzulul Qeqchi	N	Relative Abundance
1	*Mimon cozumelae*		1		1	1.23
2	*Carollia brevicauda*		10		10	12.35
3	*Carollia perspicilliata*		3		3	3.7
4	*Carollia sowelli*		7	10	17	20.99
5	*Dermanura azteca*		3		3	3.7
6	*Dermanura phaeotis*		2		2	2.47
7	*Dermanura tolteca*		2	3	5	6.17
8	*Dermanura watsoni*		5	5	10	12.35
9	*Desmodus rotundus*	1			1	1.23
10	*Diphylla ecuadata*		2		2	2.47
11	*Glossophaga soricina*		1	1	2	2.47
12	*Glossophaga sp.*		3		3	3.7
13	*Mimon cozumelae*		1		1	1.23
14	*Myotis arbescens*		3		3	3.7
15	*Myotis sp.*		1		1	1.23
16	*Platyrrhinus helleri*		1		1	1.23
17	*Pteronotus helleri*			1	1	1.23
18	*Pteronotus parnelli*		2		2	2.47
19	*Sturnira ludovici*	2			2	2.47
20	*Tonatia saurophila*		2	2	4	4.94
21	*Trachops cirrhosus*		1		1	1.23
22	*Uroderma bilobatum*	1			1	1.23
23	*Carollia sp.*		1		1	1.23
24	*Dermanura sp.*		1		1	1.23
25	*Sturnira lilium*	4			4	4.94
Total individuals		7	52	22	81	
Total Bat Species Richness		**4**	**20**	**6**	**22**	

APPENDIX 10. Regional connectivity of conservation units in Northern Alta Verapaz



Appendix 11. Tree Species of Sierra Chinajá, Source: Inventario Forestal APROBA-SANK 2005 CONAP Red List: 1=Almost extinct, 2=Endangered,3=Special Management; CITES Appendix: I=endangered, II=Potentially at risk

No	COMMON NAME	SCIENTIFIC NAME	FAMILY	RED LIST CONAP, CITES
1	Aceituno	*Simarouba glauca* DC	SIMAROUBACEAE	
2	Aguacatillo	*Nectandra globosa* (Aubl.) Mez	LAURACEAE	
3	Amate	*Ficus radula* Humb.& Bonpl.ex Willd	MORACEAE	
4	Am che'	*Rhus striata* Ruiz & Pav.	ANACARDIACEAE	
5	Anona de Monte	*Annona scleroderma* Saff.	ANNONACEAE	
6	Anonillo	*Guatteria anomala* R.E. Fr.	ANNONACEAE	
7	Aq' al	*Eugenia spp.*	MYRTACEAE	
8	Baas	*Trichospermum grewiifolium* (A.Rich.)Kosterm.	TILIACEAE	
9	Balsa	*Ochroma lagopus*	BOMBACEAE	
10	Bálsamo	*Myroxylon balsamum* (L.) Harms	FABACEAE	3
11	Bac car			
12	Baq' el	Laetia procera	FLACOURTIACEAE	
13	Cacaute	*Desmopsis stenopetala* (Donn. Sm.) R.E. Fr.	ANNONACEAE	
	Canche	*Morinda spp.*	RUBIACEAE	
14	Cansin	*Lonchocarpus castilloi* Standl.	FABACEAE	
15	Canxan	*Terminalia amazonia* (J.F. Gmel.) Exell	COMBRETACEAE	
16	Caoba	*Swietenia macrophylla* King	MELIACEAE	3
17	Cedrillo	*Guarea glabra* Vahl	MELIACEAE	
18	CheTzul	*Parathesis spp.*	MYRCINACEAE	
19	Chechen blanco	*Sebastiania longicuspis* Standl.	EUPHORBIACEAE	
20	Chechen negro	*Metopium brownei* (Jacq.) Urb.	ANACARDIACEA	
21	Chico zapote	*Manilkara zapota* (L.) P. Royen	SAPOTACEAE	
22	Chilacayote	*Sapium spp.*	EUPHORBIACEAE	
23	Cocl			
24	Cochalaw			
25	Colay	*Sickingia salvadorensis (Standl.)Steyer.*	RUBIACEAE	
26	Copal Colorado	*Cupania belizensis* Standl.	SAPINDACEAE	
27	Copal blanco	*Protium copal* (Schltdl. & Cham.) Engl.	BURSERACEAE	
28	Escobo negro			
29	Faisán			
30	Guapinol	*Hymenaea coubaril L.*	CAESALPINACEAE	
31	Golondrina	*Albizia adinocephala* (Donn Smith)Britt & Rose		

32	Oreja de burro	*Clusia sp.*	CLUSIACEAE	
33	Iq' malay			
34	Izote de montaña	*Dracaena americana* Donn. Sm.	LILIACEAE	
35	Ji			
36	Jobillo	*Astronium graveolens* Jacq.	ANACARDIACEAE	3
37	Jocote	*Spondias mombin*	ANACARDIACEAE	
38	Keq'i tzol	*Blomia pisca (Standl.)Lundell*	SAPINDACEAE	
39	Koo			
40	Laurel	*Cordia alliodora* (Ruiz & Pav.) Oken	BORAGINACEAE	
41	Laurel de Montaña	*Cordia gerascanthus* L.	BORAGINACEAE	
42	Llora sangre	*Virola koschnyi* Warb.	MYRISTICACEAE	
43	Luin hembra	*Ampelocera hottlei* (Standl.) Standl.	ULMACEAE	
44	Majagua	*Heliocarpus donnellsmithii* Rose	TILIACEAE	
45	Manax	*Hieronyma alchorneoides* Allemão Pseudolmedia oxiphyllaria	EUPHORBIACEAE	
46	Mapola	*Pseudobombax ellipticum* (Kunth) Dugand	BOMBACACEAE	2
47	Medallo	*Vatairea lundellii* (Standl.) Killip ex Record	FABACEAE	
48	Molleja de chunto			
49	Paatache	*Psidium sartorianum* (Berg.)Niedenzu	MYRTACEAE	
50	Palo algodón			
51	Palo gusano	*Lonchocarpus guatemalensis* Benth.	FABACEAE	
52	Palo jiote	*Bursera simaruba* (L.) Sarg.	BURSERACEAE	
53	Palo lagarto	*Zanthoxylum belizense* Lundell	RUTACEAE	
54	Palo limón	*Trichilia glabra* L.	MELIACEAE	
55	Palo verde	*Guettarda combsii* Urb.	RUBIACEAE	
56	Peine de mico	Apeiba aspera Aubl.	MALVACEAE	
57	Pok xic	*Coccoloba spp.*	POLYGONACEAE	
58	Pomte			
59	Ramón blanco,	*Brosimum alicastrum* Sw.	MORACEAE	
60	Ramón colorado	*Trophis racemosa*		
61	Sacamam			
62	Sacsi	*Licaria spp.*	LAURACEAE	
63	Saqi tzol	Alseis yucatanensis	RUBIACEAE	
64	Silion Colorado	*Pouteria amygdalina*	SAPOTACEAE	
65	Sta. María	*Calophyllum brasiliensis* L.	CLUSIACEAE	3
66	Subin	*Acacia spp.*	FABACEAE	
67	Tamarindo	*Dialium guianense*	FABACEAE	

		(Aubl.) Sandwith		
68	Tem	*Sideroxylon capiri* (A. DC.) Pittier	SAPOTACEAE	
69	Tzinte	*Ormosia monosperma*	FABACEAE	
70	Valerio colorado	*Aspidosperma cruenta*	APOCYNACEAE	
71	Valerio blanco	*Aspidosperma megalocarpon*	APOCYNACEAE	
72	Zapotillo	*Pouteria sp.*	SAPOTACEAE	2

Appendix 12. Importance values of tree species in primary forests of Sierra Chinajá

Common Name	Scientific Name	Family	V/ha	BA total	F total	D/ha	Bar	Fr	Dr	IV	N
Canxan	*Terminalia amazonia*	COMBRETACEAE	34.01	8.38	0.62	8.57	10.24	2.94	1.89	15.07	18
Palo jiote	*Bursera simaruba*	BURSERACEAE	14.78	3.89	0.48	36.19	4.75	2.27	7.98	15.01	76
Chico zapote	*Manilkara zapota*	SAPOTACEAE	20.79	4.81	0.76	18.10	5.88	3.60	3.99	13.47	38
Silion Colorado	*Pouteria amygdalina*	SAPOTACEAE	18.67	4.76	0.57	21.90	5.82	2.70	4.83	13.35	46
Qeqitzol	*Blomia pisca*	SAPINDACEAE	12.25	3.71	0.71	20.48	4.54	3.36	4.52	12.42	43
Zapotillo	*Pouteria sp.*	SAPOTACEAE	6.88	1.97	0.90	20.00	2.41	4.27	4.41	11.09	42
Paata che	*Psidium sartorianum*	MYRTACEAE	7.68	1.81	0.57	22.38	2.21	2.70	4.94	9.85	47
Cacaute	*Desmopsis stenopetala*	ANNONACEAE	8.18	2.54	0.43	17.14	3.11	2.04	3.78	8.92	36
Mapola	*Pseudobombax ellipticum*	BOMBACACEAE	14.13	3.68	0.33	10.95	4.49	1.56	2.42	8.47	23
Palo gusano	*Lonchocarpus guatemalensis*	FABACEAE	5.61	1.49	0.43	17.14	1.82	2.04	3.78	7.64	36
Palo algodon	*Ochroma lagopus*	BOMBACACEAE	7.38	2.26	0.48	11.43	2.76	2.27	2.52	7.56	24
Aqal	*Eugenia spp.*	MYRTACEAE	3.37	0.88	0.57	15.24	1.08	2.70	3.36	7.14	32
Tamarindo	*Dialium guianense*	FABACEAE	7.90	2.29	0.43	9.52	2.80	2.04	2.10	6.93	20
Colay	*Sickingia salvadorensis*	RUBIACEAE	7.07	1.70	0.43	10.95	2.08	2.04	2.42	6.53	23
Tem	*Sideroxylon capiri*	SAPOTACEAE	11.88	3.03	0.29	4.76	3.70	1.37	1.05	6.13	10
Amate	*Ficus radula*	MORACEAE	8.08	2.58	0.38	5.24	3.16	1.80	1.16	6.11	11
Ramon blanco	*Brosimum alicastrum*	MORACEAE	6.03	1.43	0.43	8.57	1.75	2.04	1.89	5.68	18
Palo lagarto	*Zanthoxylum belizense*	RUTACEAE	5.50	1.34	0.38	8.10	1.64	1.80	1.79	5.23	17
Chechen blanco	*Sebastiania longicuspis*	EUPHORBIACEAE	5.28	1.36	0.38	7.14	1.67	1.80	1.58	5.04	15
Laurel de montana	*Cordia alliodora*	BORAGINACEAE	4.12	0.80	0.33	8.57	0.97	1.56	1.89	4.43	18
Jocote	*Spondias mombin*	ANACARDIACEAE	2.17	0.55	0.43	7.14	0.68	2.04	1.58	4.29	15
Chilecayote	*Sapium spp.*	EUPHORBIACEAE	8.83	2.12	0.19	2.86	2.59	0.90	0.63	4.12	6
Manax	*Hieronyma alchorneoides*	EUPHORBIACEAE	3.06	0.65	0.33	7.62	0.80	1.56	1.68	4.04	16
Santa Maria	*Calophyllum brasiliensis*	CLUSIACEAE	3.86	0.89	0.38	5.24	1.08	1.80	1.16	4.04	11
Aguacatillo	*Nectandra globosa*	LAURACEAE	3.99	1.13	0.24	5.24	1.38	1.14	1.16	3.67	11
Balsamo	*Myroxylon balsamum*	FABACEAE	5.97	1.46	0.24	3.33	1.79	1.14	0.74	3.66	7
Pok xik	*Coccoloba spp.*	RUBIACEAE	2.07	0.57	0.38	3.81	0.69	1.80	0.84	3.34	8
Izote	*Dracaena Americana*	LILIACEAE	3.12	0.59	0.33	4.76	0.72	1.56	1.05	3.33	10
Valerio blanco	*Aspidosperma megalocarpon*	APOCYNACEAE	1.66	0.37	0.38	4.76	0.45	1.80	1.05	3.30	10

Copal pom	*Protium copal*	BURSERACEAE	1.45	0.36	0.29	6.67	0.44	1.37	1.47	3.29	14
Pomte			1.39	0.37	0.33	5.24	0.46	1.56	1.16	3.18	11
Escobo negro			1.32	0.35	0.33	5.24	0.42	1.56	1.16	3.14	11
Luin hembra	*Cordia gerascanthus*	BORAGINACEAE	1.35	0.32	0.29	5.71	0.40	1.37	1.26	3.03	12
Cansin	*Lonchocarpus castilloi*	FABACEAE	2.89	0.69	0.29	2.86	0.85	1.37	0.63	2.85	6
Faisan			1.16	0.33	0.33	3.33	0.41	1.56	0.74	2.71	7
Anonillo	*Guatteria anomala*	ANNONACEAE	0.61	0.21	0.18	2.86	0.25	0.85	0.63	1.74	6
Anona de monte	*Annona scleroderma*	ANNONACEAE	1.08	0.26	0.15	2.38	0.31	0.71	0.53	1.55	5
Valerio Colorado	*Aspidosperma cruenta*	APOCYNACEAE	0.64	0.14	0.10	1.90	0.17	0.47	0.42	1.07	4
Medallo	*Vatairea lundellii*	FABACEAE	1.03	0.22	0.05	0.95	0.27	0.24	0.21	0.71	2

D=Density
F=Frequency
BA=Basal Area
IV=Importance Value
V=Volume

n=952

Appendix 13. List of plant species acquired through non-systematic sampling of reproductive specimens from June-September 2005 in Sierra Chinaja. Legend: Profile, T= tree, B= Bush, H= Herb, V=Vine, E= Epiphyte, CONAP Red List: 1=Almost extinct, 2=Endangered,3=Special Management; CITES Appendix: I=endangered, II=Potentially at risk

No	Scientific Name	Red List CONAP, CITES	Family	Profile
1	*Acalypha costarricensis*		Euphorbiaceae	B
2	*Acalypha glummifera*		Euphorbiaceae	B
3	*Acalypha sp.*		Euphorbiaceae	H
4	*Adiantum radiate*		Fern	H
5	*Adiantum sp.*	3	Fern	H
6	*Aechmea bracteata*		Bromeliaceae	E
7	*Ageratina sp.*		Asteraceae	B
8	*Allopectus vinaceus*		Gesneraceae	E
9	*Alseis yucatanensis*		Rubiaceae	T
10	*Androlepis skinneri*		Bromeliaceae	E
11	*Anthryphylum onsiforme*		Fern	E
12	*Anthurium pentaphyllum var. bombacifollium*		Araceae	E
13	*Anthurium sp.1*	2	Araceae	H
14	*Anthurium sp.2*	2	Araceae	E
15	*Anthurium sp.3*	2	Araceae	H
16	*Anthurium sp.4*		Araceae	H
17	*Aphelandra aurantiaca*		Acanthaceae	H
18	*Aphelandra deppeana*		Acanthaceae	B
19	*Ardisia sp.*	3	Myrsinaceae	T
20	*Ardisia sp.*	3	Myrsinaceae	B
21	*Asclepias curasavica*		Asclepiadaceae	B
22	*Aspidosperma sp.*		Apocynaceae	T
23	*Asplenium sp.*		Fern	E
24	*Asplundia microphylla*		Cyclantaceae	V
25	*Bauhinia divaricata* L.		Fabaceae	T
26	*Begonia manicata*		Begoniaceae	H
27	*Begonia nelumbiifolia*		Begoniaceae	H
28	*Begonia sp.1*	3,2	Begoniaceae	H
29	*Begonia sp.2*	3,2	Begoniaceae	H
30	*Begonia sp.3*	3,2	Begoniaceae	H
31	*Begonia sp.4*	3,2	Begoniaceae	H
32	*Begonia sp.5*	3,2	Begoniaceae	H
33	*Begonia sp.6*	3,2	Begoniaceae	H
34	*Billbergia viridiflora*		Bromeliaceae	E
35	*Blechnum schedianum*		Fern	E
36	*Calathea allouia*		Maranthaceae	H
37	*Calathia unsigues*		Heliconiaceae	H
38	*Campelia zanonia*		Comelinaceae	H
39	*Campyloneuron sp.*		Fern	H
40	*Casearia sp.*		Flacourtiaceae	B
41	*Cassia sp.*	3	Mimosaceae	B
42	*Catopsis sp.*		Bromeliaceae	E

43	*Catopsis hahnii*		Bromeliaceae	E
44	*Cephaelis tomentosa*		Rubiaceae	H
45	*Cestrum nocturnum*		Solanaceae	B
46	*Chamaedorea elegans*		Arecaceae	H
47	*Chamaedorea sp.*		Arecaceae	H
48	*Choccoca alba*		Rubiaceae	V
49	*Chrysophyllum mexicanum*		Sapotaceae	T
50	*Cissus sp.*		Vitaceae	V
51	*Clidemia petiolaris*		Melastomataceae	B
52	*Clidemia sp.*	3	Melastomataceae	H
53	*Clusia guatemalensis*		Clusiaceae	T
54	*Clusia sp.*		Clusiaceae	T
55	*Coccoloba sp.1*	2	Polygonaceae	T
56	*Conostegia xalapensis*		Melastomataceae	B
57	*Cordia alliodora* (Ruiz & Pav.) Oken		Boraginaceae	T
58	*Cornutia sp.*		Verbenaceae	B
59	*Costus rubber*		Costaceae	H
60	*Coussopoa sp.*		Moraceae	T
61	*Cranichis sp.*	3, II	Orquidaceae	H
62	*Croton glabellus*		Euphorbiaceae	B
63	*Cupania sp.*		Sapindaceae	T
64	*Cymbopetalum penduliflorum*		Annonaceae	T
65	*Dalechampia heteromorpha* Pax & K. Hoffm.		Euphorbiaceae	B
66	*Dendropanax arboreus*		Araliaceae	T
67	*Dendropanax sp.*		Araliaceae	T
68	*Dioscorea sp.*	3	Dioscoreaceae	V
69	*Diospyros sp.*		Ebenaceae	T
70	*Displazium plantaginifolium*		Fern	H
71	*Dorstenia lindleyana*		Moraceae	H
71	*Dracaena americana* Donn.Sm.		Liliaceae	T
73	*Elaphoglossum sp.*	3	Fern	E
74	*Elleanthus capitatus*	3, II	Orquidaceae	E
75	*Encyclia sp.*		Orquidaceae	E
76	*Epidendrum rigidum*		Orquidaceae	E
77	*Epidendrum nocturnum*	3, II	Orquidaceae	E
78	*Eugenia sp.1*	2	Myrtaceae	T
79	*Eugenia sp.2*	2	Myrtaceae	T
80	*Euphorbia leucocephala* Lotsy		Euphorbiaceae	B
81	*Ficus sp.*		Moraceae	T
82	*Garcinia sp.*		Clusiaceae	T
83	*Greigia sp.*		Bromeliaceae	E
84	*Hamelia patens* Jacq.		Rubiaceae	B
85	*Hamelia rovirosae* Wernam		Rubiaceae	T
86	*Helecho*		Polypodiaceae	H
87	*Heliconia latispatha*		Heliconiaceae	H
88	*Heliconia sp.*	3	Heliconiaceae	H
89	*Heliocarpus sp.*		Tiliaceae	T
90	*Heliocarpus donnel smithii*		Tiliaceae	T
91	*Hoffmania sp.*	2,3	Rubiaceae	H
92	*Hyperbaena mexicana*		Menispermaceae	T
93	*Inga sp.*		Mimosaceae	T

94	*Justicia sp.*	3	Acanthaceae	H
95	*Lasiacis divaricata*		Poaceae	H
96	*Lepidanthus pasanticus*		Orquidaceae	E
97	*Licaria sp.*	3	Lauraceae	T
98	*Lonchocarpus sp.*		Fabaceae	T
99	*Luehea candida*		Tiliaceae	T
100	*Lycianthes sp.*		Solanaceae	H
101	*Mascagnia sp.*		Malphigiaceae	V
102	*Maxillaria muricata*		Orquidaceae	E
103	*Maxillaria sp.*		Orquidaceae	E
104	*Maxillaria uncata*		Orquidaceae	E
105	*Maxillaria variabilis*		Orquidaceae	E
106	*Melanthera nivea*		Asteraceae	H
107	*Miconia sp.*	3	Melastomataceae	B
108	*Monstera sp.*		Araceae	V
109	*Morinda sp.*		Rubiaceae	B
110	*Mortoniodendron sp.*	2	Tiliaceae	T
111	*Muhlenbergia sp.*		Poaceae	H
112	*Neurolaena lobata*		Asteraceae	H
113	*Ocotea licaria*		Lauraceae	B
114	*Olyra lalifolia*		Poaceae	H
115	*Oreopanax obtusifollium*		Araliaceae	T
117	*Oreopanax sp.1*		Araliaceae	T
118	*Oreopanax sp.2*		Araliaceae	T
119	*Ouratea lucens* (Kunth) Engl.		Ochnaceae	H
120	*Parathesis sp.*		Mircinaceae	T
121	*Passiflora biflora*		Passifloraceae	V
122	*Passiflora sp.*		Passifloraceae	V
123	*Paullinia sp.*		Sapindaceae	V
124	*Peperomia sp.1*	2	Piperaceae	E
125	*Peperomia sp.2*	2	Piperaceae	E
126	*Peperomia sp.3*	2	Piperaceae	E
127	*Peperomia sp.4*	2	Piperaceae	E
128	*Phenax hirtus*		Urticaceae	B
129	*Pitcairnia spp.*		Bromeliaceae	E
130	*Picramnia sp.*		Simaroubaceae	B
131	*Piper aduncum*	2	Piperaceae	B
132	*Piper auritum*		Piperaceae	H
133	*Piper sp.1*	2	Piperaceae	B
134	*Piper sp.2*	2	Piperaceae	H
135	*Pirina humilis*			H
136	*Pitcarnia wendlandlii*		Bromeliaceae	E
137	*Pithecelobium sp.*	2	Mimosaceae	T
138	*Platystele sp.*		Orquidaceae	E
139	*Pleopeltis lanceolata*		Fern	E
140	*Pleopeltis sp.*		Fern	E
141	*Pleurothalis grobyii*		Orquidaceae	E
142	*Pleurothalis sp.1*	3, II	Orquidaceae	E
143	*Pleurothalis sp.2*	3, II	Orquidaceae	E
144	*Pleurothalis sp.3*	3, II	Orquidaceae	E
145	*Plumeria rubra*		Apocynaceae	T

146	*Polypodium sp.*		Fern	E
147	*Polystachia cerea*		Orquidaceae	E
148	*Pouteria sp.*		Sapotaceae	T
149	*Psychotria chiapensis*		Rubiaceae	B
150	*Psychotria sp.1*	2	Rubiaceae	B
151	*Psychotria sp.2*	2	Rubiaceae	B
152	*Psychotria sp.3*	2	Rubiaceae	B
153	*Psychotria sp.4*	2	Rubiaceae	B
154	*Psychotria sp.5*	2	Rubiaceae	H
155	*Rinorea guatemalensis* (S. Watson) Bartlett		Violaceae	B
156	*Rondeletia buddleioides*		Rubiaceae	B
157	*Rondeletia sp.1*	2	Rubiaceae	B
158	*Salvia sp.*	2	Labiaceae	B
159	*Saurauia sp.*		Sauraureaceae	B
160	*Scaphyglottis sp.1*		Orquidaceae	E
161	*Scaphyglottis sp.2*		Orquidaceae	E
162	*Scaphyglottis sp.3*		Orquidaceae	E
163	*Schizolobium o Clitostoma*		Fabaceae	V
164	*Scleria sp.*		Cyperaceae	H
165	*Senna sp.*		Fabaceae	T
166	*Sobralia sp.*		Orquidaceae	H
167	*Solanum sp.*	2	Solanaceae	B
168	*Spathyphyllum blandum*		Araceae	H
169	*Stelis sp.*	3, II	Orquidaceae	E
170	*Swartzia sp.*		Caesalpinaceae	T
171	*Syngonium podophyllum*		Araceae	E
172	*Tabernaemontana sp.*	3	Apocynaceae	T
173	*Tectaria heraclifolia*		Fern	H
174	*Ternstroema tepezapote*		Theaceae	T
175	*Thelypteris sp.*		Fern	H
176	*Thevethia ahouai* (L.) A. DC.		Apocynaceae	B
177	*Tillandsia bulbosa*	3	Bromeliaceae	E
178	*Tillandsia butzii*	3	Bromeliaceae	E
179	*Tillandsia matudae*	3	Bromeliaceae	E
180	*Tillandsia schiedeana*	3	Bromeliaceae	E
181	*Tillandsia valenzuelana*	3	Bromeliaceae	E
182	*Topobea calicularis*		Melastomataceae	B
183	*Topobea laevigata*		Melastomataceae	B
184	*Trema micrantha*		Ulmaceae	T
185	*Trichila sp.1*		Meliaceae	T
186	*Trichilia sp.2*		Meliaceae	T
187	*Trichospermum galliothi*		Tiliaceae	T
188	*Urera sp.*		Melastomataceae	B
189	*Vernonia sp.*	3	Asteraceae	H
190	*Vismia camparaguay*		Gutiferae	B
191	*Vitex gaumerii*		Verbenaceae	T
192	*Vittaria graminifolia*		Orquidaceae	E
193	*Vochysia guatemalensis*		Vochisiaceae	T
194	*Vriesia heliconoides*		Bromeliaceae	E
195	*Xiphidium caeruleum*		Haemodoraceae	H
196	*Zamia sp.*	2, II	Zamiaceae	B

197	*Zexmenia salvinii*		Asteraceae	H
198	*Zygocactus sp.*	2, II	Cactaceae	E

Appendix 14. Orchid Species of the Sierra Chinajá. Lista Roja de CONAP: 1= Almost Extinct, 2= Endangered, 3= Special Management; CITES Apendices: I=Endangered, II= Potentially in danger.

Scientific Name	Red List CONAP, CITES Apendices
Arpophyllum giganteum	2,II
Brassia caudate (L.) Lindl.	2,II
Campylocentrum scheidei	2,II
Catasetum integerrimum	
Chysis bractescens Lindl.	
Coelia bella	
Coelia sp	
Corymborkis forcipigera (Rchb. F.) L.O. Wms.	
Elleanthus capitatus (R. Br.) Reichb. F. Walp. Ann.	3,II
Elleanthus graminifolius (Barb.Rodr.) Lojtnant	
Elleanthus poiformis Schltr.	
Elleanthus caricoides	
Encyclia asperula	
Epidendrum isomerum Schltr.	
Epidendrum polyanthum Lindl.	
Epidendrum rigidum Jacq.	
Epidendrum veroscriptum	
Eurystyles spp.	
Gongora cassidea Rchb.f.	2,II
Goodyera spp.	
Hexadesmia imbricata (Lindl.) Rchb.f.	
Isochilus linearis	
Jacquiniella cobanensis	
Jacquiniella equitantifolia (Ames) Dressler.	
Maxillaria aciantha Rchb.f.	
Maxillaria brunnea	
Maxillaria crassifolia (Lindl.) Rchb.f.	
Maxillaria densa Lindl.	
Maxillaria meleagris	
Maxillaria pulchra (Schltr.) L.O. Wms.	
Maxillaria scorpioidea	
Maxillaria uncata Lindl.	
Maxillaria variabilis Batem. ex Lindl.	
Mormolyca ringens (Lindl.) Schltr.	
Nidema boothii (Lindl.) Schltr.	
Notylia barkeria	
Oncidium oerstedii	
Ornithocephalus bicornis Lindl.	
Pleurothallis grobyi	
Pleurothallis lewisii	
Pleurothallis pansamalae	

Pleurothallis sanchoi	
Pleurothallis segovienses	
Pleurothallis yucatanensis Ames & Schweinf.	
Polystachya masayensis Rchb.f.	
Ponera juncifolia Lindl.	
Ponera striata	
Prostechea cochleata	II
Prostechea fragans	
Prostechea pygmaea	
Sarcoglottis sp.	
Scaphyglottis crurigera	
Scaphyglottis lendyana	
Sobralia macanthra	
Sobralia fragrans Lindl.	2,II
Stanhopea aff. oculata (Lodd.) Lindl.	2,II
Stelis Sp. 1	3,II
Stelis Sp. 2	3,II
Stenorrhynchus coloratus	
Trichosalpinx violacea	
Trigonidium egertonianum Baten. Ex Lindl.	
Vanilla spp.	2,II
Zootrophyon tribuloide	

APPENDIX 15. Description of 8 oldest communities of Sierra Chinajá based on focus group discussions held in Sept. 2005.

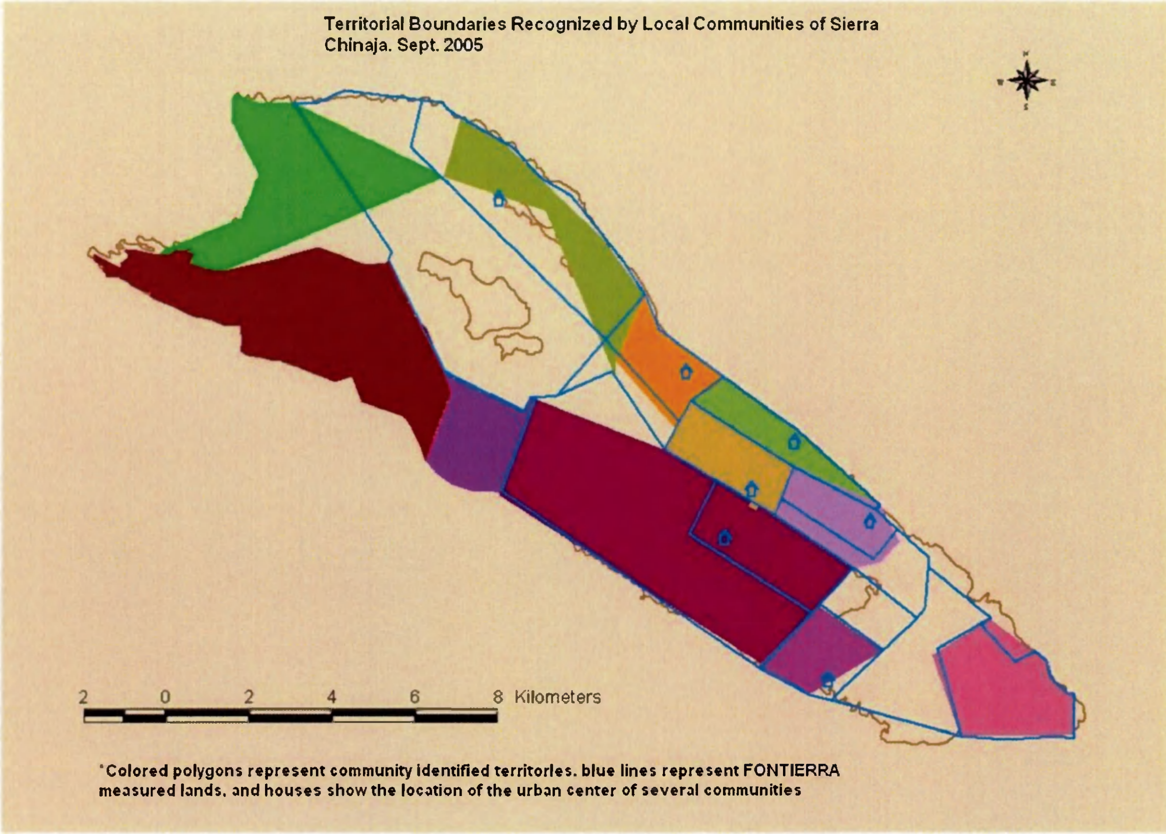
Community	Members of COCODE/ Informants	Precedence	Size	Infrastructure	No. of families soliciting land	Size of each parcel	Unique characteristics	Water Access	Modes of access
Seraxtzucl	Luis Ical Cab, Santiago Quib Xol, Rigo Tzib Oxom, Santiago Choc Chub, Carlos Pop Choc	Finca Chimelb Lanquin	362 ha	School, church, soccer field	20	10.5 ha	Caves, tombs in caves, sink holes	Ephemeral pool/modified spring	8 km by foot entering from paved highway in Yalpemech
Nueva Palestina	Ignacio Chub, Domingo Tzi, Felipe Caal Chub, Jose Sagui, Victor Tiul, Ramon Ax	Finca Yalpemech?	362 ha	Meeting house, school, church	15	10.5 ha	Sink hole, springs	Perennial spring protected by cement	2km of dirt road from main paved highway
Nueva Esperanza	Pedro Pec Caal, Sebastián Gualna Cholom, Alberto Xo Mucu,	Finca Rubelquiche	226 ha.	School, soccer field, water catchment project	13	1.4 ha	Caves and ephemeral streams	Spring found on the edge of a parcel of adjacent land owner, 200 m distance from the	1 km by foot from the paved highway in Yalpemech

	Ignacio Caal, Oscar Xe Butz							community	
Tzulul Qeqchi	Vicente Tiul Choc, Macario Xo Cuc, Andres Caal Cac, Pedro Maquin, Cristóbal Bolom, Alejandro Tec Choc, Pedro Gualna, Marcos Xol Caal	Finca Setal, Carcha, Playa Grande	1041 ha	Higway access, electricity, church, running water, cardamom dryers	100	3.5 ha	Sacred caves, ephemeral streams, waterfalls, sinkholes, springs	Potable water system from local spring 3 km distance from community	Dirt road 3 km from paved highway at Cruce del Pato
Belen	Carlos Ical Mucu, Domingo Coc Cuz, Santos Chocooj, Pedro Gualna, Francisco Coc Cucul, Sebastián Ico Gualna, Santiago	Campur, Carcha, Chisec, Fray, Lanquin	362 ha	School, Soccer field, church, highway access	32	2.8 ha	10 caves, headwaters of the San Pablo river	Temporal stream at the edge of the community	6 km of dirt road from the paved road junction in Cooperativa Sechaj

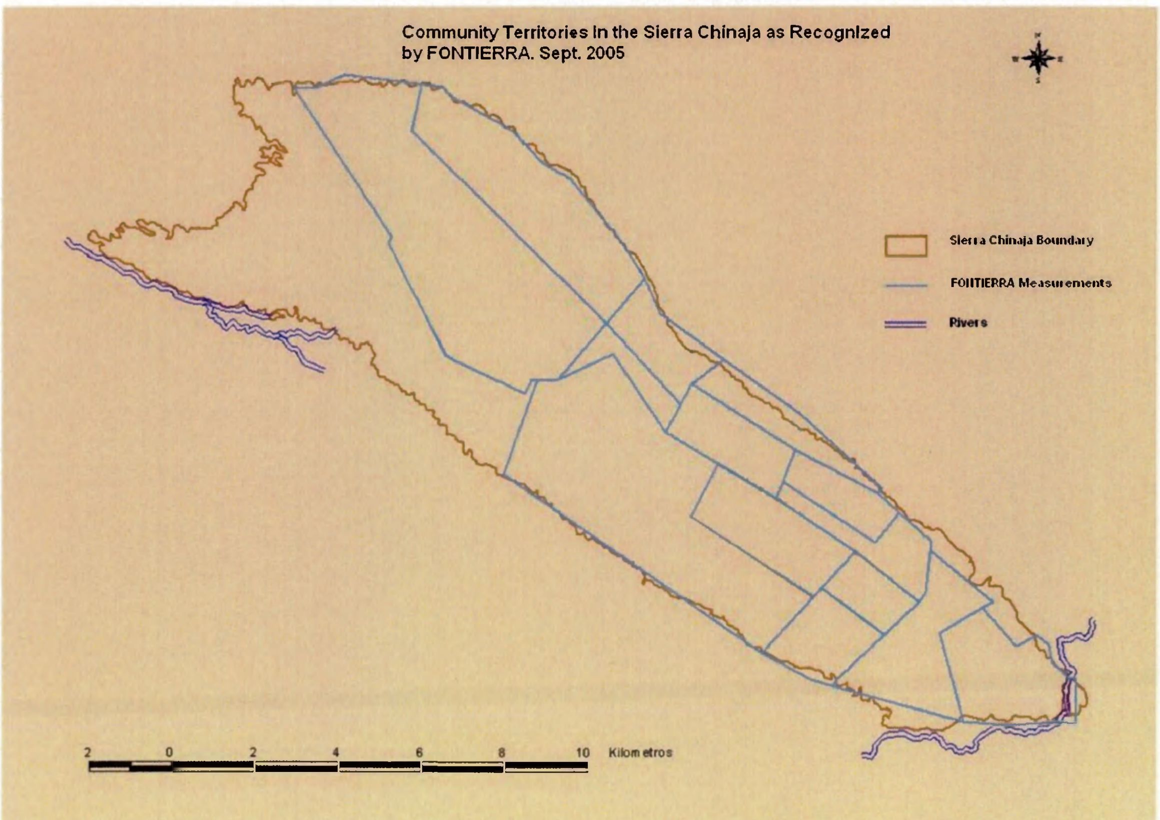
Sesaltul	Marcelino Tiul, Martin Mucu, Dionisio Siquic, Juan Che Botzoc, Juan Caal, Sebastián Ax Chub, Pedro Botzoc	Aldeas de Carcha	543 ha.	Meeting house, school, churches, soccer field, cardamom dryers	46	10.5 ha	Cave with Mayan paintings, caves with springs inside, sinkholes	A modified spring fed pool at the edge of the community	4 km by foot from Sechaj II, or 6 km by foot from Yalpemech
Montaña Seacte	Manuel Cuz Tiul, Jose Coc Choc, Francisco Tiul Cacao, Ernesto Xuc, Pedro Tiul, Manuel Che Cucul	SanAntonio de las Cuevas, Candelaria Camposanto, Cooperativa Sechaj, El Estor, Izabal	272 ha.	School, soccer field, churches	14	2.1 ha.	Cave, waterfalls, river	River	4 km by foot from paved road in Canlech
Mucbilha II	Jaime Tiul Choc, Ricardo Tun Beb, Mario Pan Choc, Marcelino Macz, Arturo Chun Caal,	Cahabon, Fray, Raxruha, Chisec	996 ha..	Highway access, school, meeting house, bridge	50	5 ha. y 8.4 ha.	2 caves, hole where hot air comes out, deposits of sand	River in the community	8 km on dirt road from Samaria

	Vicente Patul Mo, Oscar Coc Xol								

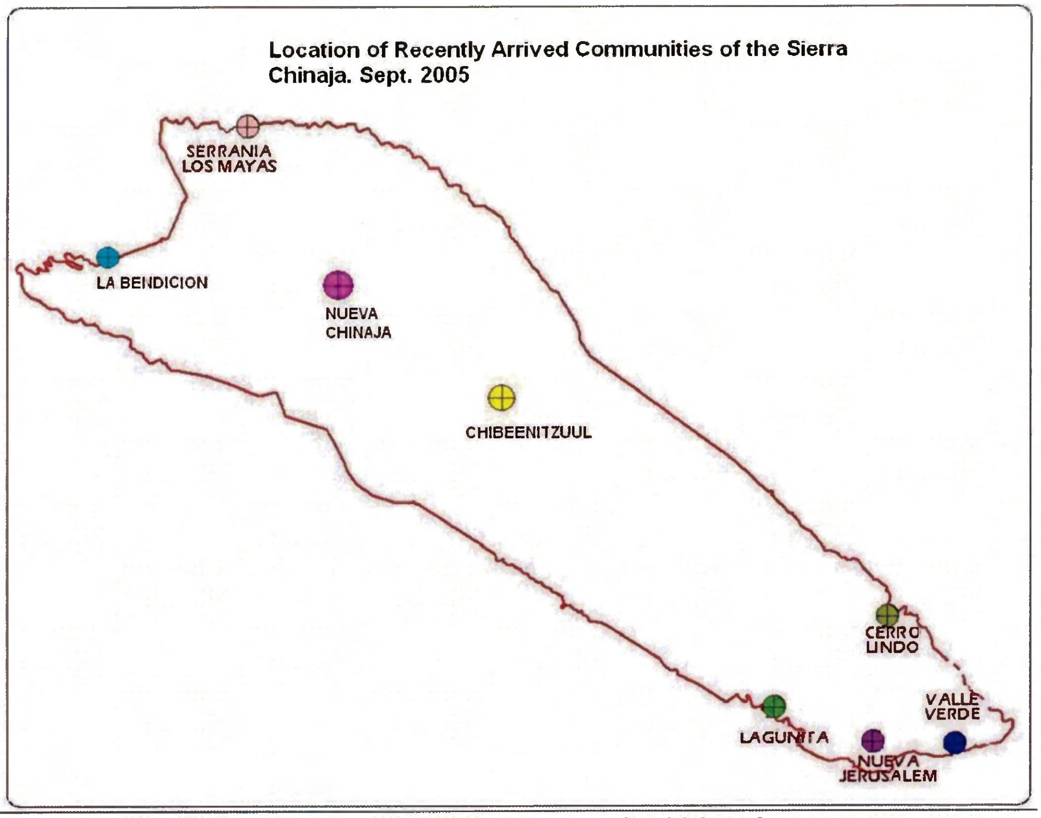
Appendix 16. Community Mapping Results Overlay



Appendix 17. Preliminary measurements according to FONTIERRA



Appendix 18. Location of Newly Arrived Communities



APPENDIX 19. Current Land Use in Sierra de Chinajá, Alta Verapaz, Guatemala.