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NON TIMBER FOREST PRODUCTS OF THE MAYA BIOSPHERE RESERVE, PETEN, GUATEMALA

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CHAPTER 1: EXECUTIVE SUMMARY

1.1 Introduction

Throughout the tropics new efforts are being made to manage forest resources sustainably. These efforts are a response to wide-spread and rapid forest conversion, which threatens not only biological diversity but the bases for economic and social sustainability in rural areas of the tropics. As such, these efforts depart from previously accepted sustained-yield doctrine, in that they promote both timber and non timber forest product industries and protect biodiversity while providing for intergenerational human welfare and improved economic and social equity. This combination of development with biodiversity conservation has received considerable attention through promotion of the "extractive reserve" concept. We believe that this concept is a good one, but needs further exploration and case studies. Through this document we explore one example of this concept, the Maya Biosphere Reserve in northern Guatemala, in considerable detail.

This document reports the results and conclusions of field work conducted by an interdisciplinary team of Guatemalan and North American researchers from April through October 1990. We analyze the sustainability of forest use in the Maya Biosphere Reserve, a recently established 1.5 million hectare protected area of subtropical moist forest in the Petén region of northern Guatemala. Our analysis presents ecological, social, and economic data for three extractive industries that harvest, process, and export several non timber forest species. Through this work we hope to provide resource managers and researchers alike with the baseline data needed to reinforce sound natural management resource strategies for the Maya Biosphere Reserve.

The species analyzed are, in order of greatest employment and income benefits for forest harvesters: the leaves of two palm species, Chamaedorea oblongata and Chamaedorea elegans, both locally called xate, which are used in floral arrangements; chicle, the latex of Manilkara zapota, which is used in chewing gum base; and allspice, the fruit of Pimenta dioica, which is used as a food seasoning and preservative.

A basic premise of this study is that "sustainability" in the Maya Biosphere Reserve region means not only long-term forest production, but also meeting the needs and expectations of rural people while protecting forest biodiversity. To achieve these goals, forests must be used. Otherwise, rural people with little access to secure land tenure, technical assistance, capital, markets, and often with little understanding of the richness of forest resources nearby, exercise their only alternative: they fell forest for food production. Such forest conversion reduces biodiversity and, given the region's scarce capital and poor soil resources, results in diminished economic productivity, with attendant social strife, over the long-term.

Rural people's opportunities are constrained for many reasons, such as skewed land tenure and high population density, both a result of historical circumstances and global economic relations. Fundamentally, any major change in the current trend of widespread tropical forest conversion requires that such constraints be addressed, however intractable they may seem. However, for the present, forest management strategies must provide sustained commercial and subsistence production while avoiding any loss of species by minimizing forest disturbance. Moreover, the benefits of forest use must be equitably distributed.

This report is organized as follows. This chapter provides a summary discussion of the information detailed in the report. Chapter Two provides an introduction to and detailed background on the Maya Biosphere region, including a brief history of forest product extraction and a discussion of the biophysical environment and land-use practices. Chapter Two also discusses sustainability, providing a context for evaluating the design and forest management goals of the Reserve. Chapter Three reports the results of interviews conducted with forest harvesters, characterizing the predominant forces in their lives that motivate them to harvest forest resources. Chapter Four provides an overview of the methodology used in researching the non timber forest product industries.

The three extractive industries, xate, allspice, and chicle, are discussed in Chapters Five, Six, and Seven, respectively. Each chapter provides a botanical description and illustration, and describes the ecological association of each species, harvesting techniques, and the impacts of those techniques on the species. The extraction history is discussed, as are processing, supply and demand, market structure, and distribution of benefits. Each chapter concludes with a discussion of the sustainability of each industry, calculating the forest area needed to supply international demand. This is followed by a general discussion of recommended management strategies that attempt to ensure the sustainability of the industry, both the ecological viability of the plant resource and the social welfare of harvesters.

1.2 Land Use in the Maya Biosphere Reserve

The Maya Biosphere Reserve was established by law in February of 1990 (see Figure

2.1) and is administered by the newly establish Consejo Nacional de Areas Protegidas (National Council of Protected Areas - CONAP). On paper, the Reserve is zoned for several uses, including strict preservation of sensitive ecosystems and Maya archaeological sites, managed extraction of timber and non timber resources, oil production, and agriculture and agroforestry adjacent to the several communities within the Reserve's boundaries. In a phrase, the vision for the Maya Biosphere Reserve is to meet the needs of the region's growing population by optimizing the economic value of sustainable land-uses within the Multiple Use Area, while protecting the region's biodiversity and cultural resources.

Approximately 50% of the 15,000 square kilometer (km^2) Reserve, the eight core areas (areas nucleos), is theoretically protected from any human activities, with the exception of tourism and research. In the case of the 3,500 km^2 Laguna del Tigre National Park, oil production is permitted. The remaining 50% (7,500 km^2) of the Reserve is zoned as a Multiple Use Area, the predominant use being the extraction of forest resources. In the Multiple Use Area, the intent of the law is to promote uses that leave the forest relatively intact, a strategy consistent with historical land-use patterns.

In addition to the non timber forest products (NTFPs) mentioned, timber is extracted, predominantly mahogany (Swietenia macrophyla) and Spanish cedar (Cedrela odorata). With the increasing scarcity of old-growth stands of these lucrative species, the timber industry is shifting towards value-added production (e.g. veneers) and secondary hardwood species.

Tourism also brings in substantial revenue. Tourists are attracted to the region for both its natural history and the archaeological remains of Pre-classic and Classic Maya civilization, with the excavated city of Tikal attracting at least 15% of the tourists that visit

Guatemala each year. Guatemala earned nearly $185 million from tourism in 1990, so Tikal and other archaeological and nature tourism sites represent millions of dollars in potential revenue annually (INGUAT 1990).

The forested ecosystems of the Maya Biosphere Reserve extend beyond its political boundaries. Based on soil and vegetation potential maps, we estimate that approximately 84% of the Petén's 36,000 km² was originally forested, the remaining area being natural savannah. Current estimates suggest that less than 50% of the department is forested today (Charles Vieman[1], pers. comm. 1991). To the south of the Reserve is a 15 km wide buffer zone (Zona de Amortiguamiento), an area to be administered by both CONAP and the Guatemalan forestry agency, DIGEBOS. In this region and farther south, extensive areas have been converted for cattle and agricultural production, a fate that probably awaits most remaining forests south of the Reserve and much of the buffer zone, with the exception of three proposed protected areas, the Río Chiquibul, Machiquila and Dos Pilas protected area complexes (Figure 2.2).

The Reserve is the largest and most important piece of a regional conservation scheme (Figure 2.2). To the east in Belize is the Rio Bravo Conservation Area, 610 km² in size (Nicholas Brokaw[2] 1990, pers. comm.). To the north, in Campeche, Mexico, is the 8,250 km² Calakmul Biosphere Reserve. To the west, in Chiapas, is the recently established

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[1]Charles Vieman is forester working with the Guatemalan government's regional development coordinating agency, SEGEPLAN VIII.

[2]Nicholas Brokaw is a forest ecologist and senior scientist at the Manomet Bird Observatory. He has extensive experience studying forest composition and dynamics in the Maya Biosphere Region, including years of research in the Rio Bravo Conservation Area of Belize, which abuts the Maya Biosphere Reserve.

Montes Azules Biosphere Reserve, 410 km^2 in size.

In total, over 25,000 km^2 of contiguous forested land is protected for preservation or limited forestry production. We call this area, which spans three countries and a wide variety of ecosystems, the Maya Bioregion.

1.3 The Biophysical and Human Environment of the Reserve

The Reserve is part of the Yucatán Peninsula and is underlain by limestone. The resultant landscape varies from gently undulating plains to karst topography with its characteristic steep-sided hills and narrow valleys. Large regions of the Reserve are covered with seasonally flooded forest and wetlands (humidales) while other upland regions are well-drained. Soils can be characterized as falling into roughly two types. Those encountered in the seasonally inundated lowlands are deep, poorly drained, clay substrates with poor structure. Those encountered in the uplands are shallow (< 50 cm) clay soils with good structure, a result of a relatively high percent (>7%) organic matter. Neither are suitable for sustained, low-input agricultural production.

The Reserve is covered in subtropical moist forest. The canopy is partly deciduous, with certain species losing their leaves during the dry season that extends from February to June. Total precipitation, most of which falls from July to January, varies widely. Estimates average between 1,200 and 1,500 mm annually. The canopy ranges from 10 to 25 meters in height, with some forest emergents such as Manilkara zapota attaining heights of 40 meters. The canopy is lowest in the seasonally inundated forests.

There are, of course, many forest and soil types, and gradients exist between them.

But this simplified division has important implications for forest production: Population densities of economically valuable species and harvesting activities are concentrated in upland forest. Because of their value, it is important to know the aerial extent of upland forest. For example, we calculate the upland forest area needed to supply each product for international markets. Yet we do not know, accurately, how much of this forest exists. We estimate, based on existing soils and vegetation maps and our own field experience, that 3,000 to 4,000 km^2 of the 7,500 km^2 Multiple Use Area contains upland forest. This estimate will be much improved, and forest types better defined, in the near future using remote sensing techniques.

In the dryer, upland forest, the non timber species considered in this report are often encountered in groupings called manchas (spots). Such groupings are the result of species' adaptations to the conditions of a given location (soil, light, competing species) and forest history (fire, treefalls, harvesting intensity). However, it is widely speculated that, at least for certain species like *Pimenta dioica* and *M. zapota*, the high plant densities encountered are a botanical artifact of Maya land-use strategies over 1,100 years ago (Brokaw et al. 1990). Either way, for either ecological or cultural reasons, densities of economically valuable species are high, a fact that has led to their important role in the recent human history of the region.

The last remaining independent lowland Maya polity in Petén was conquered by the Spanish in the late 17th century. Human population levels have historically been low: the census of 1973 reports a population of 64,500, an increase over levels that held steady for over a century at about 15,000 people. Current population is estimated at 250,000 to

300,000 (Schwartz 1990). Using these figures, the rate of growth is approximately 7 to 9%, which means that, if this rate is sustained, population will double in 10 years or less.

Such rapid growth results from immigration from different regions of southern Guatemala. As a result, great ethnic and cultural diversity exists both within and among recent colonist communities, giving rise to a rapidly transforming society. In the midst of this social change are the native Peteneros and other long-term residents, the majority of whom are experienced in the economy of the forest. Though not "indigenous" in the sense of the tribal societies that inhabit forested regions throughout the tropics, the Petenero culture is generations-old, comprising a forest society. For example, in the case of chicle and timber, harvesting dates back over 100 years and, in the case of xate and allspice, harvesting has occurred for at least 30 years. For most people in the forest society, harvesting of a diversity of forest resources is mixed with swidden agricultural production (milpa) to form a relatively secure, diverse income strategy. A merchant class of the forest society has concerned itself with the international marketing of forest resources (Schwartz 1990). We underscore the point that this forest society, and its knowledge of forest resources and commercial forest products industries, is a key to successful forest management strategies.

In contrast, more recent colonists, particularly those living in southern Petén, depend on milpa agriculture as their sole source of income and subsistence. Even though a combination of milpa and forest resource extraction may be a better combination, recent colonists stick with what they know best, at least at first, which is milpa agriculture. Many colonists will not adapt the income and subsistence strategy of longer-term residents because they are not familiar with forested environment and its resources and must insure that they

will at least survive. Food is the first priority. In addition, few monetary resources, little technical assistance, and only limited markets are available to help these people diversify and intensify their agricultural strategies, let alone sustainably manage forest resources. Though many colonists eventually adopt to some degree the mixed economic strategy of both harvesting NTFPs and making milpa, they nonetheless accelerate the pressure on the forest through their sheer numbers. The result is forest conversion for food production to overharvesting of forest resources, often their only source of wage-paying employment. Both pressures threaten the ecological integrity and economic productivity, hence the social welfare, of the region.

It is important to stress here the complexity of the social environment encountered in Petén. The two groups discussed above, colonists and native Peteneros, subdivide into those living inside the Reserve and those living outside it. Furthermore, there are migrant workers, such as chicleros from Alta Verapaz, who use the Reserve on a seasonal basis. The point is that the social landscape is every bit as complex as the ecological landscape and demands equal is not greater research and management efforts if forest conservation is to be successful.

1.4 Natural Forest Management

Despite economic and population pressures, the potential value of these forests, as well as their contribution to sustained social welfare in the region, is great. Yet, in order to tap this potential, it will be necessary to implement a previously unrealized level of natural forest management (NFM).

We define NFM as the management of forested ecosystems for the production of a wide variety of timber and non timber forest products by regulating harvesting to ensure future production and by pursuing vegetation treatments that increase population densities of economically valuable species. Successful implementation of NFM strategies requires that both governmental and non governmental institutions charged with managing the Reserve's resources, together with the contractors and collectors who extract the products work closely with one another in developing and applying these strategies. Only then can forest resources contribute to long-term regional social welfare and economic development. And only then can the region's unique cultural resources and sensitive ecosystems be conserved, particularly given the radical social, demographic, and economic changes likely to occur in the region over the next few decades.

In the following discussion, we outline some of our data for each of the three forest product industries from Chapters Five (Xate), Six (Allspice), and Seven (Chicle). We believe that such data provide a foundation for successful NFM strategies in the Multiple Use Area of the Reserve. The ecological and productivity data presented here are summarized in Table 1.1. Economic data are summarized in Table 1.2. Summaries of the principal threats to each industry's sustainability and associated recommendations are summarized in Table 1.3. For a discussion of data collection methods see Chapter Four. Socio-economic data collection methods are discussed in Chapter Three (Socio-economic Profile of the Forest Harvester). The main points presented in Chapter Three are included throughout the following discussion.

1.5 Characteristics common to NTFP industries

There are important characteristics shared by the three industries. First, all NTFPs are extracted through similar market channels. Harvesters work out of forest camps or communities adjacent to forests. They are paid by the quantity of harvest by middlemen, who, in turn, transport the product by mule and truck for sale to exporters.

Second, harvesting cycles, dependent on both ecological productivity and market demand, are seasonal. Xate is harvested all year with demand lowest from June to September and highest in April. Allspice is harvested from mid-July to mid-September, depending on when the fruit ripens. Chicle extraction also depends on plant physiology; harvesting occurs during the rainy season from September to January.

Third, this seasonal cycling of harvesting activities provides employment through most of the year. Because of the similar methods used in all three industries, many individuals diversify their income strategies by working in two if not all three industries. This tendency is also supported by the fact that these species all occur in close ecological association--they grow together.

Fourth, an economic or income strategy that emphasizes diversity is the rule rather than the exception, especially among long-time Petén residents. Moreover, such economic strategies often include milpa production. Milpa provides food, forest harvesting provides money, both together provide a common economic strategy for the inhabitants of the Northern Petén. Forest resources are more important to Reserve inhabitants than to people who live outside the Reserve, though for this latter population the forests are still a critical component of their income strategies. Of the three NTFPs, xate is the most important source

of income for both populations, but all three play critical roles, especially in providing employment when demand for seasonal labor is otherwise low.

Fifth, non timber forest products in Petén appear to be open-access resources. That is, anybody can take as much of any of the resources as they wish. However, cultural values do promote a conservation ethic and respect for the forest's economic productivity, particularly in the case of chicle. Nonetheless, overharvesting is common, especially for xate. Overharvesting results not from harvester ignorance, as some people suggest, but more from poverty, which forces harvesters to abandon a long-term view in their quest to simply survive. Educational efforts among harvesters can certainly improve resource management efforts, but blaming harvesters for overharvesting is equivalent to blaming the victim--both harvesters and forest resources suffer from the difficult socio-economic conditions of rural Guatemala.

Finally, these forest product industries provide the foundation for a forest society. The people employed in these industries have, through several generations, acquired considerable knowledge not only in the use of commercial species, but several other forest species as well, such as materials for construction and farm implements, game species for food, and medicinal plants. This diversity of species also make a considerable economic contribution to the region's communities.

1.6 Xate

The harvesting of xate, Chamaedorea elegans and Chamaedorea oblongata, occurs throughout the Maya Bioregion in Mexico and Guatemala. Unlike allspice and chicle,

harvesting occurs both beyond the boundaries of the Reserve and, because it is an activity that can be conducted undetected, in all the protected areas of the Reserve. In the Multiple Use Area, we estimate that plant densities range from 1,747 to 2,586 individuals/ha for C. oblongata, and from 731 to 1,920 individuals/ha for the more lucrative and sought after C. elegans. Both understory palms grow in undisturbed upland forest. Highest densities are encountered in Tikal National Park where harvesting is prohibited. These populations are being illegally harvested, however.

Harvesting techniques are simple, requiring little skill or equipment. Individual leaves are cut with a single-blade knife as the harvester quickly moves from one plant to the next. The rates and characteristics of harvesting practiced in the Petén have resulted in diminished plant productivity. Evidence for this is seen in the low rates of flowering, fruiting, and regeneration in harvested populations, as opposed to higher rates in protected area populations. These low rates are most clearly seen in the more highly exploited populations of C. elegans. Losses in productivity likely occur as individual plants transfer energy from reproduction to the generation of replacement leaves. Subsequent harvesting of new leaves may diminish the plant's ability to survive. Accordingly, forested regions with greatest accessibility have the lowest plant densities. As leaf supply decreases, leaf quality goes down as more immature, undersized, and damaged leaves are cut. In turn, this practice leads to higher waste and greater costs, further reducing extraction efficiency while increasing harvesting impacts and extraction costs. This is most dramatically seen in the volume of waste. Up to 60% of the leaves are thrown out in the process of selecting and packaging harvested leaves for export.

Benefits include an average gross daily wage to harvesters of at least Q15.30 (net wage = Q9.14; Q = Quetzal; $US1.00 = Q5.00 at the time of this study), a result of an average daily harvest of 1,200 leaves. This compares favorably to the regional gross daily labor rate of approximately Q10.00 -- when alternative labor can be found. Selection occurs in the warehouses of exporters and employs women. Paid on a piece-work basis, an individual can gross Q15.00 per day.

Accurate export statistics are difficult to obtain, but with certain simplifying assumptions, we calculate that 1989 exports grossed approximately $3.5 million, the result of an export volume of 1,575,000 kg or 250,725,000 leaves. Also, depending on export levels, employment is as high as 209,000 working-days per year. If we assume that full time employment entails 17 work days per month and that the average worker spends three months per year collecting xate, about 4,100 people per year are employed in the xate industry. Since many of these people are primary providers in a household, it is safe to say that nearly 4,000 households are supported during this time by this activity. The principal market for C. elegans, and some C. oblongata, is Europe. Demand from the U.S. is principally for C. oblongata.

Potential yields, based on a production of two leaves per plant per year from actively harvested forests, are 1,346 leaves/ha/yr for C. elegans and 1,980 leaves/ha/yr for C. oblongata. Using 1989 export data, we estimate the annual amount of forest area necessary to supply international demand as ranging from 2,078 km^2 for C. elegans, to 1,100 km^2 for C. oblongata. These are rough estimates, and ones that will be improved as more research is conducted and management implemented. If these are correct, they indicate that rotations of

a year or more would be feasible to allow an area to recover from intensive harvest. Nonetheless, we wish to stress the importance of forest resources harvested outside the boundaries of the Reserve. As colonists clear land outside the Reserve and enforcement increases in protected areas, plant populations within the Reserve, and particularly within the Multiple Use Area, will be the focus of intensified harvesting pressures, thus highlighting the need for coordinated and integrated resource management in this area.

In sum, the benefits to the region's inhabitants are very high and provide the most important alternative to activities that require forest conversion: xate harvesting is a principal deterrent to forest conversion because it provides alternative employment to those who would otherwise make milpa, thus reducing the need to clear land to grow food for subsistence and cash.

Nonetheless, overharvesting is clearly reducing plant densities. Hence, our recommendations emphasize reducing harvesting through pricing mechanisms, inspections, rotations, and increased "ownership" on the part of collectors, contractors, and exporters. We anticipate that such changes will shift the current industry emphasis from quantity to quality. This regulatory effort must be accompanied by improvements in the education, worker safety, benefits, and health of forest harvesters.

1.7 Allspice

Nominally, allspice is the least economically important of the three industries. However, its importance is best seen not in dollars, but in the key role it plays in diverse household income strategies, that of providing wage labor at a time of year when other

employment sources are scarce.

The berries of Pimenta dioica are harvested, dried, and packaged for export. The common forest tree is easily distinguished by its smooth tan bark, arcuate trunks, and the strong, aromatic smell of its leaves and fruit. The species favors the thin, rocky, well-drained soils of upland forest. Regeneration is most commonly found in the light gaps of tree falls. As a result, the species is often found in even-age groupings.

Our field measurements reveal tree densities that range from 9 to 31 trees/ha, measured at diameter at breast height (DBH) greater than 5 cms. Of these, approximately 40% had fruit, so we assume that they are female. Some non fruit-bearing trees may also be female. Harvesting requires scaling the tree and coppicing fruit-laden branches. Yields range widely, depending on the size and age of the individual, and harvesting history, among other factors. Based on interviews and direct field measurements, we estimate an average of 5.7 kg/tree of green, undried fruit every five years. Once the fruit is dried for export, weight decreases by 60% to about 2.3 kg/tree. Overall, we estimate that average annual yields are about 1.8 kg of dried fruit per hectare after taking into account rotations of five years and the average number of fruiting trees encountered.

Harvesting impacts appear to be low. Currently, not all fruit-bearing trees are harvested in a given season and both field observations and interviews indicate that coppicing-induced mortality is low. Coppicing delays fruiting while the tree grows a new canopy, though refruiting generally occurs within five years according to harvesters and contractors. Increased human population, however, brings inexperienced harvesters to the region. Reports of felling trees instead of climbing and coppicing them are common, though

we encountered relatively few felled trees.

The average net daily wage for harvesters is Q14.36, based on harvesting 4-6 trees for a total daily yield of about 18 kg of green (undried) fruit. The gross and net benefits of middlemen and exporters are presented in Chapter 6.

Jamaica supplies 70% of the world's allspice -- 3000 to 4000 metric tons with a value of $5 to 7 million annually -- the result of plantation production. The remaining 30% comes from Guatemala and Mexico, with a small contribution from Belize and Honduras. The largest consumers are the United States, the Soviet Union, and the several countries in the Middle East. World prices fluctuate and are dependant on the volume of Jamaican production, considered the highest quality, weather conditions at the time of flowering and fruiting, and the size of the Soviet herring catch, for which allspice is used as a preservative.

Based on interviews with contractors, we estimate that 75% of Guatemalan production comes from the Maya Biosphere Reserve's Multiple Use Area, the remaining 25% coming from plantations in southern Guatemala. Total exports for 1989 were 416,833 kg, which grossed, at a price of $1.32/kg (f.o.b.), $550,220 and provided over 43,000 person-days of work. If we assume 17 work-days per month, this yields two months of work for about 1,270 people, each person harvesting an average of 615 kg of green fruit.

As noted above, we estimate that yields from actively harvested forests average 1.8 kg/ha/yr of dried product. The area of forest needed to satisfy 1989 levels of production, 312,625 kg, is 1,737 km^2, significantly less than the 7,500 km^2 of the Multiple Use Area, and less than the estimated 3000-4000 km^2 of productive upland forest. As harvesting impacts appear low, we estimate current yields are ecologically sustainable, as are potential

future, market-driven increases in harvests. Even so, current harvesting techniques can be improved. In particular, greater emphasis must be placed on cutting only fruit-laden tertiary branches instead of the current practice of coppicing the entire tree. Fruit drying and sorting techniques could also be improved easily, as could levels of worker health and safety. All these efforts will help to improve the quality of the allspice harvested in Petén, thereby increasing the price on world markets.

1.8 Chicle

Manilkara zapota is a dominant forest tree, an indicator species for this region. Throughout chicle's history, the harvester, the chiclero, has been one of the highest paid laborers in the region. Export receipts provided rationale for the establishment of the principal communities of the northern Petén, and led to the establishment of airstrips throughout the region beginning in 1934.

Densities increase from south to north and range from 23 to 47 trees/ha (DBH > 10cm). The tree is common in all upland forest regions and, like P. dioica, often occurs in groupings.

Harvesting chicle requires considerable skill, equipment, and stamina. A machete is used to cut the boles of individual trees with intersecting gashes from the base up to the principal branches. The cuts penetrate the outer cambium (just inside the coarse bark), cutting into a system of latex-bearing cells. The latex drains into a collection bag at the base of the tree and is later thickened through boiling and formed into eight to ten kg blocks for transportation and eventual export. Tree physiology demands that harvesting occur only in

the rainy season; both high soil moisture and atmospheric humidity are necessary for the latex to flow freely.

While considerable skill is required, chicle collecting is still rather crude. Mortality is estimated to be at least 5% of the trees tapped and, once tapped, healing trees produce little fruit, potentially reducing regeneration. The machete blows of the chiclero cut into the cambium, thus interrupting the flow of nutrients and water from the roots of the tree to the canopy. Removal of the bark also leaves the tree vulnerable to predation by insects and fungus, both of which slow healing and increase mortality.

Data on plant population densities earlier in the century is unavailable, making impacts difficult to quantify. Perhaps most indicative of such impacts is the fact that current seasonal harvesting levels for a chiclero range from 5-10 quintals (1 quintal = 100 lbs; 45.4 kg). During the heyday of the industry, seasonal averages ranged from 18-23 quintals. Nonetheless, significant regeneration (height < 1 m) is encountered and, after 100 years of collection, plant densities remain relatively high.

Collecting chicle for use as a chewing gum base has historically been an economic foundation for human occupation of the Petén's northern forests. The market for chicle began in the late 1880s and grew tremendously from 1920 through the late 1940s. Exports peaked in 1947 with 1,909,091 kg (47,000 quintals; 4,700,000 lbs). Post-war development of synthetic, petroleum-based substitutes and changing market structures in Guatemala initiated a decline in international demand which reached it lowest point in the late 1970s. In the 1980s, demand has steadily increased to an export volume in the late 1980s and early 1990s of about 454,545 kg (10,000 quintals; 1,000,000 lbs) with a value of about $1,750,000

(f.o.b.), fueled primarily by exports to Japan.

Based on this level of exports, the industry provided over 126,000 person-days of work, translating into six months of work for over 1,200 people. Current average net daily wages are about Q42.40 ($8.48), the result of an average daily harvest of 3.6 kg (processed weight). Distribution of benefits are dictated by law among the different levels of the industry.

The average yield from actively harvested forest ranges from 1.1 to 1.7 kg/ha/yr, depending on five or eight year harvesting cycles. The estimated forest area needed for international demand of 11,500 quintals, 15% more than current average exports, ranges from 3,075 km^2 to 4,752 km^2, both values at or above the estimated area of productive forest in the Multiple Use Area. Any attempts to increase supply above this amount should be carefully studied to ensure ecological sustainability. Growing market for natural products make such increases possible. However, in order to ensure the industry's sustainability, harvesting impacts must be monitored and less destructive techniques developed. Most importantly, the plants must be given adequate time to recuperate between harvests, a goal best achieved by establishing forest rotations.

TABLE 1.1

Summary ecological statistics for each of the three non timber forest product industries. See Chapters Five, Six, and Seven for the field data and assumptions that provide the basis for these numbers.

	CHARACTERISTIC		
Species	Plant Pop. Densities (ind./ha)	Pot. Yield Per Hectare Per Year	Min. Forest Area for Int'l. Demand (km^2)
C. elegans	731-1920	1,364 leaves	1,386
C. oblongata	1747-2586	1,980 leaves	739
P. dioica	9-31	1.8 kg	1,737
M. zapota	23-47	1.1-1.7 kg	3,075-4,752

TABLE 1.2

Summary economic statistics for each of the three non timber forest product industries. See Chapters Five, Six, and Seven for field data and assumptions.

	CHARACTERISTIC			
Species	1989/90 Exports	Value (f.o.b.)	Employment (person-days)	Average Net Daily Wage*
C. elegans C. oblongata	1,515,000 kg (250,725,000 lvs)	$3,540,000	209,400	Q 9.00
P. dioica	416,833 kg	$550,220	43,000	Q 14.36
M. zapota	454,545 kg	$1,750,000	126,000	Q 42.40
All species		$5,840,220	378,200	Q 20.75**

*Exchange rate at time of study: US$1.00=Q5.00
** Weighted Average

TABLE 1.3
Summary of principal threats to sustainability and basic points outlining a strategy for NFM.

Species	Threats	NFM Strategy
C. elegans C. oblongata	In general, high. Over-harvesting induced mortality and reductions in both leaf production and regeneration.	Regulated waste reduction; improved distribution of benefits; education to improve harvesting techniques and camp conditions.
P. dioica	In general, low. Some reduction in productivity.	Improved harvesting techniques; regulatory efforts to monitor forest populations; improved distribution of benefits; improved fruit drying and sorting techniques.
M. zapota	In general, moderate to high; current harvesting levels are high relative to the available resource; mortality at least 5% of harvested population; reduction in productivity and reproduction.	Improved harvesting techniques; regulatory efforts to monitor forest populations; forest rotations and/or concessions.

1.9 Conclusions

The establishment of the Maya Biosphere Reserve provides a unique opportunity to avoid in Guatemala the severe environmental and socio-economic problems often associated with the expansion of human populations elsewhere in the forested tropics. Table 1.3 summarizes the threats facing the Reserve and the products harvested there. This table also summarizes potential management strategies to counter these threats. The forest society, the forest products industries, historical and current land-use designations, established domestic and international markets for forest resources, and high plant densities all contribute to the possibility that forest resources may form part of a platform for sustained human welfare well into the future. Moreover, this unique combination of factors may enable forest resources to be harvested with very low environmental impacts, maintaining biodiversity not

only in exploited regions of the Reserve but safeguarding the ecosystems of adjacent protected areas from human disturbance. Similarly, the Reserve also provides the opportunity to safeguard the rich archaeological remains of past Maya civilization for both scientific inquiry and the economically important tourism industry.

We caution that the harvesting of forest resources will be only one part of a basis for sustained human welfare in the region. Increased agricultural production, development of agroforestry systems, stabilization of agricultural communities via secure land tenure, credit, and technical extension, expansion of tourism, and diversification of value-added forest products industries will all be necessary to accommodate the needs of a growing human population and to minimize continued forest conversion.

We also caution that while the opportunity exists to use forest resources as part of a base for promoting sustained human welfare, there is no guarantee that this will occur. Current forest value--its contribution to regional employment and income--has been diminished by decades of harvesting, nonexistent management, and over-exploitation of common-property forest species. For forests to play a continued role in the region's economy--as they must if the region's current economic transformations are to result in sustained human welfare and biodiversity--effective natural forest management strategies must be implemented.

1.10 Natural Forest Management Recommendations

The overall goal of these recommendations is to help promote a management system, guided and coordinated by CONAP, to increase the efficiency of extraction of non timber forest products, while maintaining biodiversity and equitable benefits distribution. Many of the recommendations that follow assume a certain level of technical and administrative capacity on the part of CONAP, as well as political acceptance and support for CONAP's efforts at many levels in Guatemalan and Petén society. As a young institution in an area with the problems and characteristics of a frontier, CONAP does not yet have the administrative and technical ability to realize many of the recommendation below. Nonetheless, we hope that they provide direction for CONAP, communities, harvesters, contractors, and so in an effort to improve the management and conservation of a wide variety of forest resources.

General Management Recommendations:

- CONAP, in association with other governmental agencies, local communities, contractors, exporters, and resource harvesters must stop the continuing incursions into forested areas of the Reserve. Populations of all the major NTFPs, and the forests that support them, are under considerable threat from population growth and associated forest conversion activities. Stopping continued forest clearing and other illegal activities will require strong political and economic support at all levels of Guatemalan society and from international partners as well. Without adequate controls of the borders of the Reserve, all of the goals discussed below are academic.

- CONAP must develop a formal, clearly articulated system that will bring communities, harvesters, contractors and other concerned parties into the management and enforcement effort and maintain this system over the long-term. The groups that draw up the criteria for allocating forest resources should include representatives from those groups and communities with a big stake in NTFP extraction. Developing such a system is a slow, stepwise process, and demands strong leadership on the part of CONAP. It is this stepwise process, however, that will produce the details, the trust,

the commitments, and the capacity to bring about long-term resource conservation. Anything that attempts to short circuit this process will ultimately fail or produce less than optimal results.

- Any intervention must carefully consider existing formal and informal access rights to forest resources. That is, do contractors, harvesters, communities and others divide up the resources among themselves or is the system completely "open access" such that there are no rules at all about who has rights to what resources? Some of the answers are contained in this report, but many questions remain, some of which are actively under investigation.

- Improve the integration of timber and non timber forest product harvesting. In the long-run, timber and wood products are probably the most valuable resources in the forest, outside of oil and tourism. Nonetheless, NTFP production fills in many gaps, mainly by providing income while trees are reaching marketable sizes, providing year-round income, and providing thousands of jobs that do not require high degrees of skill nor investments of capital. Timber and non timber products are strongly complementary and this should be considered in all management decisions. There are a few simple things to do to minimize the impact of logging, such as avoiding chicozapote and allspice trees when felling and removing timber species. In addition, there should be a complete ban on the cutting of chicozapote and allspice trees, except when they are clearly dead or nearly so.

- Develop a system to license, monitor and tax the extraction of NTFPs as part of a larger management strategy. Options developed should draw on the growing body of common property resource management and be flexible enough to accommodate new data on social, economic, and ecological aspects of the extractive system and the forest on which it depends. Based on accurate vegetation, soil, and extractive infrastructure maps, a knowledge of how resource extractors organize themselves and divide up resources among themselves, and a good economic understanding of the production characteristics in the extraction industry, a system of monitoring, licenses, concessions and rotations can be proposed and implemented.

  As a monitoring system is implemented which records where and how much contractors are harvesting, new vegetation data, the state of roads, etc., more data on production potential from different areas of the Reserve can be fed into the system, allowing fine tuning.

  The system should be able to shut off access to an area relatively easily. Given the nature of the extraction system, particularly the transportation infrastructure, it may be possible to control NTFP harvesting by restricting road access at critical points. Thus, specific areas can cordoned off to allow the resource to recuperate from past overharvesting. How long recuperation takes will need to be established from applied research activities.

A major effort must be made to structure the licensing system so that it is clear how much or what kind of NTFP is coming out of what management area. User fees must be developed in conjunction with the licensing system, rotation and concession systems to ensure that resource harvesters and contractors alike have assured access to resources while guaranteeing that they have a long-term commitment to sustained resource management.

- More accurate information concerning the network of roads and trails, camps, and water sources throughout the Area Uso Multiple must be developed. This information should be produced, at a minimum, at a scale of 1:50,000. If feasible, these data should be incorporated into a computerized geographic information system that will allow constant updates of information as well as ease of access to a wide variety of data. These data are critical in designing and maintaining a system charged with managing over 750,000 hectares of forest with a wide variety of resources.

- The extent of different vegetation types within the Area Uso Multiple and selected areas of the buffer zone should be mapped, and periodically updated, at a scale of 1:50,000 using remote sensing technology (both satellite and air photo data) and field surveys. Combined with information on extraction infrastructure discussed above, these data will go a long way toward refining estimates of resource stocks and dictating how extraction should be regulated, be it through long-term concessions, rotations, or some other system.

Research to Improve Natural Forest Management:

All Non Timber Forest Products:

- Study the life cycles and plant ecology of selected species to construct predictive models of regeneration and growth. Life cycle research should focus on the rates and characteristics of germination, seedling establishment, growth, flowering, fruiting and seed dispersal. Plant ecology studies should characterize edaphic factors (i.e. soils, sunlight, topography, etc.) that control seedling establishment and growth. With the elaboration of species' life cycles, models should be developed to predict regeneration and growth of species' populations under different harvesting regimes. These studies demand permanent plots should be strongly coordinated with the descriptive forest studies described below.

- Conduct basic, descriptive forest studies to understand the ecological role NTFPs and timber species play, focusing on interactions with other species. These studies should describe and quantify forest composition in a variety of forest types. Field work should involve periodic surveys of trees, shrubs, herbaceous plants, lianas, and epiphytes. Treefalls and resulting gaps also affect species composition and forest structure, so areal extent and frequency of canopy gaps should also be measured. These studies should take place in a range of both vegetation and successional types

(e.g., primary upland forest, disturbed upland forest, young secondary upland forest, etc.) and should be strongly coordinated with environmental assessments. Information from forest composition and structure studies should be combined with remote sensing data to generate vegetation classification keys.

- Examine the impacts of differing rates and techniques of harvest on NTFP populations. Experimental treatments should be species-specific and should test a range of harvesting rates and techniques. Associated plots can be used to test forest enrichment strategies. This research should draw on the basic research in the descriptive forest studies and species ecology studies discussed above to both guide research and develop more sustainable harvesting regimes. This research should also mesh with environmental assessments to improve the process of NTFP extraction.

  In addition to the major NTFPs, xate, chicle, and allspice, research into growth rate and mortality under different harvesting techniques should also include Ramón (*Brosimum alicastrum*) and bayal (*Desmoncus* spp., a New World rattan). Other species should be identified by ethnobiological surveys. As they are identified, research plans should be developed on a species by species basis.

  The results of this research should be incorporated into CONAP management strategies, particularly for training initiatives, establishment of quotas and concessions, and vegetation treatments and other interventions.

- Investigate the formal and informal resource allocation systems that exist in the MBR region and the potential effects of division of resources through formal semi-privatization or concessions. This research must be interdisciplinary. Social, economic, and ecological factors be studied, including ecological and technical constraints of the industries, government regulations and their impact, and formal and informal rules of resource use. Emphasis should be placed on the identification of factors that work for and against sustainability and what factors (which may offer disincentives to voluntary cooperation and compliance) should be avoided in monitoring and regulatory efforts.

Natural Forest Management Strategies

All Non Timber Forest Products:

- Improve forest product harvester education and increase their stake in long-term resource viability. Forest harvesters and forest communities may be the single greatest resource available for managing these forests over the long-term. One thing is certain: without them, there is little hope for good management and dim future for the forests themselves. These harvesters number in the thousands and know the forest well. In addition, most of these harvesters are cognizant of good and bad harvesting practices. For example, most harvesters know which xate leaves are good are which

are bad. They also know how to cut the leaves correctly. However, poverty, an emphasis on quantity versus quality and the resulting lack of long-term commitment to the resource does not allow them to think of the plant's future. While increased wages will provide strong incentive for improving the treatment of plants, education will reinforce it by focusing not only on correct harvesting techniques, but on improving harvester welfare and self-esteem. Training courses in improved camp sanitation, basic first aid, and better harvesting techniques are badly needed. Harvesters who complete the course will receive a license to harvest, without which they should not be allowed to work in the Reserve. Furthermore, if these harvesters could be paid to work in natural forest management tasks particularly during periods of low labor demand, new employment in forest-based activities would be created while tapping into an immense body of working knowledge concerning forest ecology and productivity.

- Develop ways to add value to non timber forest products locally and nationally, through additional processing, so that residents of Petén and Guatemala will have greater incentive to maintain the forest as an economic base.

- Find other non timber forest products that can be added to the existing "mix" of NTFPs already traded locally, regionally, and internationally, in an effort to improve the "portfolio" of products offered and thereby reduce the effects of volatile international commodity markets. Particular efforts should be devoted to systematic ethnobotanical studies and literature searches. These efforts should produce a prioritized list of potential products which can then be sampled by potential buyers.

- Increase the value of the product on the international market. This can be done in a number of ways, particularly by improving the quality of the product and the consistency of supply. While some of these factors may be beyond the control of harvesters, contractors and exporters, some things can be easily improved. A good example is allspice and the fact that Guatemalan production consistently commands a lower price on international markets because much of the crop has a smokey flavor and is highly irregular in size.

- Increase population densities of desired species through a variety of natural forest management interventions. Such manipulations should be structured so that the best balance between preserving biodiversity and increasing the presence of desired species. These actions include the investigation and implementation of vegetation treatments, such as the cutting of vines, the encouragement of regeneration, and the felling of competing species to favor important NTFPs. Much research, as described above, is still needed in this area and Petén provides a good region for such research because of the relatively high densities of many desirable species.

Xate:

- Reduce leaf waste through pricing and regulation. Decreasing the number of leaves discarded during processing requires that more high quality leaves arrive at the processing warehouses. In turn, this demands that fewer, higher quality leaves be harvested and damage during transport be reduced. This will entail a higher price paid to xateros, and the need to shift harvest from quantity to quality. For this to happen exporters will have to pay more for the fewer, higher quality leaves that contractors deliver. To be feasible, control will have to take place in the warehouses, and penalties will have to be consistently levied if waste exceeds a certain level.

- Improve wages for harvesters; halt the decline in real wages due to devaluation of the quetzal. Currently, regulatory mechanisms dictating benefit distribution across the industry exist for chicle; similar legally enforced distribution could be established in the xate industry. If costs of selection and transportation can be reduced because of reduced leave flow, it should be possible to increase the price xateros receive for their leaves without increasing the export price.

- Establish a series of defoliation experiments, with controls and replication will be established. Germination and transplanting experiments should also be conducted. These studies should be done in conjunction with the research discussed above.

Chicle:

- Investigate growth rates and mortality of trees in different size classes. Studies should include a variety of tapping regimes (time between tapping, tapping methods), with controls and replications. While current harvesting techniques result in mortality, they are, according to the work of Karling and Lundell, the best available. However, little or no work on tapping methods has been done since that of Karling and Lundell in the 1930s. Therefore new tapping techniques should be investigated. Methods to improve regeneration and growth should also be investigated.

- Initiate research to answer or clarify the following questions (per A. Jorgenson):
  - How many chicleros are there in Petén?
  - Do all chicleros extract about the same amount of chicle?
  - Do all chicleros harvest chicle throughout the entire harvesting season?
  - Do chicleros really wait the five to seven years they say are necessary for the trees to recover?
  - How do chicleros know how many years have passed since the last tapping?
  - Is there a significant difference between the yield of zapote "rojo" and "blanco"?
  - Do chicleros intentionally or unintentionally manage chicle trees to improve regeneration and productivity?

- Reduce population decline due to tapping mortality. The long-established chiclero culture reinforces many values that promote sustainability. The pride of the chiclero, the importance of apprenticing, a long regulatory history, and strong industry organization all combine to provide a collective concern for the condition of the resource. These characteristics should be enhanced and formalized to produce a training regimen that will improve the consistency and quality of tapping. Periodic training of this sort will also permit new techniques to be introduced and that Research as described above will also aid in reducing mortality.

- Cap chicle production at 12,000 qq (1,200,000 lbs.; 545,455 kgs) per year. Until more information is available, we should assume that this is the maximum sustainable yield from the Area Uso Multiple of the Reserve.

- Implement a basic regulatory strategy for chicle extraction. A basic regulatory strategy can be implemented immediately, one that ensures a minimum rest time for trees between harvests. The basic idea is to establish forest rotations, restricting the use of camps in specific forest regions for a period of time deemed necessary for the sufficient recuperation of a given M. zapota population. We suggest a minimum rotation time of seven years based on yield data and very rough estimates of the number of chicozapote trees in the Area Uso Multiple. Future research will identify a rotation cycle that provides a sustained-yield of latex, taking into account mortality, diminished productivity, fruiting, regeneration, and annual growth. We caution that sustainability raises not only ecological questions, but equally important social and economic questions. Any value for rotations that is experimentally derived must be carefully balanced with the needs and expectations of the region's inhabitants, as well as with the demands of the international market.

Allspice:

- Find new markets for Petén allspice. Based on our field data, this resource currently faces little danger of overexploitation, so production could increase significantly. Of course, production still must be carefully monitored and new harvesting and processing techniques implemented. Much more information is still needed about population densities, production levels, etc, as described in needed research, above.

- Explore alternatives to current extraction techniques. Total coppicing of female trees is the current harvesting technique. We recommend that the production systems in Jamaica and Mexico be assessed for different harvesting techniques and that these improvements be passed on to harvesters and contractors through some kind of training course.

- Develop methods to extract the essential oils from the allspice leaves, thereby using male trees as well. Steam distillation techniques can be relatively simple. Jamaica is the only major producer of this essential oil. Secondary processing of allspice should be investigated, with emphasis on the production of essential oils. Essential oil production allows use of leaves, including the leaves of male trees, so the leaves of coppiced branches could be used, as could a larger percentage of the trees overall.

- Improve the wages and working conditions of the forest harvester. Like the xatero, and unlike the chiclero, pimenteros have suffered as a result of the devaluation of the Quetzal. In addition, must be improved and the harvester must be more directly involved in management decisions regarding these and other forest resources.

- Improve the value of the product on world markets. The sale of allspice produced in the Petén should be better coordinated with production in other countries, and with the demands of large buyers to improve prices. It may be necessary to build storage facilities. Spice quality could also be improved with some simple changes in drying and sorting techniques, such as reducing the practice of drying allspice berries over an open fire. Guatemalan allspice, about 75% of which comes from wild stands in the northern Petén, is of much lower quality than Jamaican or Mexican allspice. The problem is that the Guatemalan berries are variable in size and color while often having a smokey taste and smell to them, a result of being dried over an open fire. Most of the product from Jamaica and Mexico is dried in the sun, usually on concrete patios or plastic mats. One idea, therefore, is to improve the drying methods in the field in the Petén and to increase the uniformity of the berries by improving sorting techniques.

2.0 INTRODUCTION AND BACKGROUND

Continued population growth and economic expansion in Central America, attended by poverty and social inequity, have converted over two-thirds of the region's forests for agriculture, grazing and other land uses (Nations and Komer 1983). In the Petén, agricultural expansion and logging have resulted in the conversion of between 200 and 400 km^2 per year for the last 10-15 years (CATIE 1990a, 1990b). Population has risen from 64,500 in 1973 to a present level of 250,000 to 300,000 (CONAP 1989, Schwartz 1990). Under the current pattern of extensive agriculture and cattle production, widespread forest conversion will continue, threatening the region's social stability and ecological and economic productivity.

In response to this threat, the Maya Biosphere Reserve, encompassing about 1.5 million hectares, was established in the northern Petén in 1990 (Figure 2.1). The Reserve has been accepted into the international system of biosphere reserves as recognized by the United Nations Educational and Scientific Organization (UNESCO). The Reserve is part of an "arc" of protected areas that stretches from Chiapas in the west, northeast to the Petén and Campeche and east and south into Belize (Figure 2.2). The National Council of Protected Areas (Consejo Nacional de Areas Protegidas - CONAP) was established to administer this and other protected areas in the country. Although the legal framework is in place, both CONAP and communities in and around the Reserve face many challenges in the effort to improve the management of the Reserve's cultural and natural resources.

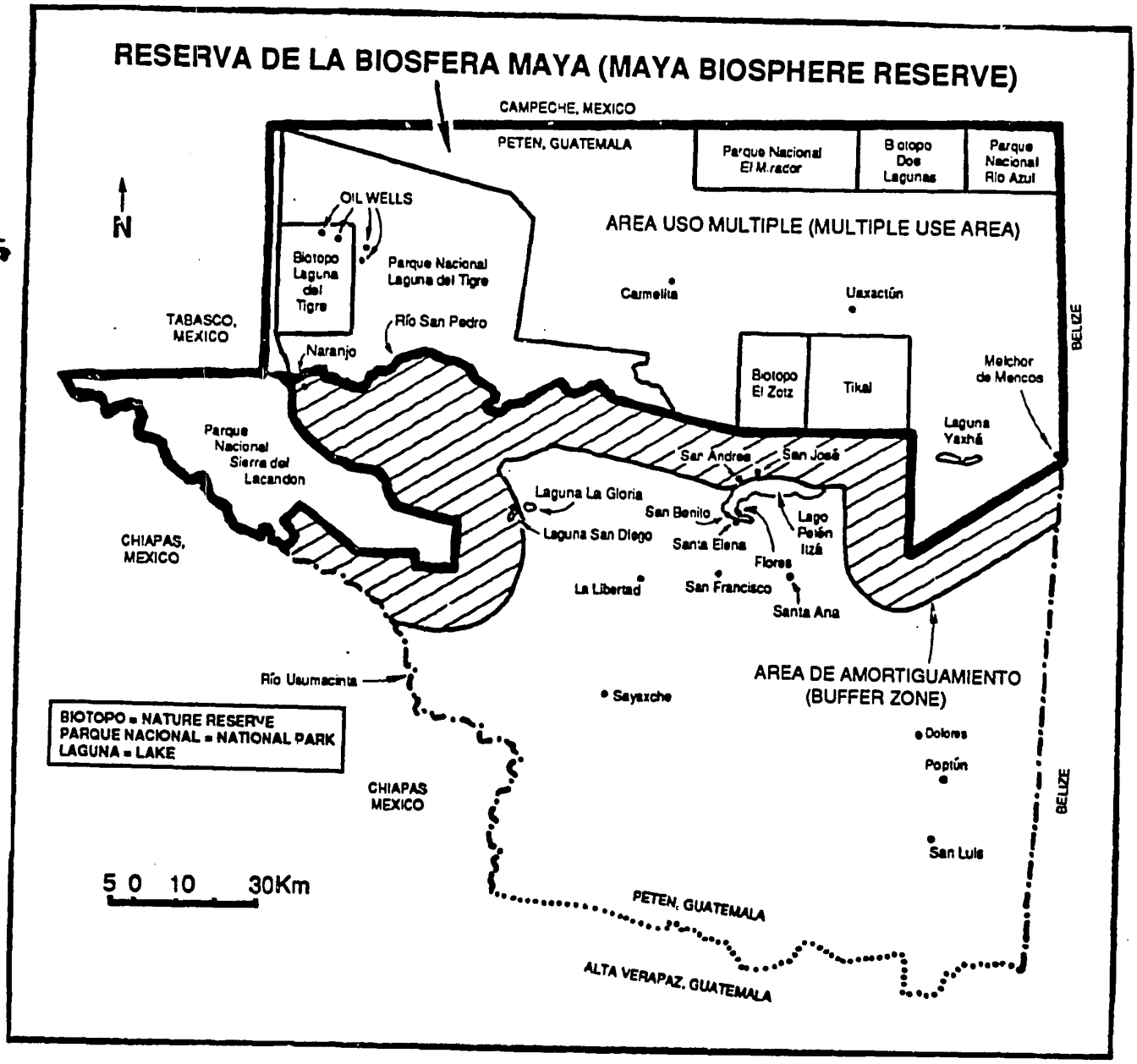

FIGURE 2.1

Department of El Petén, showing the Maya Biosphere Reserve and towns. The Reserve is broken down into several zones, including a multiple use area or extractive reserve (Area uso multiple), biological reserves (Biotopos), and national parks (Parques Nacionales).. To the south and east of the Reserve proper is a buffer zone (Area de Amortiguamiento), which will be the focus of activities designed to stop the advance of the agricultural frontier further into the Reserve.

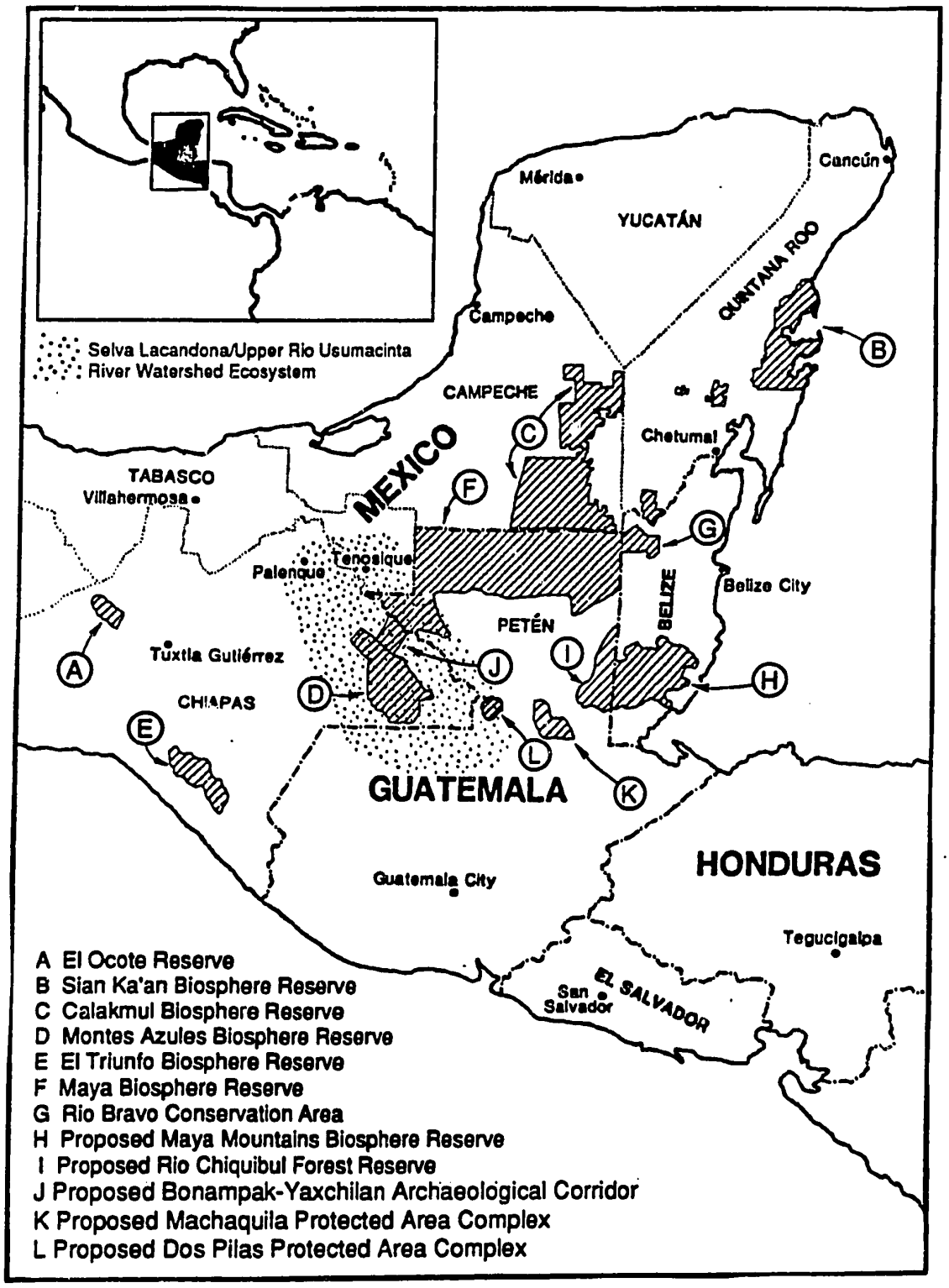

FIGURE 2.2

Regional overview indicating the location of the Maya Biosphere Reserve with respect to selected protected areas in the southern Yucatán peninsula, Chiapas, and Belize. Note that, with the addition of key corridors, existing protected areas form an arc that spans three countries and encompasses a diversity of ecosystems, ranging from subtropical moist forest to savannas and wetlands.

This study focuses on one set of natural resources, non timber forest products (NTFPs). NTFPs include gums, ornamental plants, spices, resins, oils, waxes, medicinal plants, honey, construction materials, and many other products important in regional and international trade. This study considers three economically important products, namely chicle, the latex of Manilkara zapota (Sapotaceae), xate, the leaves of Chamaedorea elegans and C. oblongata (Arecaceae), and pimienta gorda or allspice, the dried berry of Pimenta dioica (Myrtaceae). These species are common forest plants and are widely collected full- or part-time by thousands of people, many of whom depend on these resources for a substantial part of their cash income. Furthermore, the extraction of these products has been practiced for at least 30 years in the case of xate and pimienta gorda, and more than 100 years in the case of chicle. Therefore, these resources are exploited by a well-established ladino (people of mixed indigenous and European ancestry) forest culture, with considerable knowledge and experience in extracting a diversity of forest resources. Some extraction practices are far from sustainable, as is well illustrated by chicle exploitation during the boom years before and during World War II and by current xate exploitation. Though some of these practices were and are not sustainable, there is a basic familiarity with and dependence on the forest and its resources on the part of the forest culture of the Petén. This familiarity and dependence provides a basis for establishing more ecologically sustainable harvesting practices while simultaneously developing the economic base of the Petén and, we hope, ensuring the long-term conservation of the forest.

The Maya Biosphere Reserve includes zones for strict preservation of forests, wetlands, and other natural ecosystems. About 7,500 km^2 has been zoned for the sustained

production of both timber and non timber species. This latter area, designated an extractive reserve, is known as the Multiple Use Area (Area Uso Multiple). It presents governmental natural resource managers and members of local communities with several challenging questions: 1) What level of extraction for each species is ecologically sustainable? 2) Does forest production yield sufficient income to meet the expectations of rural people? 3) Combining these questions: How do forest product industries fit into a strategy for sustained rural development in the Northern Petén?

With these questions in mind, this report has five main objectives:

1) To discuss the social and biophysical context in which the Maya Biosphere Reserve is set.

2) To present representative densities and harvest levels within the Multiple Use Area for the three important NTFPs. In the case of chicle and allspice, basal areas and importance values are also presented.

3) To calculate the area of forest necessary to sustainably supply current international demand, and outline a series of strategies to achieve this supply.

4) To present a socio-economic profile of forest workers, using interviews conducted in camps and communities.

5) To recommend management strategies and applied research that will advance efforts to improve the management of the Reserve's cultural and natural resources.

The Maya Biosphere Reserve is a grand experiment. Because of the need to balance use and protection, the management of the Reserve presents more challenges than a national park. People live in and around the Reserve and have done so for centuries. Sustained production of forest products inside the Reserve and intensified agricultural production in the buffer zone outside the Reserve must be balanced with outright protection. These are the

hallmarks of a true biosphere reserve as envisioned by the United Nations Educational and Scientific Organization (UNESCO). Research and management must be multidisciplinary and attuned to solving problems at many ecological and socio-economic levels. Most importantly, as we emphasize in this report, people who live in and around the Reserve, particularly those who draw their livelihood from diverse forest resources, must be involved in both planning and management decisions. Involving local people is not a luxury: it is an absolute necessity. The objectives of the Reserve will be undermined without their participation.

This report thus seeks to ensure the success of the Reserve by illuminating critical ecological and socio-economic characteristics of NTFP production to aid institutional planners and community leaders as they seek to balance the conflicting goals of forest use and the preservation of the region's unique and vital natural and cultural resources.

2.1 Biophysical Environment

2.1.1 Climate

The Reserve, which occupies the northern 40% of the Petén, is located within a larger bioregion that includes eastern Chiapas, southwestern Campeche, and southeastern Quintana Roo in Mexico, as well as northwestern Belize. In the Holdridge et al. (1971) system, this bioregion falls within the "sub-tropical moist (hot)" lifezone. There is much seasonal variation in precipitation and some in temperature. The wet season extends from June through December and into January. The most intense periods of rainfall occur in June-July and again in September-October. Estimates of yearly rainfall vary widely, but most

estimates indicate an average between 1,200 and 1,500 mm/yr, increasing from northeast (near Rio Bravo Conservation Area in Belize) to southwest (cf. Hartshorn et al., in Brokaw and Mallory 1989, CATIE 1990a, CATIE 1990b).

The Petén, and the Reserve in particular, experiences substantial variation in rainfall. Lundell (1937) stresses that "cycles of dry years and occasional extremely dry seasons are of far greater importance in interpreting the vegetation and its distribution than any average of rainfall conditions."

April to September is the warmest period. Mean annual maximum temperature in the Biotopo San Miguel La Palotada, located in the south-central part of the Reserve (Figure 2.1), averages about 32°C, and daily maximums may reach 38-39°C in April and May. The coolest period is November through January. Minimum temperatures average about 20°C, giving an average yearly temperature of 26°C. At Rio Bravo, in northwest Belize, temperatures drop to 10°C during this period with the arrival of a "norther." Easterly and northeasterly winds blow intermittently from February to September at Rio Bravo, changing to northerly or northeasterly from September to January. At the Biotopo the winds blow from the north, south, and southeast from February to June, with speeds fluctuating between 3.5 and 4.1 m/s.

2.1.2 Geology and Physiography of the Reserve

The Yucatán Platform underlies the Reserve. The southern boundary of the Platform runs roughly east-west, following the geological structure which includes Lake Petén-Itzá, Lakes Yaxhá, Sacnab, and other bodies of water (Area 1, Figure 3.1). During the early

Eocene (58-47 million years ago), this platform was submerged, creating the foundation for the Santa Amelia and Buena Vista limestone formations of the Petén Group (Hartshorn et al., 1984). These limestone deposits, along with the topography of the region, exert strong influences on soils and vegetation.

The Reserve is comprised of three major ecosystems, all subcomponents of Area 1, Figure 2.3 (Godoy and Castro 1990). First, in the far northwest, the "humedales" of El Tigre predominate. This is a large wetland area dominated by grasses and sedges with occasional outcroppings of limestone uplands. Second, in the central and northeastern portions of the Reserve, "tintales", characterized by wooded swamps (bajos) punctuated by extensive limestones uplands, predominate. There are numerous small lagunas (lakes), many of which have extensive grassy vegetation around their edges. Cooke (1931, cited in Lundell 1937) and others believe that these bajos once formed shallow lakes

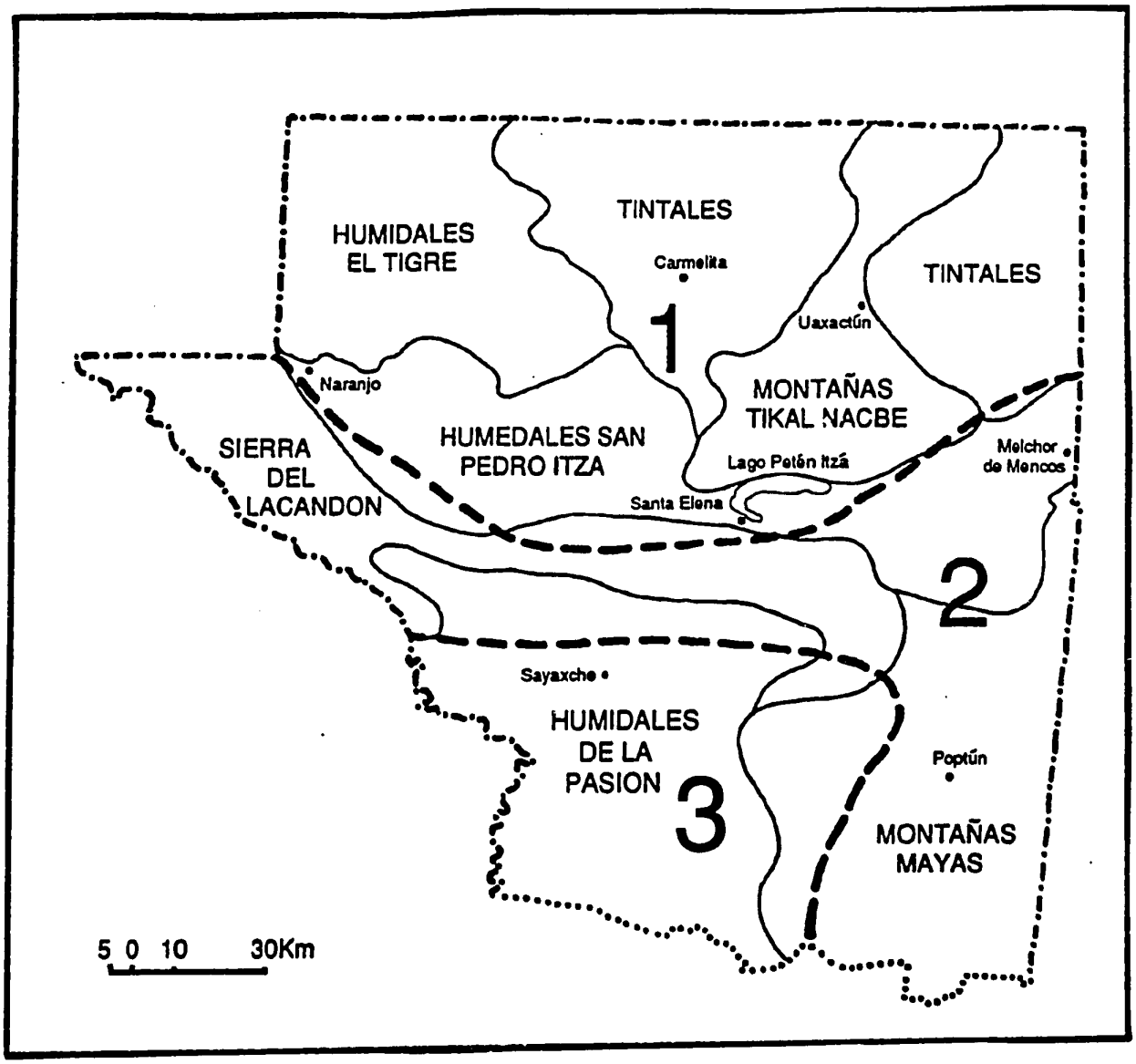

Figure 2.3
Map of Petén physiography and major ecosystems. This map delineates the major ecosystems of the Petén and superimposes them on the underlying physiography. Note the large expanses of tintales, areas of seasonally saturated soils punctuated by "islands" of well-drained upland forest.

The heavy clay soils of the bajos largely prevent water infiltration. During the rainy season water collects in and above these clayey soils, producing saturated, swampy conditions. Standing water may be present in the bajos for the greater part of the year. There is some controversy concerning the history of these bajos, though recent soil analyses in the bajos around El Mirador, in the north central part of the Reserve, lend further support to the theory that these bajos were once lakes (Tom Sever and Frank Miller[3], pers. comm. 1990).

The third, major ecosystem is the upland region called the Montañas Tikal Nacbe. These uplands are characterized by karst topography, with its broadly rounded hills punctuated by deep erosional depressions. These uplands are sandwiched between the two large areas of tintales. Gentle slopes predominate, though cliffs and steep slopes may be encountered near the summits of some hills. In these uplands of Tikal Nacbe, numerous sinkholes (dolines) exist. Those containing accessible water are called aguadas and form through subterranean erosion of the soluble limestone. Some aguadas have clayey, impervious bottoms and capture and retain rainfall. Often, these aguadas are seasonal, drying out completely during the dry season.. Other, often larger, aguadas are depressions that intersect the water table and hold water year round (Lundell 1937).

As a result of limestone dissolution, the northern Petén has a subterranean drainage system that is so well developed that little surface drainage occurs except during flood periods. Rivers, lakes, aguadas, and bajos are fed by both surface and subterranean drainage waters (Lundell 1937). Overall, both surface and subsurface water is difficult to obtain and

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[3]Tom Sever is archaeologist at the Stennis Space Center in Mississippi. Frank Miller is a forester at Mississippi State University. Both are researching vegetation in and around Maya ruins.

of often questionable quality throughout the northern Petén. This has been, and will continue to be, a substantial barrier to colonization.

The uplands of the Montañas Tikal Nacbe probably contain the highest proportion of upland forest of any of the major landforms. In turn, this upland forest contains the largest quantities of important NTFPs, making the Montañas Tikal Nacbe one of the most important economic regions within the Multiple Use Area.

2.1.3 Soils

The three major ecosystems discussed above, as well as local variations in conditions between uplands and depressions, strongly influence soil development. We will only distinguish between upland and depression soils, though many subdivisions exist within each type.

Calcareous rock is the parent material of Petén soils. As a result, the soils produced through weathering and other decomposition processes contain a high percentage of clay. In the well-drained soils of the uplands or colinas, the soils are usually thin (7.5-15 cm on slopes, 30-40 cm in level areas), dark brown in color, and contain calcareous gravel. Stoniness ranges from moderate to high. Soil structure is good, a result of relatively high percentage of organic matter (OM >7%). In flatter areas of the uplands, higher clay concentrations are usually found. Because of the high percentage of clays and positively charged calcium ions, the essential element phosphorus, available as phosphate, is often bound up in clay structures or produces relatively insoluble calcium phosphate salts. Therefore, phosphorous availability is probably a strong limiting factor in vegetation growth.

In both sloped and level areas, pH ranges from slightly acid to slightly basic (6.5-7.5). In addition, both upland soil types vary greatly in moisture holding capacity: some are exceedingly droughty in the dry season (Hartshorn et al., 1984). The soils on slopes are tentatively classified as Lithic Rendolls, while soils in flatter areas are Typic Rendolls in the USDA soil taxonomy (CATIE 1990b).

The more poorly drained soils are found in depressions, both in the sloping hills of the uplands and in the tintal basins. These soils are usually saturated or inundated for part of the year. Black to dark grey in color, clayey to clay-loam in texture, the aluminum rich montmorillonite clays expand when saturated, cracking and hardening during the dry season. Unless high levels of moisture are maintained in these soils, water is functionally not available for either natural vegetation or cultivated plants. The "edaphic drought" that develops in these soils in the dry season is produced by strong adhesive forces in the clay matrix which bind the water molecules so tightly that they cannot be taken up by plant roots. The soils in these depressions are generally classified as Chromuderts (CATIE 1990b, Brokaw and Mallory 1989, Lundell 1937).

As a whole, the soils of the northern Petén are suited for little more than forestry or perennial crops, a conclusion echoed by the extensive soil surveys of Simmons et al. (1959) and a later FAO-sponsored land-use study (1966). These studies, and the interest in timber resources formed a basis for the recent emphasis on forest conservation in northern Petén. Without this emphasis, there would probably be considerably less forest in the northern Petén because colonization and subsistence agriculture would not have been discouraged. According to Kneib (1989, cited in CATIE 1990b; see also FAO 1966), only 13% of the

soils in the Petén are both deep and well-drained, and these few are situated almost exclusively in the southern Petén. In general, the soils of the Petén are composed principally of clays whose internal drainage ranges from good to bad, they are easily compacted, are highly subject to erosion, and are often quite thin. For these reasons alone, there is a strong justification for the establishment of the Maya Biosphere Reserve and continued forest conservation.

2.1.4 Vegetation

The forest that extends throughout the northern Petén, southernmost Campeche and Quintana Roo, and into northwestern Belize is consistent in terms of structure and species composition (Lundell, 1937). Several seminal studies of tropical ecosystems have been conducted at Rio Bravo in northwestern Belize. We refer to these studies periodically because they are the best representative data now available for the larger bioregion. At Rio Bravo, vegetation types include upland broadleaf, seasonally flooded swamp, and palm forest, as well as savanna and marsh vegetation. As our investigations took us mostly into upland broadleaf forest, this discussion will focus on this vegetation type.

In addition to being classified as subtropical moist forest, Pennington and Sarukhan (1968, cited in Hartshorn 1984) also classify the upland vegetation as "medium-high semi-deciduous forest." This distinguishes the northern Petén forest from more uniformly wet and warm "tropical wet forest" (true rainforest) and from dryer "subtropical dry forest." Variation within the broadleaf forest is dependent on topographic position and soil characteristics, especially soil moisture. "In particular, the gentle topography of most of Rio

Bravo [and the northern Petén] produces a long, shallow gradient of soil moisture and a correspondingly long continuum of subtly different forest types (Brokaw et al. 1990)."

Forest structure and composition appear to reflect the land-use practices of the Maya and the impact of more recent selective logging pressures. The density of Maya ruins throughout the bioregion is high, suggesting that much of the upland forest was once cleared at least in large patches. Brokaw et al. (1990) summarize this situation as follows.

> About 1000 AD the Maya population declined abruptly, and since then the forest has regrown with comparatively little disturbance. Because trees have long generation times the species composition of Rio Bravo [and northern Petén] forest should still reflect the processes of forest clearing and regrowth set in motion by the Maya. The forest would also reflect the cultivation or protection of particular species by the Maya. Any tree species the Maya favored would have had a reproductive advantage in the centuries of regrowth, affecting the relative abundance of species in the current vegetation. Species they may have favored, and which are often found near ruins at Rio Bravo [and the northern Petén], are: Brosimum alicastrum (ramón or breadnut), Manilkara zapota (chicozapote or sapodilla), Orbignya cohune (corozo or cohune), Pimenta dioica (pimienta gorda or allspice), and Protium copal (copal) (Bartlett 1935, Lundell 1937, Lambert and Arnason 1978, Barrera et al. 1977)

Much of the bioregion has been highgraded for primary hardwoods, particularly caoba (Swietenia macrophylla) and cedro (Cedrela mexicana), as well as some secondary hardwoods such as Santa Maria (Calophyllum brasiliense var Rekoi). There are extensive logging roads throughout the Reserve, and in the course of our transects we found very few healthy individuals of these primary hardwoods larger than 50 cm in diameter. As early as 1937, Lundell noted that in particularly accessible forest there were very few caobas and chicozapotes remaining, a result of years of exploitation. What results is a culled forest in which several of the most dominant and valuable species have been removed.

At Rio Bravo, Brokaw et al. (1990) distinguish between mesic (moist but adequately drained) and dry upland forests. The mesic forest usually occurs on level areas, but also some slopes; the dry forest occurs on hill tops and slopes. We encountered much the same distinction in our work, as did Lundell (1937) and other researchers. While this distinction is rough and includes many soil subdivisions, for our purposes the distinction is good one and closely corresponds to the two major soil types that occur in the well-drained uplands. Figure 2.4, an adaptation of a figure from Lundell (1937), illustrates the relationship between topography, soils, and vegetation.

An excellent description of the upland vegetation structure is provided in Brokaw et al (1990):

> In both [mesic and dry upland] forest types the canopy is usually uneven, consisting of tree crowns with gaps between them. Tallest trees in the mesic upland forest reach 30 m, while average canopy height is 15-20 m. Trees are generally shorter in the dry upland forest. Vertical structure is typically heterogeneous; layers of vegetation from top to bottom in the upland forest are not distinct. Most of the canopy trees are slender (less than 50 cm in diameter), but there are many of larger diameter. Exceptionally large trees (> 100 cm in diameter) are uncommon. Buttressing is well expressed in some species, absent or moderate in many. Within upland forest there is much variation place-to-place in canopy height and in tree size and density....From place-to-place in the upland forest the species composition of trees and the relative abundance of species vary greatly. The distribution of a given species is usually patchy.

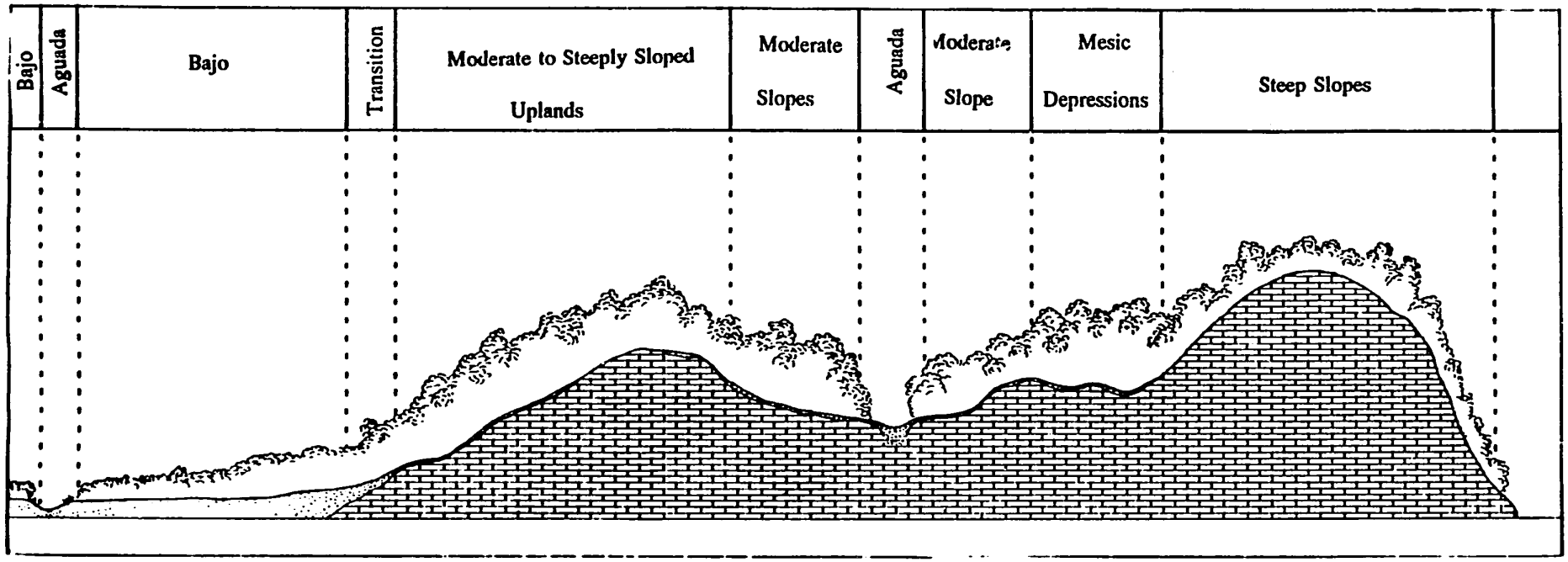

FIGURE 2.4

Relationship between topography, soils, and vegetation in the limestone uplands of northern Petén, an adaptation of a figure from Lundell (1937). In general, soil development is greater at the foot of a slope and in depressions. These areas are generally mesic, or relatively moist but well-drained. As such they support relatively luxuriant vegetation. The summits and steep slopes exhibit less soil development, are more xeric and thus support shorter, less luxuriant vegetation. Certain areas, usually at the bottom of a slope or in a valley, will fill up with sediment. Depending on the drainage these areas will sometimes hold water year round. Other areas are only seasonally flooded, and so support low but dense woody vegetation (bajos).

Brokaw and Mallory (1989) note that "this variation in composition and in structure is a natural phenomena in tropical forests. It results both from permanent contrasts in microenvironment, such as moisture differences between slopes and level ground, and from chance events of tree death and seedling establishment, such as occur after windthrow of a group of upper canopy trees." This natural variation is compounded by the legacy of ancient Maya occupation and modern selective logging.

At Rio Bravo, the prominent plant families among trees in the upland forest are Sapotaceae, Leguminosae, Moraceae, Apocynaceae, Meliaceae, and Palmae. There are at least 300 species which reach five meters or more in height. Common or conspicuous trees at Rio Bravo are shown in Table 2.1, along with indicator species in dry and mesic upland forest. Within the mesic upland forest, Ampelocera hottlei, corozo (Orbignya cohune), copal (Protium copal), botán (Sabal morrisiana), cojotón or huevos de caballo (Stemmadenia donnell-smithii), and cedrillo or chaltecoc (Trichilia pallida) are prominent. Within the dry upland forest, palo de jiote (Bursera simaruba), palo de gusano (Caesalpinia gaumeri), chicozapote, Laetilla thamnia, chechen negro (Metopium brownii), pimienta gorda, and amapola (Psuedobombax elliptican) are characteristic.

TABLE 2.1
Common or conspicuous tree species in upland forest at Rio Bravo, Belize

Scientific Name	Common Name
Acacia cookii	cockspur, bull's horn acacia
Acacia glomerosa	---------
Alseis yucatanensis	wild mammee
Aspidosperma cruenta	mylady
Brosimum alicastrum	ramon, breadnut
Bursera simaruba*	gumbo limbo
Caesalpinia gaumeri*	bastard logwood
Ampelocera hottlei**	female bullhoof
Calophyllum brasiliense	santa maria
Cryosophila argentea (palm)	give-and-take
Dypetes brownii**	male bullhoof
Guettarda combsii	glassy wood
Lonchocarpus castilloi	black cabbage bark
Manilkara zapota*	sapodilla, chicle
Matayba oppositifolia	boyjob
Metopium browneii*	black poisonwood
Orbignya cohune**	cohune
Pimenta dioica*	allspice
Piper psilorhachis	spanish elder
Pithecellobium arboreum	barba jolote, wild tamarind
Pouteria amygdalina	silly young
Pouteria durlandii	mammee cerera
Pouteria reticulata	zapotillo
Protium copal	copal
Pseudobombax ellipticum*	amapola
Sabal morrisiana**(palm)	botan
Pseudolmedia (spuria?)	cherry
Rinorea sp.	wild coffee
Simira salvadorensis	john crow redwood
Stemmadenia donnell-smithii	cojoton
Swietenia macrophylla	mahogany, caoba
Terminalia amazonia	nargusta
Trichilia pallida**	carbon del rio
Trichilia minutiflora	———
Vitex gaumeri	fiddlewood

* Characteristic of dry upland forest
** Characteristic of mesic upland forest

Source: Brokaw et al. 1990

Based on work by CATIE (1990b) and Gálvez et al. (1990), we can determine a number of common or conspicuous trees in the upland forest of the El Zotz. Table 2.2 contains these species. Common or conspicuous species include chechén blanco (Sebastiana sp.), zapotillo hoja fina (Pouteria durlandii), amapola, chicozapote, ramón, palo jiote, pimienta gorda, manchiche (Lonchocarpus castilloi), caoba, and quebracha (Pouteria sp.).

TABLE 2.2

Common or conspicuous trees in the Biotopo El Zotz

Common Name	Scientific Name	Family
Chichique	Aspidosperma megalocarpum	Apocynaceae
Ramón	Brosimum alicastrum	Moraceae
Palo jiote	Bursera simaruba	Bursuraceae
Santa Maria	Calophyllum brasiliense var Rekoi	Guttiferae
Tzol	Cupania prisca	Sopindaceae
Amate	Ficus lundellii	Moraceae
Sare	Lisiloma sp.	Leguminosae
Manchiche	Lonchocarpus castilloi	Leguminosae
Chicozapote	Manilkara zapota	Sapotaceae
Laurel	Ocotea lundellii	Laura ae
Pimienta Gorda	Pimenta dioica	Myrtaceae
Quebracha	(Pouteria sp.?)	Sapotaceae
Silión	Pouteria amydalina	Verbenacene
Zapotillo Hoja Fina	Pouteria (darlandii?)	Verbenacene
Amapola	Psuedobombax ellipticum	Bombacaceae
Manash (Manax)	Pseudolmedia (spuria?)	Moraceae
Chechen blanco	Sebastiania sp.	Euphorbiaceae
Jobo	Spondias purpurea	Anacardiaceae
Caoba	Swietenia macrophylla	Meliaceae
Yaxnic	Vitex gaumeri	Verbinaceae

Sources: CATIE (1990b) and Gálvez et al. (1990)

Clearly, Rio Bravo and El Zotz have different floras, but there is considerable overlap as indicated in the Tables 3.1. and 3.2. Nonetheless, considerably more floral work needs to be done throughout the northern Petén.

In terms of understory plants, lianas and epiphytes, Rio Bravo and El Zotz appear very similar. Lianas, including Desmoncus sp. (bayal), a climbing palm or rattan used to make baskets and furniture, are common in upland forests. Epiphytes are common but usually small, and include orchids, aroids, bromeliads, and cacti. Less common are the hemi-epiphytes (Clusia spp. and Ficus spp.), plants that germinate on a host tree and send roots to the ground. Psychotria spp., Piper spp., and Rinorea sp. (wild coffee) are common shrubs or small trees. Palms, including xate, escobo and botán, are fairly common in the understory and canopy (Brokaw et al. 1990; CATIE 1990b).

The plant diversity of the northern Petén does not approach that of true rainforests in the Amazon or Costa Rica, where hundreds of species of forest trees per hectare may be encountered. Although there is still considerable biodiversity, it is relatively limited and works in the favor of sustained production of tropical forest resources. Either as a botanical imprint of the Maya or as the result of other factors, one encounters a forest that is has densities of marketable species, including chicozapote, xate, and pimienta, and dozens of "secondary" timbers, thatching palms, construction materials, firewood, and medicinal plants. In many senses this is a "pre-managed" forest. As one exporter of non timber forest products noted: "Why should I make a plantation? The forests of the Maya Biosphere Reserve are already planted."

2.2 Human Environment

In this section we discuss current rates of forest conversion in the Petén, the "push" and "pull" factors that drive colonization, and the land-use and subsistence activities in the Reserve region. We also discuss the concept of sustainable development in the context of the northern Petén, and the design and objectives of the Reserve.

2.2.1 Conversion Rates

There is a great deal of guesswork involved in determining forest conversion rates. The rates range widely, from 200 to 1620 km^2/year (Galvez et al. 1990, CATIE 1990a, 1990b), and conversion itself is never clearly defined. One or two consecutive years of clearing are required for milpa, after which the land reverts to secondary growth (guamil), although some farmers plant fruit trees in fallowed plots. This is in contrast to defacto permanent conversion for cattle ranching or more intensive agriculture. Schwartz (1990) estimates that over 50% of forest cover is gone in a department originally 84% forested. Nonetheless, if we conservatively assume 200-400 km^2 per year of temporary and permanent conversion, the rate is still high and cause for concern.

2.2.2 The "push" and "pull" factors of colonization: roots of forest conversion

There are five major factors that drive human population pressure, and consequent forest conversion, in the northern Petén. Forest resources, land availability, and employment opportunity exert a pull on colonists. Yet, most of the circumstances that increase population pressures are push factors which drive a population from densely

inhabited, developed areas of southern Guatemala into sparsely populated forested regions of the northern Petén.

The first and most critical push factor is skewed land distribution, particularly in southern Guatemala. This, coupled with insecure land tenure, and severe political violence in the early 1980s provide strong impetus for migration. In 1978, 80% of the farmland in Guatemala was controlled by 2.1% of the population (World Bank 1978, cited in EPOCA 1986).

A second push factor, one inseparable from land tenure, is the change in the nature of agricultural activities, especially since the second world war. "In addition to concentration of land holdings, there has been considerable mechanization and modernization of agriculture, leading to a decline in the demand for agricultural labor and, often, a breakdown of the traditional social relationships such as tenancy and sharecropping" (Schmink 1987). In sum, capital- and technology-intensive, export-oriented agroindustry has exacerbated already troubled land tenancy and reduced rural labor opportunities. Many rural people are forced to seek land and wage labor elsewhere. The result is rural-rural migration.

A third major push factor is population growth, which intensifies the impacts of skewed land tenure and labor reducing agricultural technologies. Migrants to Petén come from other parts of Guatemala as well as from other countries, especially El Salvador. If we assume exponential growth, and a population of 15,880 in 1964 and 182,327 in 1985, we obtain a 7.0% growth rate. At this rate, population doubles every 10 years. This yields a current population of about 261,000, close to current estimates. Current population growth rate in the country as a whole is 2.9% (CATIE 1990a, based on national census data).

A fourth push factor is extensive cattle ranching, which occupies large areas of the department. How much of the Petén is devoted to cattle ranches, both large and small, is not known but we observe that much of the flat land near roads in the southern and central Petén is devoted to cattle ranching. Cattle ranching has expanded recently to the north, east and west of Lake Petén Itzá, beyond the traditional boundaries of the savanna region in the central Petén. In Petén a cattle ranch can be very profitable if well managed, though this usually means a ranch of about five caballerías (1 caballería = 45 ha) (Schwartz, pers comm. 1988). Because cattle ranches have low stocking and labor rates, they are another factor pushing settlers into forested regions. In addition to economic factors, the social prestige of owning and raising cattle contributes to the popularity of ranching (CATIE 1990a).

All the push factors discussed above are reinforced by the perceived availability of land, resources, and employment opportunity, thereby pulling people to the region and promoting forest colonization. Schmink (1987) notes that small holders who fall victim to the social changes discussed above become "shifted cultivators". Without urban job skills they have little other choice but to move into an unpopulated region and begin clearing forest for food production. In turn, these shifted cultivators are attracted to principal roads, roads opened by wood and petroleum extraction, and principal rivers, particularly the Pasión and the Usumacinta (CATIE 1990b).

In Petén, the real availability of land is actually quite limited. An optimistic assumption by Schwartz (1989, unpublished data) indicates that no more than 88,965 to 173,976 people could be accommodated in the area south of the Reserve, if all land was

suitable for cropping--though much of this land is clearly not suitable. In addition, of those people who do have land, a large number (>20,000) have not completed the titling process, have not initiated the process, or simply squat on the land. "In short, no matter which way one turns the figures, it appears that under current cropping regimes, land is becoming scarce in Petén and that many farm families will have to seek seasonal off-farm employment, as thousands of them in fact do, although this has to do with terms of trade for farmers as well as with scarcity of good farm land, feeder roads, and so on" (Schwartz, unpublished data, 1989). This need for off-farm employment is one key reason why NTFPs are so important to rural people.

2.2.3 Subsistence activities: forest harvesting

There are thousands of full and part-time workers in the non timber forest products industry in the northern Petén. These workers originate from both inside and outside the current borders of the Reserve. In addition to harvesting the major products of xate, chicle, and pimienta gorda, several other minor products are collected, notably mimbre (*Philodendron* sp.) and bayal (*Desmoncus* sp.), vines used in basket and furniture making, ramón for forage for mules and horses, the fruits of chicozapote (*Manilkara zapota*) and numerous other forest trees, medicinal plants, wildlife as meat or for live sale as pets (parrots, macaws, other juvenile animals), palms for thatching, and several tree species for beams and posts in house construction (see Gálvez et al. 1990 and CATIE 1990b for species lists).

Most extraction takes place via bush camps located throughout the Reserve. These

camps are rustic and maintained from year to year. They are located near both permanent and ephemeral aguadas, bajos, and lagunas. Some camps can only be used during the rainy season due to a lack of permanent water. Camps are reached by secondary and tertiary roads and mule trails. While in the forest, mules are fed the nutritious leaves, bark and fruit of the ramón tree. Some camps can be reached year-round by vehicle, others only in the dry season, still others only on foot. They are abundant: one informant named over 100 camps within a 20 km radius of his home in Uaxactún.

Sanitation is poor. Water is naturally high in organic acids and suspended sediments and is often visibly contaminated with human and animal waste. Very few people collect rainwater. Medical care and supplies are costly anywhere in Petén, and in chicle camps essentially unavailable.

Forest product collectors or harvesters, nearly 100% men, sell the forest products to contractors either in camps or in towns or along roads. Contractors are usually based in Santa Elena or San Benito, though occasionally in some smaller towns such as El Caoba. The contractors either sell to larger contractors based in Santa Elena or San Benito, who move the product to Porto Santo Tomás (a Caribbean sea port) or Guatemala City, or they transport the product themselves directly to a point of export. Relatively little processing is done, except for sorting and packing xate leaves, drying and bagging allspice, and coagulating and forming blocks of chicle.

For these thousands of people, mostly rural though occasionally urban, who participate in the collection of NTFPs, this activity is part of a diversified income generating and subsistence strategy that balances cash production with food production. The seasonal

relationships of both market demand and biological production between xate, chicle, pimienta gorda, and milpa are remarkably well-coordinated.

2.2.4 Subsistence activities: milpa agriculture

Because so many people are from outside the region they can be expected to have agricultural and subsistence strategies different from longer term residents. These different strategies, once implemented by this group of newcomers with their particular "goals, preferences, available resources, and constraints" (Schmink 1987), produces a fairly consistent pattern of land-use and settlement practices, one common throughout northern Petén. The practice of milpa agriculture, characterized by small holdings, is the predominant land-use pattern.

Browder (1989) outlines several features of smallholder agriculture, many of which seem very relevant in the Petén, especially regarding newcomers:

- Farming systems tend to low-input systems, characterized by low capital/output ratios and low-to-moderate utilization of labor and industrial inputs.

- Production tends to be commercially oriented, especially to national markets. Production tends to be limited to a small number of commercial food crops, and very few forest products are harvested for sale or consumption. This situation is somewhat different in Petén, where market access is poor and where more forest products are available, but the point remains that many newcomers have this orientation.

- Colonist farmers often rely on ecologically inappropriate agronomic knowledge obtained from farming experiences in different ecological zones.

- Risk aversion, rather than profit maximization, is typically the paramount concern of most smallholders and presents an obvious constraint to the successful diffusion of new agroforestry or ecologically better suited techniques. In Petén the first goal of colonists is to secure a supply of food (milpa), after which they diversify income producing strategies (NTFP, etc.).

- Unclear land tenure generally discourages small holder investment in long-term perennial tree-cropping systems.

In turn, these land use characteristics are strongly shaped by constraints. In addition to inappropriate agronomic background, these constraints include lack of adequate credit, extension, and infrastructure (roads, communication), as well as uncertain land tenure, byzantine titling procedures, and poorly developed markets.

Several distinct ecological characteristics of milpa agriculture also constrain production, hence potential social welfare, in the Petén. The short-term contribution of forest cutting and burning to soil fertility and agricultural productivity has been extensively described elsewhere (Nye 1960). Milpa agriculture is more precisely described as "land rotation cultivation" (Carter 1969). A milpa farmer cultivates only a fraction of his holding at any one time, rotating areas under fallow and cultivation to maximize productivity over time. Crops are harvested twice a year, once during the rainy season and once during the dry season. The rainy season crop (segunda) is generally larger. Some agriculturalists may make three milpas per year but this practice has declined in recent years for many reasons, primarily the availability of off-farm employment in extractive industries (Schwartz 1988, pers. comm.).

Urrutia (1967) investigated the effect of corn production on soil fertility in Uaxactún, north of Tikal. His data substantiate the widely accepted fact that low-input, continuous cropping results in significant loss of productivity after only a few seasons. The nutrient base held in forest biomass and released to the soil through cutting and burning are rapidly lost through runoff, soil erosion, and volatilization. Invasive weeds compete for growing

space and remaining nutrients, and crops in monocultures are highly vulnerable to pest attack. In addition, the percent organic matter (OM) in the calcareous, clay-rich soils of the Petén is relatively high (>7%). OM provides important control over critical soil characteristics, particularly soil structure and capacity to hold nutrients for root uptake and plant growth. However, OM rapidly decomposes as forests are cleared and soil temperatures increase after exposure to direct sunlight. The loss of soil OM is reported by several authors (Urrutia 1967, Carter 1969, Cowgill 1962). In sum, these factors result in productivity declines. By the third year a milpa plot is no longer productive enough to be extensively worked. Urrutia (1967) documents a decline in corn production of 67% within three years in a milpa cleared from 10 year-old fallow.

To maintain agricultural productivity on a given area of land, one to three years of cropping is followed by a fallow period that allows for soil regeneration under forest regrowth. It follows that an increase in either the intensity (e.g. close plant spacing) or number of years of cropping taxes soil fertility and requires a longer fallow period for the soil to 'rest.' It also follows that a shortened fallow period, without adequate agricultural technologies such as fertilizers, pesticides, and herbicides, also intensifies productivity losses. Shortened fallow periods often result from increased human population densities and pressure for increased productivity per hectare. In addition, truckers from the highlands primarily buy maize, beans and (some) rice, thus pressuring farmers to reduce intercropping, with all this implies for soil maintenance and pest infestations!

a agriculture is an effective means of producing crops as long as population is relatively low and there is sufficient land to allow the rotations necessary for the land to

regain fertility. With increased population pressure, however rotations shorten or stop completely, leaving little forest remaining in more densely populated areas. Milpa agriculture, as practiced in the Petén, will not form a good base for agricultural development if the population continues to grow as expected. Therefore, intensified agricultural and agroforestry practices, higher inputs, better markets and better access to those markets, secure land tenure, and credit will be needed if increased population and forest are to exist side by side.

2.3 Conservation, Sustainable Development and the Maya Biosphere Reserve

It is clear that continued immigration and population growth pose a substantial threat to the biodiversity and productivity of the vast forests and wetlands of the northern Petén. Nonetheless, there are growing numbers of people in the Petén, and they will not simply disappear. Furthermore, despite the importance of forests in meeting human needs, forest management in the northern Petén for sustained production has been ignored. These forests have traditionally been open-access resources that are poorly understood, undervalued, or overlooked. Therefore, to ensure the long-term conservation of the region's natural areas, we must embark on a path of improved natural resource management and sustainable resource development.

How then can the needs and expectations of the region's inhabitants be sustained, in part through the extraction of common property forest resources, while simultaneously promoting the preservation of biodiversity and archaeological and other cultural resources?

Answering this question is the responsibility of those charged with managing the

Reserve. We offer here five important considerations. Our comments are notes of caution for resource managers to consider as they intervene in the lives of the region's inhabitants, be it for the goal of preservation or increasing social welfare, or both. We emphasize forests here, but our comments are equally applicable to other land uses, particularly agriculture and agroforestry.

First, we define sustainable development as "a pattern of social and structural economic transformations (i.e. "development") which optimize the economic and other societal benefits available in the present without jeopardizing the likely potential for similar benefits in the future" (Goodland and Ledec 1987). We expand this definition by adding that no species must go extinct.

Second, though the goals of sustained production are different from land-use to land-use, regional sustainable development objectives must consider the interdependence of these different land-uses. In Petén, land-use ranges from outright preservation of biodiversity and cultural resources, to extensive agriculture and cattle production. The protection of biodiversity in protected areas will depend on successful long-term productivity in the Multiple Use Area and Buffer Zone. This seems even more the case when we assume that Petén's economic base will depend on the soil and forest resources in use today for the foreseeable future.

Third, sustainable development has both technical and social aspects, and the two must be given equal standing. Technical requirements must consider such things as nutrient balance, renewable soil fertility, energy resources, and pest control (Fearnside 1986, cited in Schmink 1987). Just as important, however, are social characteristics: profitability over

time, capital formation, and equity for the people of the region.

Fourth, forests must not be seen as slow-growing variations of agronomic systems--the vision of historical forest management strategies. Development schemes have often ignored diverse forests as suitable platforms for economic development, except perhaps in terms of land waiting to be converted into other uses, such as single-species plantation forestry or cattle pasture. We must embrace natural forest management, with its assumptions of far higher species diversity and diversified outputs, if sustainable development and conservation of forested areas in the tropics is to succeed.

Fifth, "foresters are urged not to focus their attention only on particular trees or ecosystems, but rather to make the welfare of people and their communities the actual goal in forest management" (Mergen 1980, cited in Schmink). Local people constitute a new clientele for the services of the specialist and have considerable knowledge to offer. Moreover, foresters--and agricultural specialists--must learn from the region's inhabitants. The wide diversity of forest products and the economically diverse income strategies practices by risk-adverse households are the antithesis of the homogeneous and highly capitalized market production systems emphasized in the past. Successful technical assistance that bears sustained results requires close consultation with the region's inhabitants through participatory research, training, and economic production--often a departure from the technical training and cultural aptitudes of would-be natural resource managers.

A final point is critical: sustainable development will not occur without the full involvement of people at the community level in projects directed at both protecting biodiversity and promoting economic welfare.

2.4.5 The Maya Biosphere Reserve: Design and Objectives

A biosphere reserve is a natural solution to the varied economic production and preservation challenges of the northern Petén. A biosphere reserve is traditionally defined as a large area of legally protected land, established to guarantee both the preservation of ecosystems and cultural resources as well as the continuation of traditional human activities that are based on the sustainable use of natural resources (CONAP 1990).

The Reserve encompasses a number of protected areas, administered by different institutions with different management objectives. According to Guatemalan Congressional Decree 5-90, the Executive Secretary of CONAP has primary responsibility for the administration of the Reserve, supervising and coordinating other entities that administer areas within the Reserve. These entities include the Institute of Anthropology and History (IDAEH), the Center for Conservation Studies (CECON), and the Military. To aid the Executive Secretary, a coordinating committee of the Reserve was created, composed of delegates from CONAP, IDAEH, CECON, the Santa Elena Air Base and the Santa Elena Military Base No. 23.

TABLE 2.3

Zoning of the Maya Biosphere Reserve
(Refer to figure 2.1 for location of zones)

Zone Type	Zone	Size (Ha)	Responsible Institution
Core Zones			
	Tikal National Park	57,300	IDAEH
	Mirador-Río Azul National Park (Dos Lagunas Biotopo included)	147,000	CONAP, CECON (Biotopo)
	Sierra Lacandón National Park	195,000	CONAP
	Laguna del Tigre National Park (Laguna del Tigre/ Río Escondido Biotopo included)	350,800	CONAP, CECON (Biotopo)
	Biotopo San Miguel/ La Palotada	43,500	CECON
Multiple Use Zone		800,000	CONAP
Buffer Zone		N/A	CONAP
	Note: this is a 15 km wide strip to the south and east of the Reserve. Includes the BioItzá Biosphere Reserve.	25,000	Itzá-Maya speakers from San José, Petén
Total area of the Maya Biosphere Reserve, not including the Buffer Zone:		1,593,600	

Protected areas included in the Reserve, and their respective size and managing institution, are shown in Table 2.3 (see also Figure 2.1). The Multiple Use Area is designated for extraction of forest products, as a buffer zone for the nuclear areas, and as a zone of archaeological importance. The land uses within this area will ultimately be determined by the master plan for the Reserve, which, at this writing, is in the process of being drafted. Actual management of forest resources is the emphasis of an ongoing Conservation International project. In general, the CECON-administered Biotopos will be afforded complete protection, equal to that of the national parks. The core zones are designed to protect and conserve biodiversity and archaeological sites, and to allow scientific investigations, conservation education, and ecological and cultural tourism. The hunting of wildlife and the extraction of plants are expressly prohibited.

The Buffer Zone will be the site of activities intended to prevent further degradation of the Reserve (CONAP 1990). Such activities must focus on the intensification of agricultural production, promotion of perennial cropping and agroforestry techniques, and to the development of a diversity of small-scale commercial activities based on forest resources and tourism.

This report concentrates on the production of NTFPs from the Multiple Use Area. This area is historically and currently the most important region of the Reserve for the production of these resources.

CHAPTER 3: SOCIO-ECONOMIC PROFILE OF THE FOREST HARVESTER

"If you are not poor and rural, you are an outsider."

--Anonymous

Because of the Reserve's great size, and the nature of forest use by local people, any strategy for managing the MBR must include strong participation of the people who live in and around the Reserve. To do otherwise guarantees a future of cornfields and cattle ranches where productive and diverse forest once stood. Obviously, institutions, specifically CONAP, have to establish regulations for natural forest management. Forest conservation and the prevention of continued deterioration of natural and cultural resources will be impossible without an institutional framework. Nonetheless our point is this: failure to include local people in planning and implementation, or threats to their perceived livelihood by restricting forest use without careful consultations--or by excluding their great expertise in forest resource issues--will ultimately undermine any plan for sustained forest production with equitably distributed benefits.

The following discussion presents a socio-economic profile of forest resource harvesters. The profile is based on interviews and first-hand observations.

3.1 Objectives and Methods

Interviews were conducted to determine the economic importance of forest resources for local people and to provide a basis for conservation planning that successfully includes local communities in management of the Reserve.

We interviewed 93 individuals in resource collection camps and in the communities of Uaxactún, Carmelita, and El Cruce de los Pescaditos (See Figure 2.1). Of these, 85 are used; eight interviews are excluded because of missing data. We concentrated on and selected for men who spend some, if not all, their working time in the forest. As such, we are not presenting here an overall profile of the average Petén resident but rather a focused look at forest harvesters. The interview schedule is reproduced in Figures 3.1A and 3.1B.

The interview schedule was designed to answer the following questions:

1) Who are the resource collectors and where do they come from?
2) What role do the NTFPs play in individual income strategies?
3) How do harvesters perceive the sustainability of current harvesting levels and techniques?
4) What problems do harvesters believe they encounter in the extractive industries and what solutions do they suggest?

We compare some of our data to information presented by Galvez et al. (1990), CATIE (1990a) and Schwartz (pers. comm. 1988).

Date:_____; Location:_____; Interviewer:_____
Attitude: (notes concerning the perceived state of mind of the interviewee)

---

1. Are you from the Petén or do you live elsewhere?
2. In what part of the Petén do you live?
3. How many years have you been living in the Petén? _____
4. How old are you? _____

5. Do you have family here in the Petén?
   Wife? Children? Parents? Brother/Sisters?

   So, there are X number of persons who depend on your work?

6. What products do you take from the forest?

7. Experience? Xate:_____ Pimienta:_____ Chicle:_____

8. In what months do you work in each activity? Days/month?
   Xate:_____ _____
   Pimienta:_____ _____
   Chicle:_____ _____

9. What activities outside the forest are the most important for you?

   Milpa?
   How many manzanas? _____
   Quantity destined for self consumption?_____
   Quantity destined for sale?_____

10. In what months do you work on your activities outside the forest?

    How many days per month?_____

11. Of all of your activities, which are the best sources of income for you?

12. When you are working in the forest, do you work only in this region, or in other areas? Where?

FIGURE 3.1A
NTFP harvester interview used in this study. Page one.

13. How much are you paid per quantity (e.g. handful of leaves, pound of chicle, etc.)?_____

14. Is this a good price? Why?

15. How much do you spend for food per day/week in the camp?_____

16. In this region, around this camp, in the X region, how many (handfuls of leaves, pounds of chicle, etc.) do you take out in one day?_____

Week?_____

Season?_____

Average?_____

17. Do you believe that this place is one of the better camps?

Why?

18. How frequently can one gather the same plant?

Xate:_____ Pimienta:_____ Chicle:_____

19. In the camps, do you work in the same areas?

20. How frequently can you return to the same area?

21. Are there always people working in this camp?

22. In this region do you continue to take out the same amount of X that you took out before? Why?

23. What risks and dangers exist in these activities?

Have you had malaria? Chiclero's ulcer (Leishmaniasis)? Accidents?

Besides these, what other problems are there?

24. What do you think can be done to minimize these problems?

Notes:_____

FIGURE 3.1B
NTFP harvester interview used in this study. Page two.

We divided interview respondents into two groups. One group is composed of those who live in one of the several communities other than San Miguel and Ixhuacut but within the boundaries of the Reserve. We refer to this group as "Reserve residents". A second group includes those who come to the Reserve to work but maintain homes outside Reserve limits. We refer to this group as "Non residents". The interviews emphasized the following characteristics of the harvesters:

- age;
- number of economic dependents;
- place of origin and current habitation;
- a description of income strategies;
- perceptions of forest resources;
- and harvesters' views on both the problems encountered working and living in the forest and potential solutions to these problems. In retrospect, because of the way the interview was worded, we do not believe that the answers provided in response to these questions concerning problems were accurate or revealing. Therefore, we will not present results or analysis of the responses to these questions.

In addition, we present data on the net benefits harvesters receive from working in each of the three extractive industries.

3.2 Results

Table 3.1 lists the place of origin of the interviewed inhabitants of San Miguel and Ixhuacut. Note that the populations of these communities are dominated by colonists rather than native Peteneros.

TABLE 3.1

Origin of residents of the communities of Ixhuacut and San Miguel/La Palotada in 1986 and 1989 and the two populations interviewed in this study. The two populations are residents of the Reserve (Reserve residents) and those who live outside the Reserve but work in it (Non residents). The "Other" category probably includes departments listed but because interviews were different, or origin was not indicated, many data points are blank.

	COMMUNITY OR HARVESTER GROUP				
	San Miguel		Ixhuacut	Reserve Residents	Non Residents
Year of Study	1986*	1989**	1986*	1990***	1990***
Sample Size	83	n.d.	43	55	30
ORIGIN					
Inside Reserve	n.d.	n.d.	n.d.	17.8%	0.0%
Petén	16.9%	16.1%	2.3%	28.6%	28.6%
SOUTHERN GUATEMALA					
Santa Rosa	---	---	16.3%	---	---
Alta Vera., Izabal	44.5%	27.8%	---	19.6%	14.3%
El Progresso	---	---	18.6%	7.1%	---
Esquintla	---	---	20.9%	---	---
Zacapa	---	12.9%	---	---	---
Jutiapa	---	---	---	---	10.7%
Other	38.6%	43.1%	41.9%	26.8%	46.3%
Subtotal	83.1%	83.8%	97.7%	53.5%	71.3%
Total	100.0%	99.9%	100.0%	99.9%	99.9%

n.d. -- No data.

Sources: * Schwartz 1988
** Galvez et al. 1990
*** Field Data 1990

San Miguel, also known as or to include Chunya, San Miguel La Palotada and El Cruce Dos Aguadas, is located in the Reserve on the improved road north of Lake Petén Itzá. Ixhuacut is a community south of the Reserve on the same road, approximately 5 kilometers north of Lake Petén Itzá. This community is comprised of significantly fewer Peteneros than San Miguel.

Table 3.2 presents mean residence time in Petén. That for "Reserve residents" is greater than that for "Non residents". For the population interviewed, the age of forest harvesters is greatest for "Reserve residents."

TABLE 3.2

Comparisons between Reserve residents and non resident Reserve workers for years in Petén, age, and number of economic dependents.

		Reserve Residents	Non Residents
Sample Size		55	30
YEARS IN PETEN	<10	9.3%	16.7%
	11-20	33.3%	50.0%
	21-30	38.9%	23.3%
	>30	18.5%	10.0%
	Total	100.0%	100.0%
AGE	<20	14.8%	13.3%
	20-30	22.2%	36.6%
	30-40	18.5%	20.0%
	40-50	22.2%	13.3%
	>50	22.2%	16.7%
	Total	99.9%	99.9%
NUMBER OF DEPEND.	0	28.6%	36.7%
	1-3	33.9%	43.3%
	4-6	21.4%	16.7%
	>6	16.1%	3.3%
	Total	100.0%	100.0%

It is difficult to draw distinctions between the number of economic dependents of the two populations. We indicate only that a significant percentage of the forest harvesters support more than one individual (usually spouse and children). The data also indicate that many of the resource harvesters originating from outside the Reserve are younger and have fewer dependents, or are single males.

Table 3.3 presents economic strategies pursued by residents of San Miguel as measured

by Schwartz (CATIE 1990a) and by "Reserve residents" and "Non residents" as identified in our surveys. Respondents are placed in one of four categories, each describing an economic strategy: 1) agriculture only; 2) forest extraction only; 3) mixed agriculture and extraction; and 4) mixed extraction and other income activities. A large percentage of the interviewed population of San Miguel is dedicated only to agriculture. Conversely, not one of the people whom we interviewed was dedicated solely to agriculture.

For all populations interviewed, the most important household income strategy is one of diversity: extraction of NTFPs for cash income and milpa for food security. For the people who live in the Reserve (San Miguel and "Reserve residents"), over one-half practice economic diversification. The importance of diverse economic strategies to both "Reserve residents" and "non residents" is magnified in Table 3.4. For those individuals dependent upon a mixture of milpa, NTFP extraction, and other activities, we present their perceptions as to which activity is the most important source of cash income.

TABLE 3.3

Economic strategies as practiced by the residents of San Miguel (CATIE 1990), Reserve residents and non resident harvesters.

	COMMUNITY OR HARVESTER GROUP		
	San Miguel*	Reserve Residents**	Non Residents**
Sample Size	---	55	30
ECONOMIC ACTIVITY			
Agriculture Only	38.4%	0.0%	0.0%
Forest Extraction Only	3.5%	22.6%	46.7%
Mixed Ag and Extraction	51.4%	67.9%	43.3%
Mixed Extraction and Other	7.1%	9.4%	10.0%
Total	100.0%	99.9%	100.0%

Sources: * CATIE 1990a
** Field Data 1990

TABLE 3.4

Relative economic importance of forest resources, milpa agriculture, and other wage activities to individuals that practice a mixed economic strategy, by percentage of respondents, for "Reserve residents" and "non residents".

Activity Identified as Most Important	HARVESTER GROUP Reserve Residents	Non Residents
NTFPs	67.4%	55.6%
Milpa	20.9%	44.4%
Other	11.6%	0.0%
Total	99.9%	100.0%
Unsolicited Response "All is important"	11.0%	20.0%

For all interview respondents, NTFPs are the most important source of cash income. The importance of milpa for "non residents" is relatively greater than for "Reserve residents". Several of those interviewed gave greater weight to one or another activity, but emphasized that, in reality, all activities were important. "Other" refers to work for Project Tikal in Uaxactún, restoring Maya ruins.

For the two groups, "Reserve residents" and "non residents", Figure 3.2 presents which of the three NTFPs is "most important." Note that xate is far more important to people who live outside of the Reserve than those who live within the Reserve, and that, for those interviewed, no one from beyond Reserve limits harvests pimienta--a finding that is unlikely to be generally true throughout the Petén.

Figure 3.3 presents responses to questions about which activities the interview population pursues and in which months. It can be interpreted to reveal the relative importance of each activity. Thus, according to the relative magnitude of the bars, xate extraction is the most important source of employment for forest harvesters, especially for those untrained in the methods of chicle extraction, the most lucrative activity. However, the data may be exaggerated as many respondents identified months when it is possible to participate in a given activity, not necessarily the months in which they actually pursue a particular activity. For example, while a person might harvest chicle in November, he also responded that xate harvesting happens every month of the year. We count both cases. There is also overlap in the situation where a given respondent might actually harvest pimienta and xate in the same month, as well as work milpa.

Many respondents were more precise. They identified mid-July to mid-September as the time when they harvested pimienta and September through January for chicle, thus leaving the dry season of February through June for harvesting xate and working in their milpa. This is in fact a very common strategy.

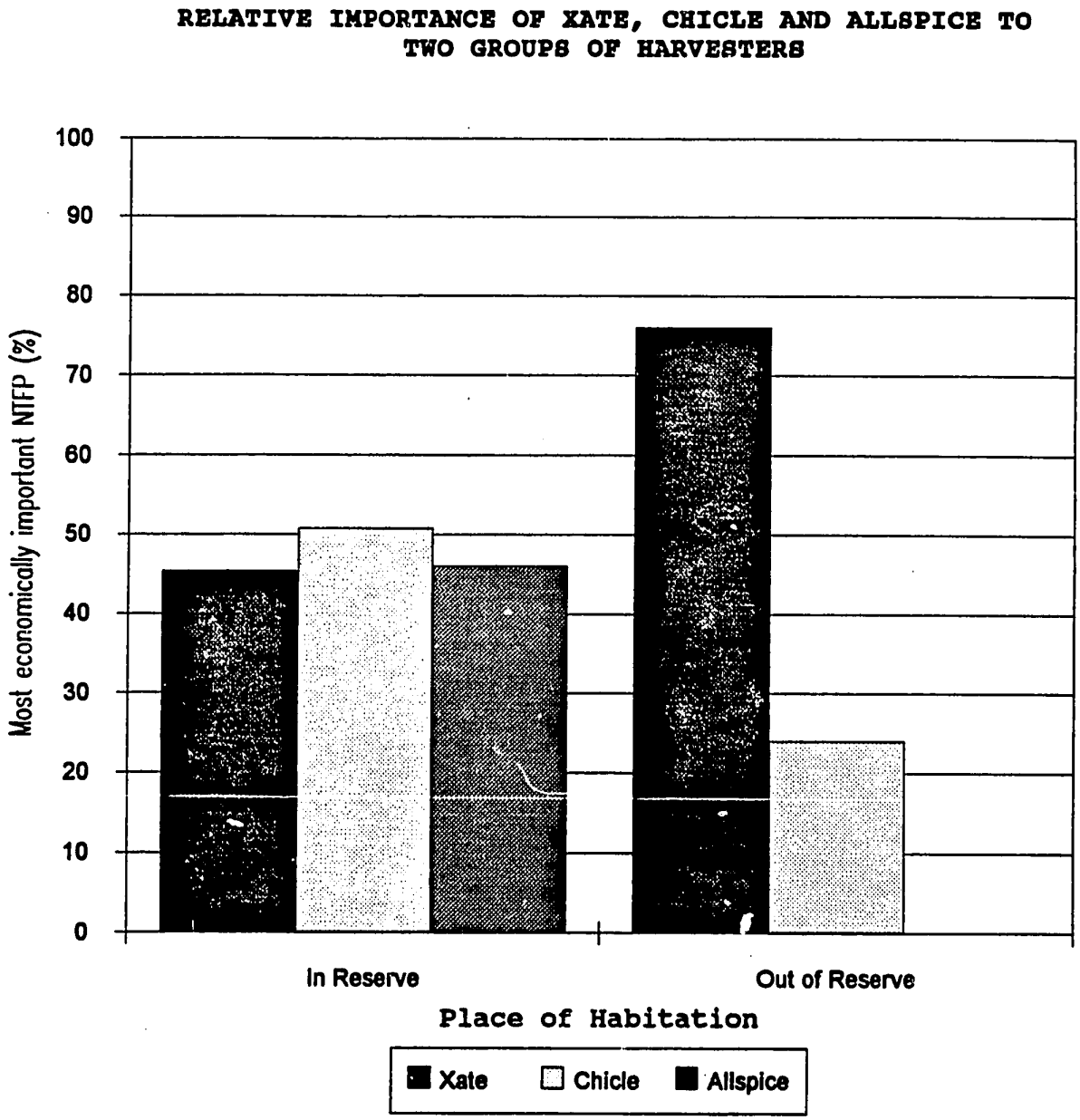

FIGURE 3.2

Relative importance of xate, chicle, and allspice to two groups of resource harvesters.

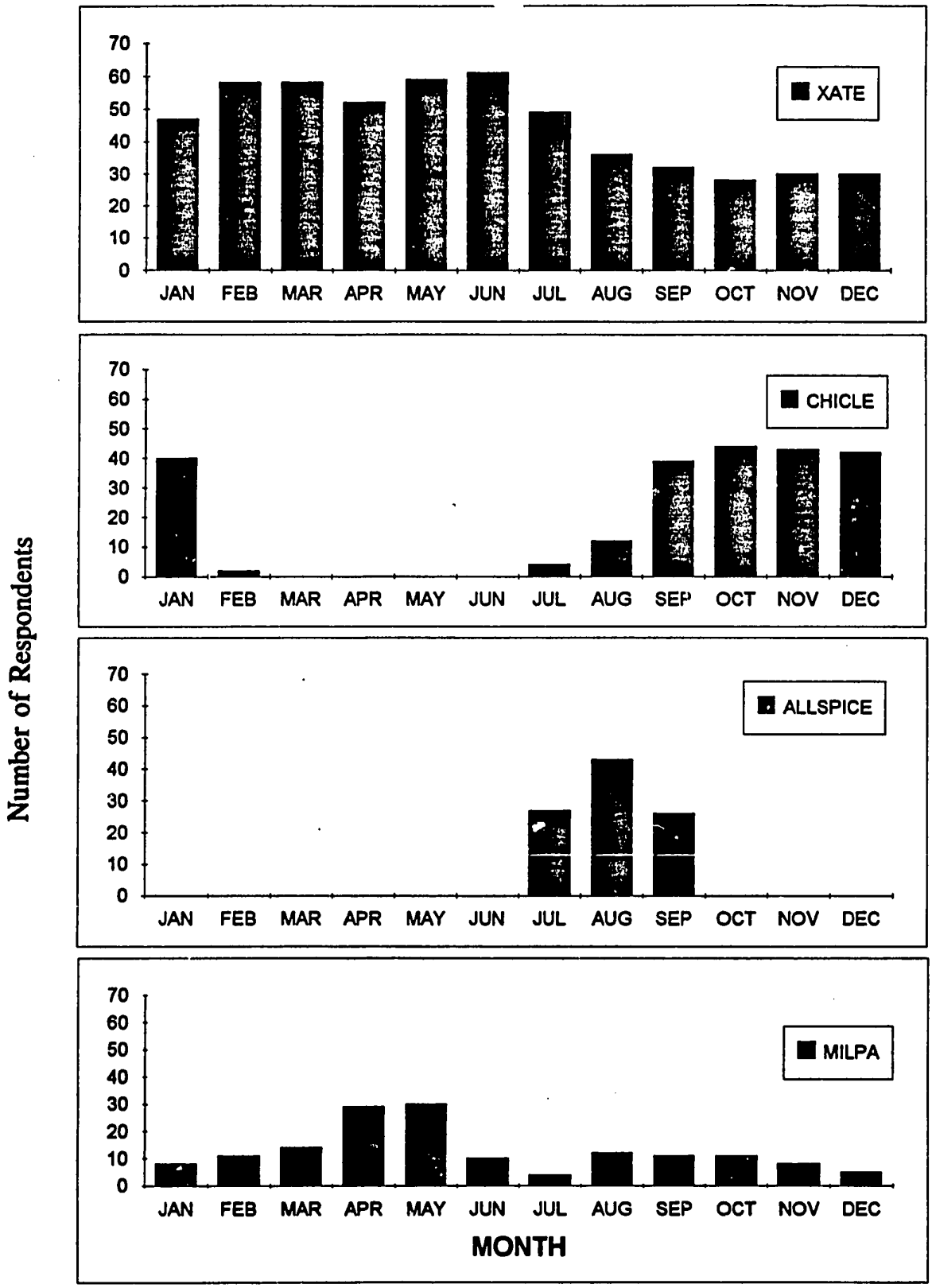

FIGURE 3.3
Timeline illustrating the complementariy of milpa and NTFP production in space and time. The left axis indicates how many forest workers, of 90 interviewed,worked in a particular activity in a given month.

3.3 Discussion

3.3.1 Bias and Limitations

There are certain limitations and biases to our profile. First, we interviewed fewer than 100 people. This may be as much as 5% of the most active group of forest harvesters, statistically a generous but non-random sample. Nonetheless, there are thousands of other people who depend directly on forest resources and tens of thousands who benefit indirectly; we do not pretend to characterize all social aspects of the extractive industries. Thus, our sample has obvious limitations. For example, we cannot establish with great precision what percentage of the forest harvesters come from beyond Reserve boundaries, or exactly how many forest harvesters there are. In addition, all of our interviews were with men--virtually all forest harvesters are male. Any decisions based on this discussion must recognize that the important role of women in household income strategies has been excluded. We maintain, however, given the similar responses in the interviews, we can represent relatively accurately the role NTFPs play in the lives of forest harvesters.

3.3.2 Relative importance of NTFP harvesting and milpa

Table 3.1 underscores the social diversity of forest harvesters. The origin of both Reserve inhabitants and those who live beyond Reserve boundaries, reflective of the large-scale immigration of the past two decades, means individual communities are "religiously, regionally, ethnically, politically and occupationally diverse" (Schwartz, pers. comm. 1988).

Such diversity results in distinct social groups and communities living in and around the Reserve that, in turn, lead to distinct income strategies and thus different uses of forest resources. Identifying the key characteristics of these diverse groups helps us to understand what motivates people to harvest NTFPs, or to concentrate on milpa, or to practice both.

Figure 3.7 orders the communities and groups discussed in this report, i.e., Ixhuacut, San Miguel, "Reserve residents" and "Non residents", according to the economic importance of milpa and NTFPs. Listed beneath are characteristics that can be attributed to each social group, in effect, a summary of the discussion to follow.

Community or Harvester Group	
Ixhuacut San Miguel (Primarily Agriculturalists)	Non Residents Reserve Residents (Primarily Forest Product Harvesters)
Characteristic	Characteristic
More colonists in population	Fewer colonists in population (more Peteneros)
Short residence time	Long residence time
Better access to ag. markets Better road quality	Better access to forest resources Less dependable road transportation
Xate most commonly harvested NTFP Chicle and pimienta less important	Xate most common NTFP but chicle and allspice also important
Mixed income strategy: xate and milpa	Mixed income strategy: all NTFPs and milpa
Milpa more important than NTFPs	NTFPs more important than Milpa

TABLE 3.6
Principal characteristics of various social groups that are important in determining the relative importance of milpa and NTFP harvesting in income strategies. In San Miguel and Ixhuacut, communities dominated by agriculturalists, milpa is more important than NTFPs. On the right, among forest harvester groups, NTFPs clearly play a more important role.

The percentage of colonists in the population is, or appears to be, the first characteristic that influences which activity, milpa or forest harvesting, is most important. Table 3.3 clearly shows that San Miguel households are more dedicated to crop production relative to "Reserve residents" and "Non residents". Similarly, 55% of Ixhuacut heads of households are dedicated, as a primary occupation, to agriculture (Schwartz, pers. comm.1988). Both of these communities can be characterized as being dominated by colonists (refer to Table 3.1).

That colonist communities are relatively more dedicated to milpa is not surprising. As one NTFP contractor noted: "The colonists do what they know how to do. They cut down the chicozapote, they cut down the pimienta, they burn them and they make milpa." The key concept is this: colonists from ecologically distinct southern Guatemala are unfamiliar with forest resources and with the benefits of harvesting them. Being risk averse, they pursue known activities--most importantly milpa--that are perceived to be secure. That is, colonists want to secure a reliable food supply, before diversifying their income strategies.

Second, the mean residence time in the Petén is important. It is true that many colonists, i.e. new residents, dedicate themselves to full-time forest harvesting, particularly xate. But, in general, colonists concentrate on milpa. For example, the mean residence time in 1985 for the inhabitants of Ixhuacut was 8.2 years and that for San Miguel was 6.5 years (Schwartz, pers. comm. 1988). The mean residence time for the individuals in the "Reserve residents" group is 24 years and that for "non residents" is 19 years, and both groups more dedicated to NTFP harvesting. Schwartz (1988 pers. comm.) notes: "Native Petén milperos are quicker to use multiple adaptive strategies than migrant milperos, who are often exclusively committed to farming. It takes at least several years for some migrants to conclude that multiple strategies are best, that is, several years before they begin to imitate the native peteneros."

Location is a third important characteristic that distinguishes income strategies between different social groups. Where road access is good within the Reserve, as is the case with San Miguel, near the southern border of the Reserve, the population is more dedicated to agriculture--there exist markets for agricultural products. By contrast, we interviewed 45 individuals from Reserve communities with less dependable road access. Not a single individual reported that they were solely dedicated to agriculture (though we know such individuals exist). As a resident of El Cruce de los Pescaditos commented, "I would like to grow tomatoes. I could stay close to my family and

avoid the hazards of the forest. But there is no way to get them to market."

Similarly, milpa is more important than forest harvesting for "non residents" than for Reserve residents" (Table 3.4). Those who live south of the Reserve, have better access to agricultural markets; milpa is more profitable.

Conversely, where proximity to forests resources is greater, so is dependency. "Reserve residents" are more dedicated to forest resources than milpa relative to both "non residents" and to the inhabitants of San Miguel, both populations of newer arrivals to the region.

Another important aspect of proximity to forest resources is reflected by where the two groups interviewed work. 80% percent of "Reserve residents" work close to home while 20% range to other regions in order to harvest forest resources. By contrast, 35% of "non residents" work in only one distinct region of the Reserve while 65% range in their harvesting activities.

This suggests that, for Reserve inhabitants, nearby forest resources are those resources that are most important and thus most likely to be intensively harvested. One result is that NTFP densities near communities are reduced. But it equally clear that those communities within the Reserve are inhabited by people who know the region in which they live.

Finally, points four and five can be considered together. For social groups relatively more dedicated to milpa, xate is the most important forest resource, and for several reasons. First, as noted, recent colonists are predisposed to agriculture. Xate harvesting is an activity that can be done one day and not the next; it complements the agricultural cycle well. Second, xate harvesting requires little skill and specialized equipment: there are few barriers to entering into the activity. Third, there are few dependable employment opportunities in the northern Petén. Where lack of skill and experience prevent the recent colonist from harvesting other NTFPs, xate harvesting is the most important source of employment and cash income.

For those social groups that live beyond Reserve boundaries, including "non residents", xate is

also the most commonly harvested NTFP (Figure 3.2). Because the predominantly urban "non residents" group is closer to markets than "Reserve residents", they can make more money with milpa. There is less incentive, therefore, for "non resident" individuals to learn the harvesting skills and to tolerate the difficult conditions endured by full-time forest harvesters such as chicleros and pimienteros. Moreover, "non resident" individuals have other employment opportunities in the economically more active region south of the Reserve.

For "Reserve residents", and for Reserve inhabitants in general, agriculture, while important, diminishes in value and all three NTFPs become more important (Table 3.3), a pattern that becomes firmer the longer people live in the MBR. Summing the responses of "Reserve residents" to the question, "Which NTFPs do you harvest?" reveals that no one of the three predominate (Figure 3.2). Nonetheless, for this social group, xate is the most important NTFP because it can be harvested every month of the year. Chicle harvesting, though it provides the highest wage, is limited to five or six months of the year. It is of secondary importance. Pimienta is the least important NTFP because fruiting, hence employment, is limited to a two month period.

3.3.3 Forest Harvester-Contractor Relations

Relations between contractors (patrones) and harvesters have been characterized as a debt-peonage system; workers are kept indebted to contractors by the latter's control over both NTFP prices and the cost of food in camps. We disagree with this generalization. It is not this simple. Many xateros stated that if they did not like their patron, they simply would work for another. We do, however, concur that the relationship is often exploitative.

From the perspective of the forest harvester, there are good contractors and bad contractors. Good contractors are in the minority. As such, a key to improving forest resource management is to improve the welfare of forest harvesters. An obvious though problematic question emerges: "Can

the objectives of improved forest management be realized under current relations between contractors and forest harvesters?" A more basic question is: "Are the contractors necessary?"

In answering the second question first, we make the following observations. First, contractors are capitalized. Currently, there are no effective worker unions that can provide the collective services of establishing and maintaining extraction camps and transportation of forest products; contractors currently play this essential role. Second, there have always been contractors (patrones); they have historical precedence. Thus, because of the role they play, and have played, in capitalizing extraction and moving goods to market, the contractors are necessary, at least for the time being.

In reference to question one, effective sustained-yield management of NTFP extraction probably cannot be realized without regulation. As certain forest harvesters observed, regulatory controls must be imposed to protect worker rights and increase their benefits. This is most obviously the case for the xate industry and less so for the chicle industry. Only then can harvesting impacts be reduced without depriving forest harvesters of social benefits. And only in this way can sustained yields and equitable benefits be realized, both being essential for sustainable development based in part on forest resources.

3.3.4 Forest harvester perceptions of NTFPs

An exhaustive discussion of forest harvesters' attitudes towards forest resources is beyond the scope of this report. Instead, we make two simple observations.

First, "Reserve residents" and in general the inhabitants of the Reserve, are more familiar with forest and forest resources than any other groups or communities. The expertise of many individuals is remarkable. The need to incorporate this expertise in management activities cannot be overestimated.

Second, respondents revealed varying degrees of sophistication in their understanding of harvesting impacts, but, in general, they know that harvesting results in plant mortality. Certainly there are educational efforts that can be made to reduce harvesting impacts. But the greater problem is socio-economic. As one xatero pointedly remarked, "Sure the xate is dying, but the people are dying, too."

To assume plant mortality results from harvester ignorance misidentifies the problem. Worse, it blames the victim, by blaming forest harvesters for destroying resources that rational economic behavior dictates they must use to meet their short-term needs.

3.3.5 Diverse income strategies

Figure 3.3 reveals a characteristic common to all social groups considered here: diversity in income strategy. Very few individuals depend only on one activity. There are several simple reasons for this.

First, occupational diversity brings greater economic security. For the majority of rural people in northern Petén, no one activity yields sufficient income or occurs for a sufficient number of months during the year to be a sole source of employment. The sole exceptions to this are xate harvesting and milpa. However, the majority of respondents (>90%) mix milpa with the harvesting of several forest resources, or harvest only a combination of NTFPs.

Again, we quote Schwartz (1988 pers. comm.): "...many migrants cannot devote all their time to farming...the opportunity costs of giving up off-farm labor can be heavy, and an increase in crop production may not make economic sense...in many cases off-farm income may generate 50% and more of total household income." Of those interview respondents who practice a mixed income strategy (Table 3.4), over 80% stated that agricultural production is not sold but instead destined for household consumption. For these individuals, it appears that NTFP production supplies nearly

100% of cash income.

Second, supply and demand for both agricultural and forest products are seasonally well-timed. Third, dependence on diverse activities insulates individuals from low prices or bad harvests. This is particularly the case given the conditions of the agricultural frontier: shortage of capital, lack of education, corrupt and non-pluralistic institutions, political violence--that is, barriers that keep them from accumulating capital and improving their lives.

Fourth, international demand provides incentive for collection of NTFPs. Fifth, densities of economically valuable plants are high. In the global effort to protect tropical forests, much discussion has been dedicated to the concept of the extractive reserve without equal consideration given to the limitations. One serious limitation in tropical forest areas is low plant densities.

Finally, there exists in the Petén a forest culture: extraction of NTFPs is a heritage more than 100 years old. Not only do the technologies and economies exist, but the cultural acceptance of forest products as key components in income strategies dominates social organization, particularly for those communities within the Reserve.

3.3.6 Recommended Management Strategies and Research

We believe that a better understanding of these issues is so important that considerable resources in the newly-initiated MAYAREMA project (or ProPetén, as Conservation International's component is called) will be devoted to the study of "common property resources", in this case the study of the access to and use of publicly held forest lands. More specifically, ProPetén will look at a) exactly how harvesters, contractors, and others define access to NTFPs, b) whether their customary definitions of access agree or conflict with one another, and c) whether their (various) definitions do or do not accord with access as defined in formal or national law. Information gleaned from this research will be translated into recommendations regarding the establishment of

regulations affecting access to and management of NTFPs and other forest products. Because such research explicitly explores traditional resource allocation systems as perceived by local people, these people's needs and desires will be incorporated into recommendations regarding forest product management.

CHAPTER 4: OBJECTIVES AND METHODS OF NON TIMBER FOREST PRODUCT RESEARCH

4.1 Non Timber Forest Product Survey Objectives

In addition to studying the people who make up the non timber forest product extraction industry, we explored the harvest, production, transport, marketing, pricing, and ecology of the resources that form the basis of the NTFP extraction industry. The objectives of this portion of the study were the following:

- To determine representative densities of the three most important non timber forest products, xate, chicle, and allspice.
- To describe the market structure in each of the three NTFP extraction industries, from the forest harvester to the exporter.
- To determine how much of each NTFP is being harvested and exported.
- To determine NTFP prices at all different stages of the NTFP market.
- To explore the state of the NTFP resource. That is, to determine if NTFPs are being overharvested or if harvest is occurring at a sustainable and stable rate.
- To estimate the forest area needed to produce a given amount of each NTFP under sustainable harvest conditions.
- To develop a series of recommendations for improved management strategies and for additional research.

4.2 Ecological Research Methods

To gather ecological data on NTFPs, transects were conducted in areas of active harvesting, using resource extraction camps as the base of operations. We also established plots in Tikal to obtain data from a relatively undisturbed area. Figure 2.1 indicates the location and number of plots.

In the field we were guided by experienced men who took us to places where they traditionally collect NTFPs. We selected for upland closed canopy forest, avoiding bajos and

places of significant forest disturbance, such as logging roads, and large (>500 m^2) gaps due to logging or windthrow. Aerial photos were used to define the forest types in which we worked. Given the small scale of the photos (1:40,000 or 1:60,000) it was difficult to make distinctions within upland closed canopy forest, though it was possible to distinguish between closed canopy upland forest, open canopy upland forest, and bajo forest.

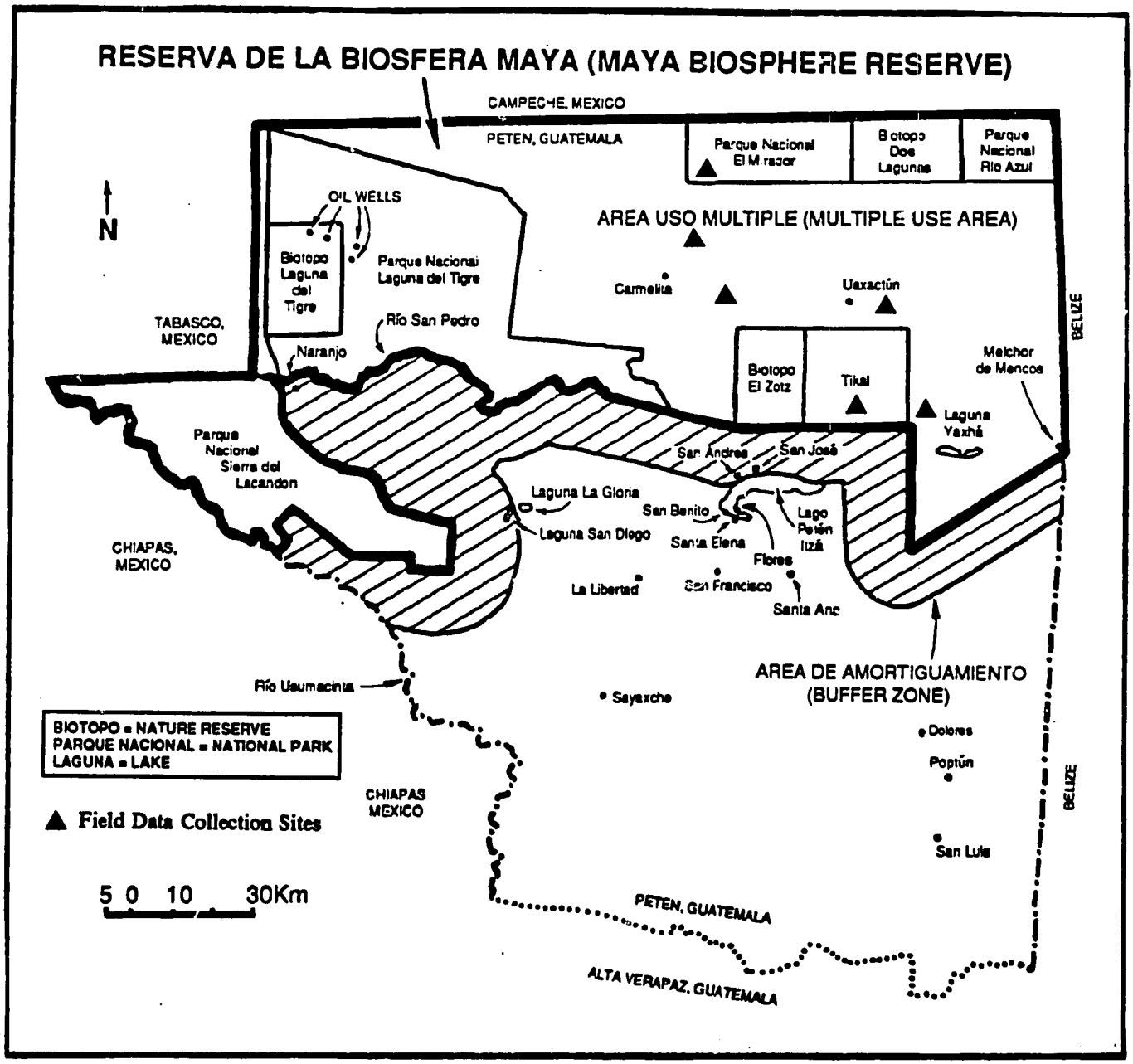

FIGURE 4.1
Location and number of ecological transects conducted during this study.

On a given day we would walk about 15-30 minutes, though sometimes an hour or more, outside of camp. We would then choose a bearing and walk for a randomly selected interval between 5 and 15 minutes and establish a plot. We averaged about 7 or 8 large plots, and between 15 and 20 small plots per day.

Circular plots of $1000m^2$ were used for trees, vines (bayal and mimbre) and understory palms (escobo and guano) greater than 3m in height. For chicle and allspice, diameter at breast height (DBH--1.3 meters), height, the state of the tree (alive or dead), and evidence of harvest were recorded for trees greater than or equal to 10 cm DBH (5 cm DBH for allspice). For ramón and other trees, DBH was recorded for all trees greater than or equal to 10 cm DBH. No effort was made to identify the many species of trees encountered in a plot, outside of the species of interest in this report. The number of individuals was recorded for other species. Slope, aspect and topographic position of the plot were noted, as were the number and size of canopy gaps and the number of dead standing trees.

For xate, regeneration of chicle and pimienta, and certain vegetation measures, 12.5 m * 2 m (25 m^2) plots were randomly located with the larger circular plot. Vegetation characteristics noted include cover at various heights (0-1 m, 1-3 m, 3-10 m, >10 m), the percent of the plot with a high canopy gap, the dominant vegetation type within the plot, the height of the canopy, the presence and density of lianas, and the density of palms at three levels (0-0.5 m, 0.5-3 m, >3 m). Both methods and vegetation characteristics to measure were determined via consultation with botanists, foresters and ecologists, as well as Cleaveland (1989), Webb et al. (1976), and Conant et al. (1984).

PARCELA

Fecha:_____; Lugar:_____; No. de sitio:_____;
Nom. de camp._____; Pendiente:_____; Aspecto:_____;
Observadores:_____; Clase de sitio:_____;
Notas:_____

Arboles

Chicle				Ramón		Otros con nombre			Otros sin nombre		
M(s/n)	DAP	Altura	P(año)	C s/n	DAP	Nombre	DAP	Nombre	DAP	DAP	DAP

Pimienta Gorda

M(s/n)	DAP	Altura	C(s/n)								

Otras Plantas

Philodendron_____

Desmoncus_____

Dioscorea_____

Guano > 3m_____

Escoba > 3m_____

Arboles Muertos_____

Brechas	
#	Tamaño
---	---

FIGURE 4.2A
Large plot data sheet

Fecha:_____; Lugar:_____; No. de sitio.:_____;
Nom. de sitio:_____; Notas:_____

Xate

No. de subparc.	Hembra	Jade	P. de vaca	altura	inflor.	No. de hojas	hojas cort.	cand.

Otras Palmas

	Guano 1	Guano 2	Corozo 1	Corozo 2	Escoba 1	Escoba 2
Rango						
0-.5m						
.5-3m						
> 3m						

Regeneración

	Chicle 1	Chicle 2	Pimienta 1	Pimienta 2
0-1m				
1-3m				
> 3m				

subparc.	Cubierta 0-1 m	1-3 m	3-10 m	>10m	Brechas	Superficie	Altura	Lianas Presen.	Lianas Dens.
1									
2									

FIGURE 4.2B
Small plot data sheet

A total of 139 large plots and 300 small plots were conducted in three general regions (Uaxactún, Carmelita, and Yaxhá), and Tikal. For trees we computed basal areas, density, and frequency in absolute and relative terms, as well as importance values. Importance value is defined as the sum of relative basel area, relative density, and relative frequency in all plots measured. Trees were also divided into diameter classes for later analyses. For xate we computed the number of individuals, inflorescences (clusters of flowers), leaves and cut leaves per hectare, for C. elegans and C. oblongata separately. We also computed number of leaves, cut leaves and inflorescences per individual for the two xate species. The same characteristics were computed for six size classes within each species of xate. We have not computed densities for the other NTFPs, nor have we conducted analyses of the effects of edaphic and vegetative factors on densities of xate, chicle or pimienta gorda.

Multiple comparisons of means, used to determine if there are significant differences between three or more values, such as plant densities, basal areas, numbers of inflorescences, etc., was done using the Tukey test, as described in Zar (1984). In addition, because the data obtained were not normally distributed in most cases, a common occurrence in this kind of investigation, a data transformation

$$X' = \sqrt{X + 0.5}$$

was used to normalize the data. Such a transformation allows the computation of descriptive statistics in a regular fashion and the use of parametric analyses, such as the Tukey test, while still providing an unbiased estimate of the population mean.

4.2.1 Validity of Comparing Ecological Data Between Regions

We compare data between areas and, based on this comparison, we infer certain harvesting impacts. These impacts range from changes within plant populations for a given area to changes in plant densities between areas. Such comparisons, as we argue in the chapters to follow, are not necessarily invalid, but must be used cautiously, and for two reasons.

First, our data represent a single moment in time. We do not know what plant population densities were previously, or do we know what the characteristics of those populations, such as size class distribution or reproduction, were in the past. For example, if Region A has fewer plants than Region B, we can not state with certainty that harvesting has reduced population densities in A more than B; A may have originally had fewer plants than B.

Second, we compare data derived with the same methods, but from different areas. Because we cannot control for all variables that affect plant populations, significant differences in populations among different areas must be interpreted cautiouslyl. For example, while plant populations may be more abundant and healthy in an unharvested area relative to a harvested area, the reason may be soil type, precipitation, or a fire 50 years ago, not just harvesting impacts. In recognition of this limitation, however, we compare several observed characteristics among populations in order to infer, or hypothesize, what the impacts of harvesting might be, not necessarily what they are. This is especially seen in the case of xate.

4.3 Market, Price, and Industry Structure Data Collection Methods

In addition to ecological data, we also collected data on prices, supply and demand, and industry structure for each of the three major NTFPS. We did this by interviewing harvesters, contractors,

exporters, government officials and others involved in the extraction system. See the questionaire in Chapter 3 for a list of questions we asked over 90 forest harvesters and contractors. We also conducted extensive research in libraries and archives both in Guatemala and the US in an effort to piece together disparate statistics and other information on Petén in particular and natural forest management in general. In many cases, data are virtually nonexistant for many aspects of the extraction system, has not been collected systematically, or are contradictory, so much of the effort in this sort of study is putting together a clear picture of the structure and functioning of the industry from very patchy data.

CHAPTER 5: XATE

Xate is the name given to the leaves of two palm species of the genus Chamaedorea, which are extracted from the forests of Petén and used internationally as a green foliage in floral arrangements. Harvesting of the palm leaves is the most important source of employment in the Reserve. Plant densities are high, though current harvesting practices reduce densities by reducing both leaf production and plant reproduction, and by direct mortality.

In this chapter we describe the two species, their ecological association, and the impacts of leaf extraction on plant populations. We also describe the market structure, harvesting benefits, and existing regulatory structures. Finally, we analyze the sustainability of current harvesting, calculate the forest area necessary to meet international demand, and provide a basic NFM strategy for the industry.

5.1 Botanical Classification and Description

Both species belong to the Arecaceae palm family. They are Chamaedorea elegans Martins, known locally as xate hembra, and Chamaedorea oblongata Martins, known locally as xate jade. There is some trade in other species, for example C. ernesti-augustii (cola de pescado or fish-tail palm), but both volumes and values are low.

Xate hembra (C. elegans) is a woody plant 0.4 to 2 m high with an erect solitary stem 0.8 to 1.5 cm in diameter with thick and prominent leaf scars (Figure 5.1A). It has five to eight alternipinnate to subalternipinnate leaves, a sheath 8 to 20.5 cm long, a petiole 12 to 27 cm long, with the underside having a yellow rib, a rachis 24.6 to 54 cm long, and 11 to 20 alternate to mostly opposite pinae on each side of the rachis. These leaflets are linear to tightly lanceolate, 11 to 20 cm long and 1 to 2 cm wide, with a long and acuminate apex.

The fruit is black, spherical, 4 to 7 mm in diameter, and has a thin exocarp with a green, aromatic membranous endocarp. The seed is round, dark reddish brown when ripe, and 3.5 to 6 mm in diameter.

Xate jade (C. oblongata) is also an woody plant, though taller, ranging from 1.5 to 3 m high with a single stem, 8.5 to 11 mm in diameter, with only slightly prominent leaf scars (Figure 5.1B). In taller individuals the stems often rest horizontally on the ground for up to 2 m, before rising vertically into a leafy crown.

C. oblongata has 3 to 8 alternipinnate leaves. The sheath is 15.5 to 21.6 cm long, petiole 14 to 32.5 cm long, and the underside is traversed by a thick yellow rib. The rachis is 31.9 to 61.7 cm long with 5 to 9 pinnae on each side.

The fruit of C. oblongata is black when ripe, oval, 11 to 13 mm long and 6 to 8 mm wide. It has a thin exocarp, a green mesocarp with little flesh, and a mucilaginous, aromatic, thick endocarp. The hard seed is fibrous, ellipsoid, and 10 to 11 mm long and 5 to 5.5 mm wide (Aguilar 1988).

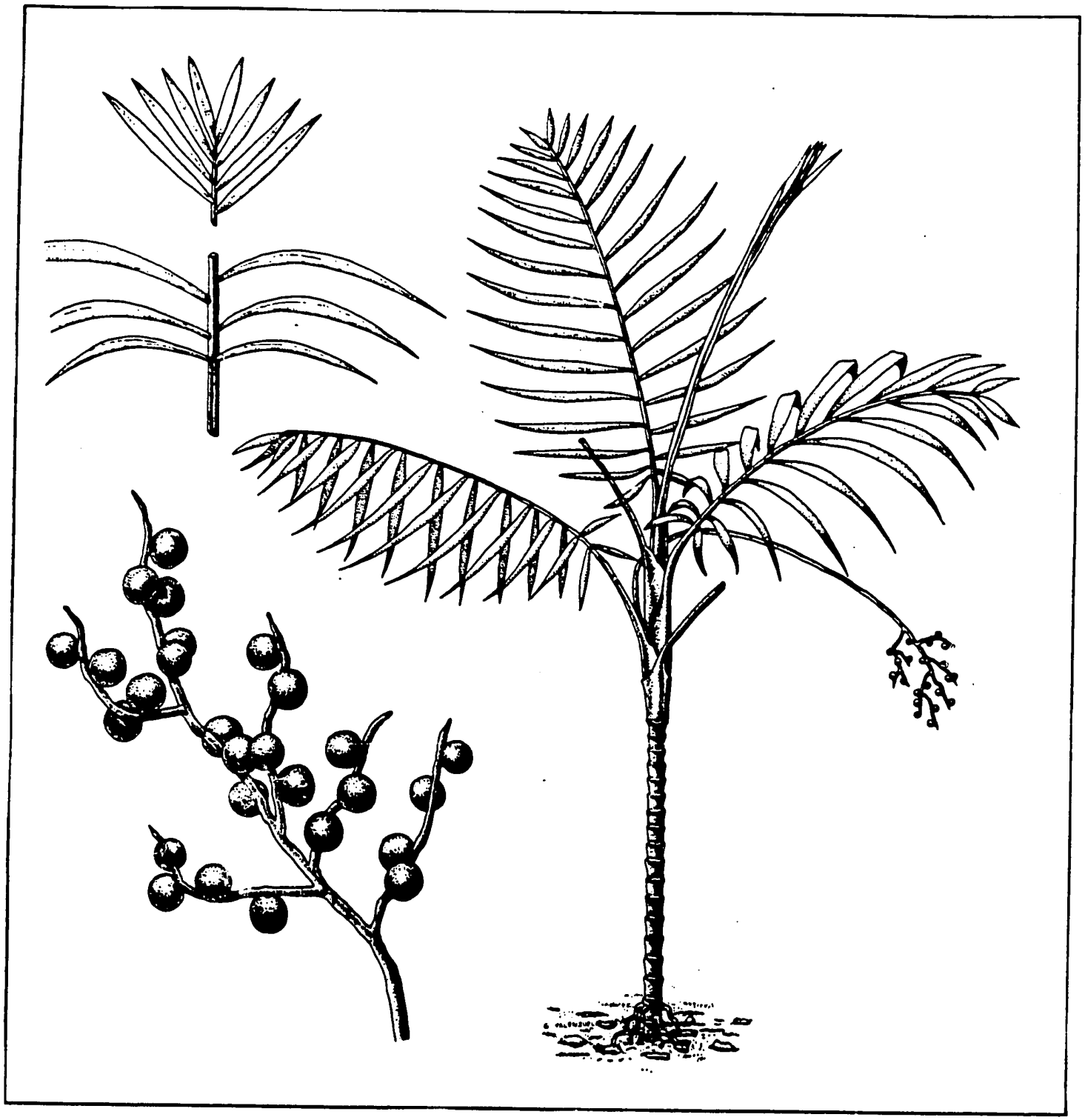

FIGURE 5.1A

Botanical drawing of Chamaedorea elegans Martins

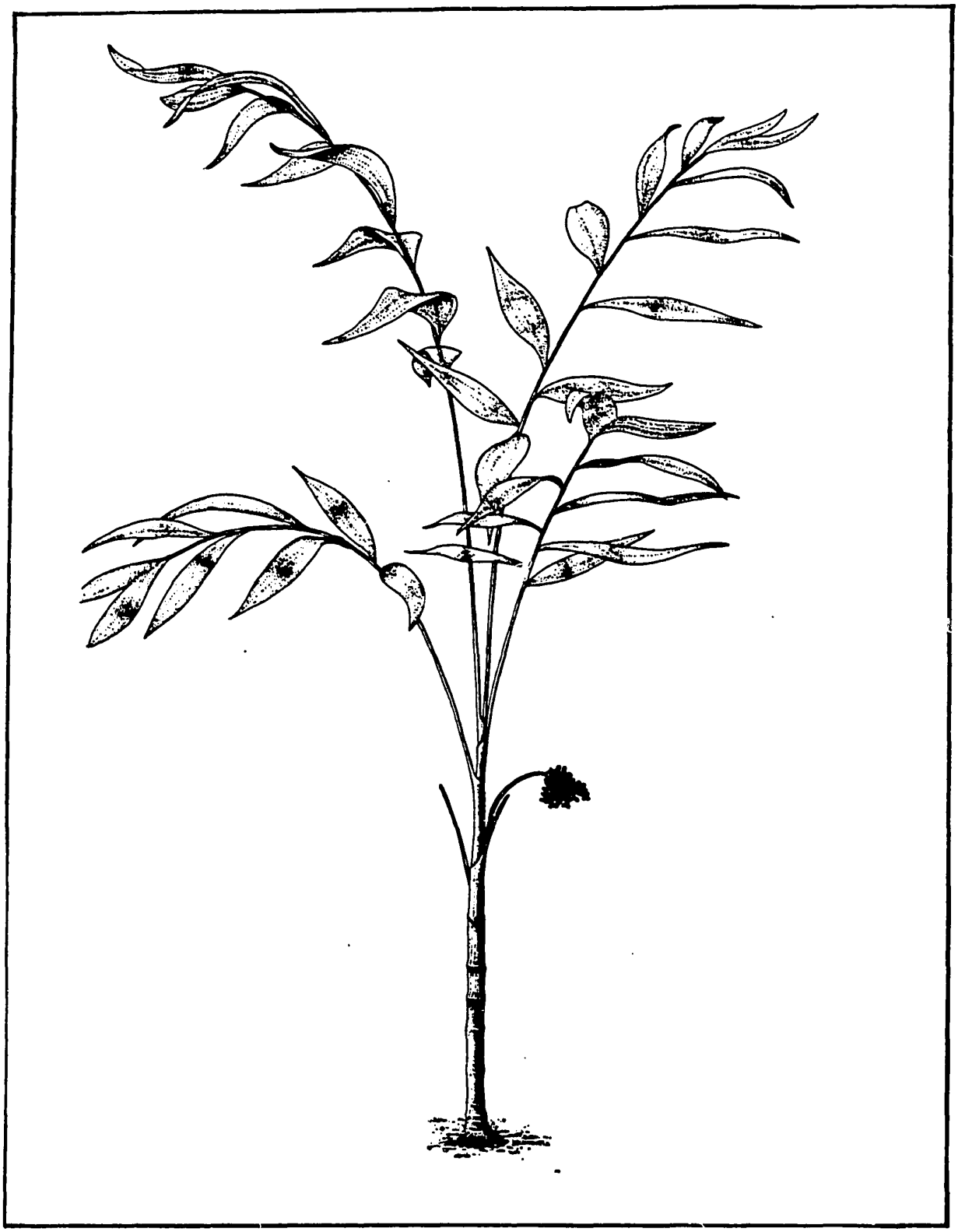

FIGURE 5.1B

Botanical drawing of Chamaedorea oblongata Martins

5.2 Xate Ecology

Both species of xate are found in the same forest association, namely primary and mature secondary upland forest. The species are often found side by side, generally distributed in patches (manchas or spots). Plant population densities are dependant upon soil type, topography, seed dispersal patterns, microclimatic factors, and forest development history.

In general, both plants grow on well-drained soils, which occur generally on hills, either on slopes or summits. Little xate is found in areas with poor drainage, such as in bajos. Both are adapted to relatively xeric environments that occur in the seasonally dry Tikal Nacbe uplands (see Figure 3.1, Map of Petén Physiography and Major Ecosystems), presumably a strategy made possible by the capacity of the leaves to reduce their rate of transpiration in drought conditions. The fact that these leaves do not dry easily makes them durable, an important feature in their use as a wilt-resistant foliage in floral arrangements on the international market.

Field observations suggest these Chamaedorea species depend on a high tree cover to provide adequate shade and humidity for their development. Under too much light, the plants become yellow and the size of the leaves decreases. Forest disturbance, such as wind throw, fires, and timber extraction allow for light penetration, with subsequent stimulation of herbaceous pioneer plants. Both Chamaedorea palms appear to compete poorly with these plants.

5.3 Harvesting Impacts

The following discussion will present data on plant population densities, size class distribution, presence of inflorescences (clusters of flowers), and the number of cut leaves per plant. These data

will illustrate the impacts of harvesting on plant populations. In general, we conclude that high levels of harvesting reduce plant densities. The extent to which plant mortality or reduced plant reproductivity occurs depends on harvesting levels, itself dependent on the accessibility, specifically road quality and proximity to large human populations, of the region in question.

5.3.1 Method of Harvesting

Xate extraction occurs all year. Most resource harvesters, called xateros, are organized by contractors in camps with 10 to 30 xateros. Each camp is used for different periods of time, from one to two months, depending on the resource potential of the surrounding forest. Many xateros also work independently around their communities.

Xateros harvest the xate leaves with a single blade knife, with which they cut the petiole of each harvestable leaf. The xatero walks from one plant to another, bends over, and with one hand cuts one leaf after the other, carrying them in a grain bag modified into a shoulder sling. Generally, a single leaf is harvested from each plant, though additional leaves are taken if available. The number of leaves harvested per plant is critical to the survival of the plant, as is discussed below.

5.3.2 Plant Population Densities

To determine representative plant population densities, transects were conducted in several areas: Tikal National Park, north of Yaxhá, and north and west of Uaxactún (Figure 2.1). Each of these areas has different degrees of access. Tikal provides some reference for comparing harvesting impacts between regions because it is a protected area where xate harvesting is prohibited and

populations of Chamaedorea spp. have therefore been more protected. In spite of surveillance, however, the more valuable C. elegans is harvested in Tikal.

Table 5.1 indicates the average densities of both C. elegans and C. oblongata. The average density of the two species combined is 4,506 plants per hectare in Tikal, 2,279 in Yaxhá and 2,478 in Uaxactún.

Analyzed separately, the densities of C. oblongata are significantly greater in Tikal, with 2,586 plants/ha, followed by Uaxactún with 1,747 plants/ha and then by Yaxhá with 1,206 plants/ha. There were also greater densities of C. elegans in Tikal, followed by Yaxhá and then Uaxactún (Table 5.1). See the ecological methods section, Chapter 4, for an explanation of statistical methods used.

TABLE 5.1
Density (number of plants per hectare) of Chamaedorea spp. in three areas sampled. Jade is C. oblongata and hembra is C. elegans.

	Density (plants/ha)		Standard Deviation		Confidence Interval (95%)		Sample Size
AREA	Jade	Hembra	Jade	Hembra	Jade	Hembra	
Uaxactún	1,747	731	1,747±350	[illegible]1±367	1,681-1,813	662-800	110
Yaxhá	1,206	1,073	1,206±327	1,073±267	1,140-1272	1,019-1,127	96
Tikal	2,586	1,920	2,586±504	1,920±426	2,436-2736	1,793-2047	46

Source: Field data, 1990.

In all cases, the average density of C. oblongata is greater than that of C. elegans. While original--pre-harvest--populations may have been significantly different, such differences may also result from harvesting-induced mortality. For example, C. elegans leaves have a better

price and weigh less, so the xatero prefers them. Consequently, there is greater pressure on this species and higher mortality. Moreover, as a leaf exporter explained, past overexploitation of C. oblongata diminished the quality to such an extent that importers reduced their purchases, resulting in reduced harvesting pressure in recent years. Consequently, with reduced demand, the populations have recovered somewhat.

5.3.3 Size Class Distribution

Size class distribution, based on plant heights, offers an indication of population health. This is most clearly seen in those classes that include individuals capable of producing seed, a condition for regeneration. In a randomly sampled population of shade-tolerant species, one expects a population in which density is inversely proportional to the height, and thus age, of the plant. That is, the larger the size class, the fewer the number of individuals encountered (Nicholas Brokaw, pers. comm., 1991).

Figure 5.2A reports average C. elegans densities per hectare in six different size classes for each of the three areas sampled. This population structure is particularly pronounced in Tikal where there are many more individuals in the smallest size classes than in the largest size classes. In Yaxhá and Uaxactún, this population structure is not as pronounced. That is, the smallest size classes contain only somewhat more individuals than the largest size classes. We infer that recent harvesting has greatly diminished the capacity of individuals in the largest size classes to produce seed and, subsequently, reduced plant population densities in the smallest size classes in Yaxhá and Uaxactún: harvested populations reproduce less. Moreover, we hypothesize that leaf harvesting in the middle size classes (45-75 cm) has

reduced growth rates, thereby reducing the number of individuals in the largest size class. Harvesting of the middle size class is particularly pronounced in Uaxactún, where the 31-45 cm class has significantly fewer individuals that Tikal or Yaxhá.

Figure 5.2B gives the average C. oblongata population densities, by size class, for the three regions. The same inverse relationship between plant height and population density can be seen, with the exception of the smallest and largest size classes, which may be an artifact of how the height classes where established. Unlike C. elegans, where only Tikal exhibited the expected inverse relationship, the expected population structure is evident in all three regions. For example, significant differences in average population densities between Tikal and Uaxactún, and Tikal and Yaxhá exist in each size class. In all cases, populations are highest in Tikal. The only exception is seen in the smallest size class (<40 cm) where densities between Tikal and Uaxactún are not significantly different. Densities in Yaxhá are significantly lower than in Uaxactún in all size classes less than 160cm.

We hypothesize that, because of lower demand for C. oblongata, populations are healthier. This hypothesis is further strengthened by the observation that in virtually every size class in all three areas, C. oblongata outnumbers C. elegans. In addition, we believe that densities in the harvested regions of Uaxactún and Yaxhá are likely to be representative of larger regions of historical harvesting. An exception may be the Sierra del Lacandón in the western region of the Reserve, where there are common reports of much higher plant population densities, and thus much higher yields.

5.3.4 Presence of Inflorescences (Clusters of Flowers) and Infructescences (Clusters of Fruit)

The presence of inflorescences and infructescences is a good indicator of the reproductive health of a plant population. As part of the field investigation, we measured the number of inflorescences and infructescences per hectare. We present data from the largest size classes for both species, that is, those size classes in which we observed the most inflorescences (>75 cm for C. elegans; >160 cm for C. oblongata). Figure 5.3 presents the number of inflorescences and infructescences in three different regions of the northern Petén. Tikal has a significantly greater average number of inflorescences and infructescences per hectare relative to the other two areas. This is especially evident for C. elegans. In fact, it is rare to encounter C. elegans inflorescences in the more exploited populations outside of Tikal. This observation corresponds to the reduction in densities in regeneration as discussed above. Note that the scale used in Figure 5.3 is logarithmic, so it downplays the contrast between Tikal and areas outside Tikal.

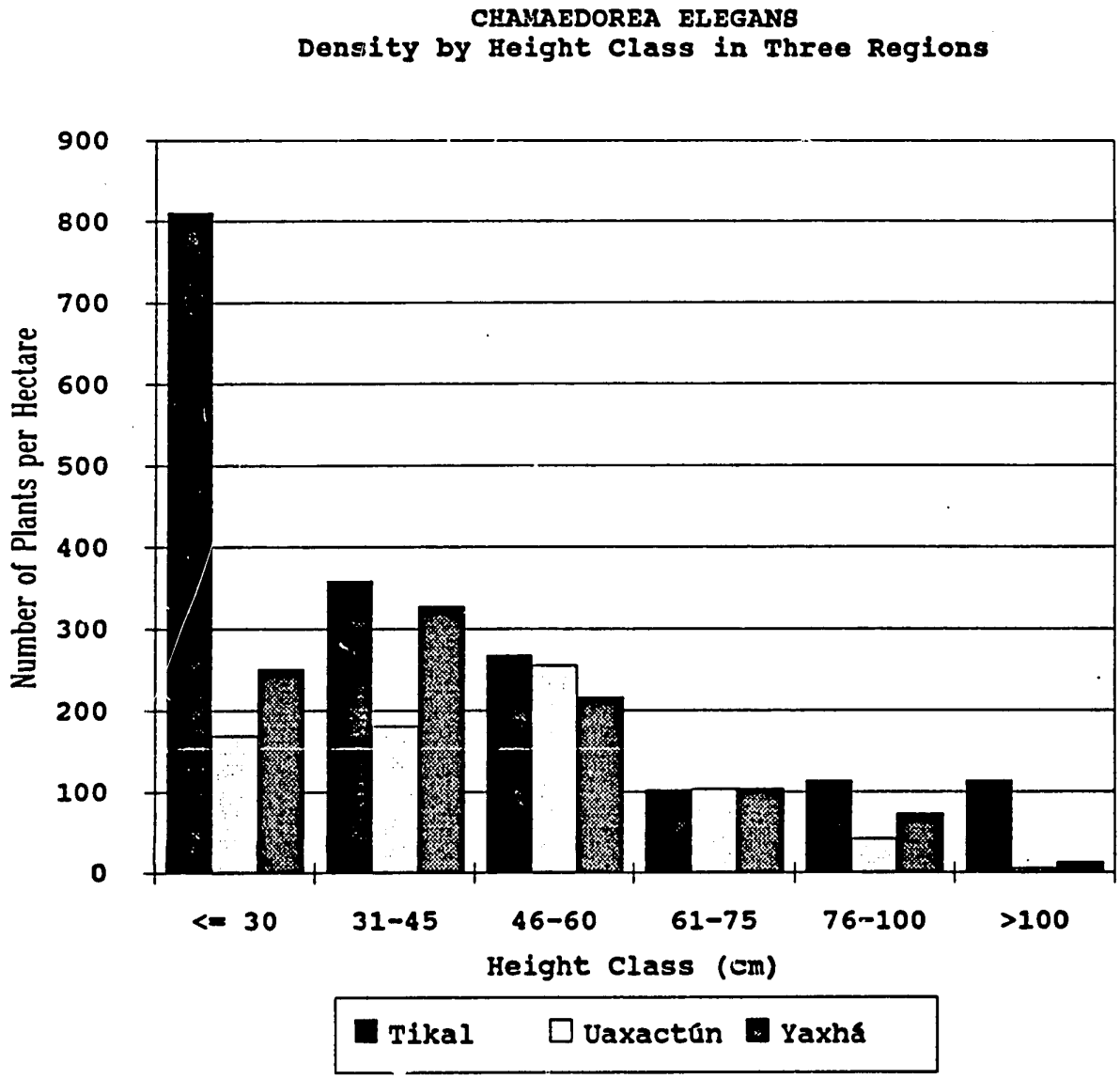

FIGURE 5.2A

Density by height class for *Chamaedorea elegans* in three regions

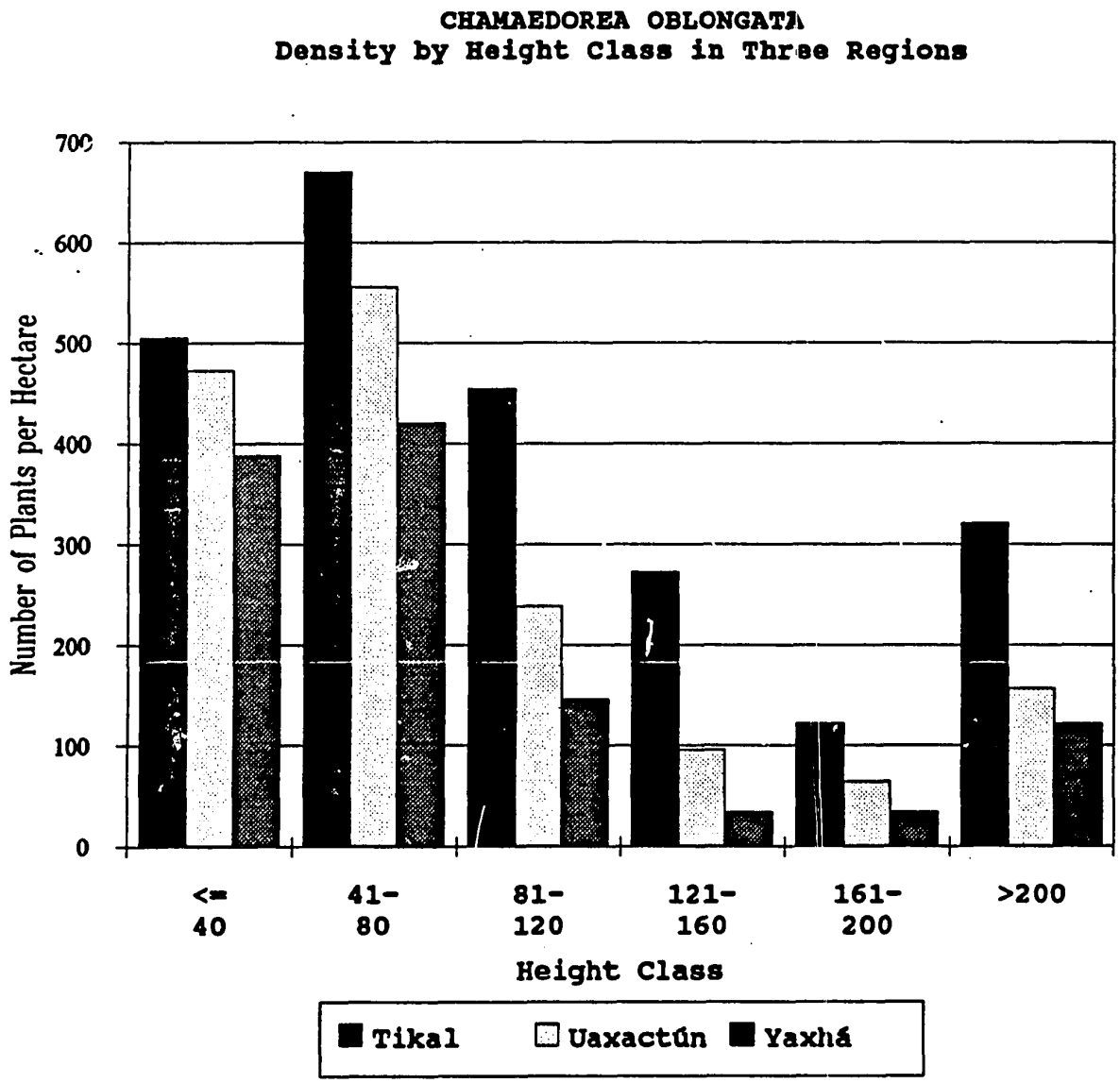

FIGURE 5.2B

Density by height class for *Chamaedorea oblongata* in three regions

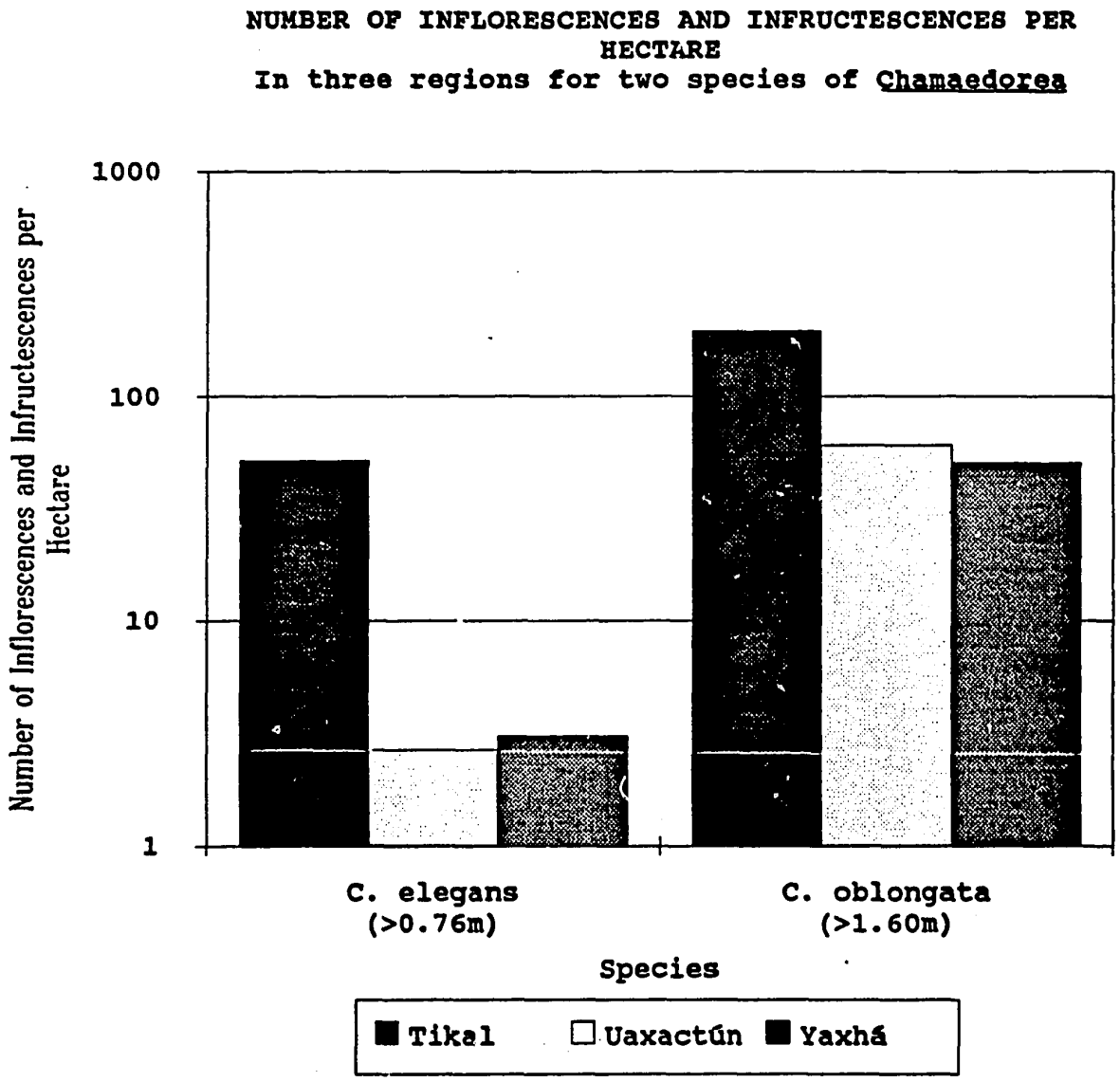

FIGURE 5.3

Number of inflorescences or infructescences per hectare in three regions for the most heavily harvested height classes.

Reductions in regeneration are less marked for C. oblongata than in C. elegans. Similarly, reductions in the number of inflorescences from protected to harvested areas are also less dramatic for C. oblongata.

5.3.4 Number of Leaves Cut per Plant

A rough measure of harvesting pressure is the number of cut leaves per plant. Figure 5.4 depicts the number of leaves cut per plant for size classes in which harvesting occurs. In recording cut leaves, we did not distinguish between recent and old cuts. The ratio of cut leaves per plant for C. elegans varies from 0.91 in Yaxhá to 1.33 in Tikal. For C. oblongata, the ratio ranges from 0.03 in Tikal to 0.33 in Yaxhá.

For C. elegans, significantly fewer leaves are cut per plant in Yaxhá than in Tikal. Fewer leaves are also cut per plant in Uaxactún than in Tikal, though the difference is not statistically significant.

The results obtained for C. oblongata are the opposite. In Tikal the numbers of leaves cut per plant are significantly lower than in both Yaxhá and Uaxactún. This is not surprising given that harvesting intensities are higher in the latter two areas. Though legally protected, the high plant densities in Tikal have attracted harvesters nevertheless, even near monuments frequented by tourists and guards. The less valuable C. oblongata leaves probably do not warrant the risk of illegal harvesting and these populations are largely uncut.

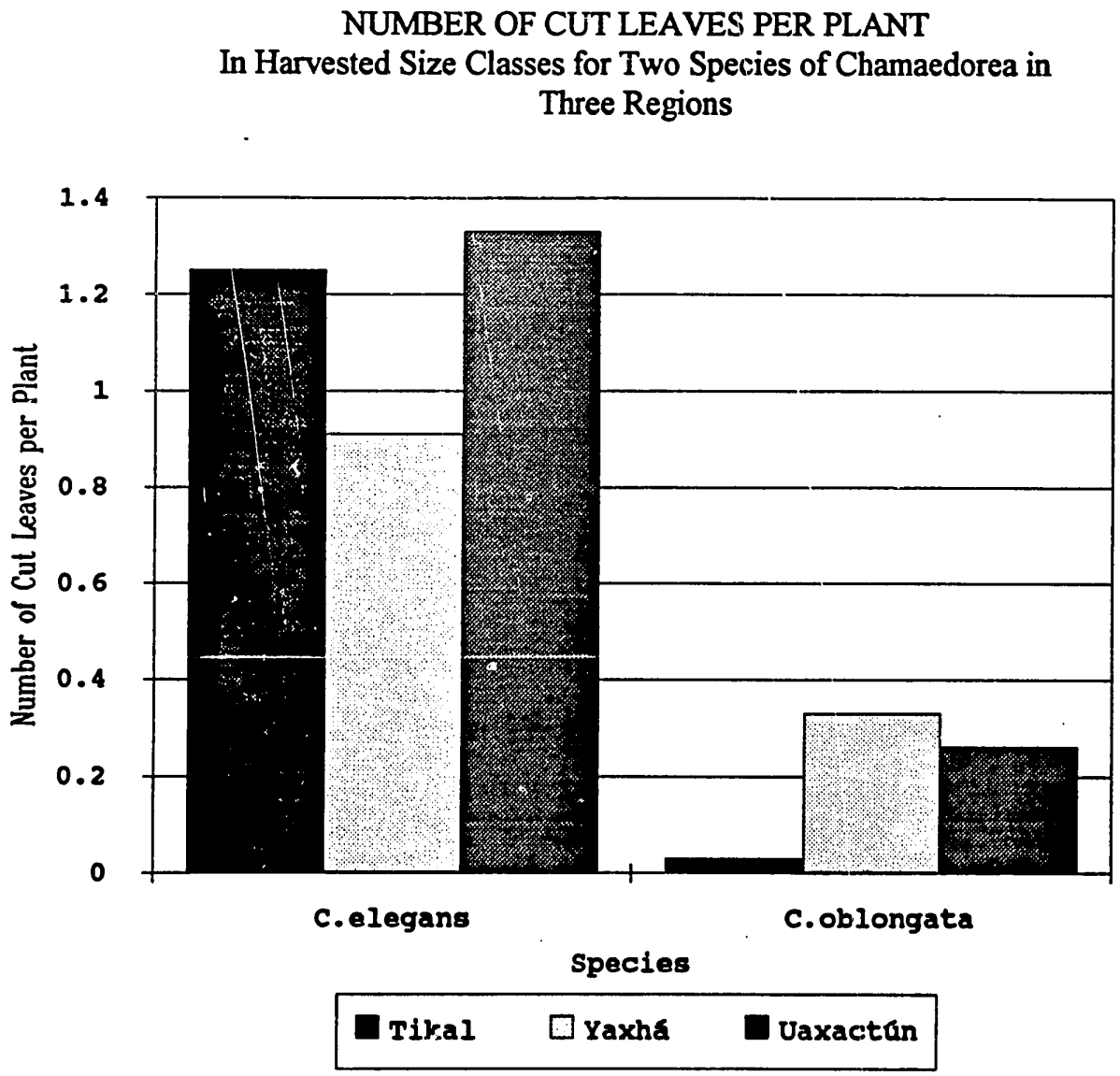

FIGURE 5.4

Number of cut leaves per plant for *C. elegans* and *C. oblongata* in harvested size classes

5.3.5 Physiological Reasons for Mortality

Over the long term, we hypothesize that the more leaves that are cut, the less inflorescences occur, with a corresponding impact on seed production and regeneration. Defoliation studies carried out with another type of understory palm, Astrocardium mexicanum, showed a significant reduction in the reproduction capacity (Mendoza et al. 1987). Although this palm does not belong to the same genus, and although more research is necessary, the results obtained with A. mexicanum reinforce our hypothesis. Defoliation studies carried out on Chamaedorea tepejilote in Mexico indicate no negative effect on leaf, flower and fruit production despite complete defoliation in some instances. These studies took place only over a two year period, however, so it is possible that longer term defoliation would have more pronounced effects.

Consistent, long-term defoliation of Chamaedorea plants may adversely affect their physiological processes. The plant loses its capacity to photosynthesize, which results in a reduction of its capacity for both growth and reproduction. We suspect that a harvested plant's energy is used to produce new leaves and not flowers and fruit. As subsequent harvests further tax plant resources the plant loses its capacity to produce leaves and dies. Clearly, additional research is needed to clarify the impacts of defoliation on xate ecology and population biology. In particular, long-term studies will contribute a great deal of information regarding the effects of variable degrees of harvesting.

Mortality is probably accelerated by inappropriate harvesting. Sometimes the xatero pulls on the plant during cutting, causing loosening of the roots. Not uncommonly, the harvester cuts the apical meristem (candela), seriously damaging or killing the palm.

Another impact of harvesting may result from the seasonal overlap of the dry season and high market demand. The dry season months of March and April correspond to high demand in the U.S. and Europe for Easter flowers and floral greens. As a result, intense harvesting and no rain may combine to produce a particularly heavy impact on xate populations.

A final impact on the xate industry comes from timber harvesting. The numerous roads and trails form an important link in the exploitation and transport of xate, but considerable forest disturbance results. Secondary roads, skidder trails, and treefalls all severely affect plant populations. As is commonly stated throughout the xate industry, "The Madereros (loggers) kill a lot of forest."

5.4 Market Structure

5.4.1 Demand

Demand for xate probably began in 1960 when a Texas flower importer developed a market for the green leaves as a background in floral arrangements (Heinzman and Reining 1990).

Currently, international demand undergoes predictable seasonal fluctuations, peaking in March, April, and May, and dropping in July, August, and September. Figure 5.5 depicts the 1989 monthly export rate. Reduction in the number of exports in December results from the fact that harvesters do not work as hard during the Christmas holidays.

The principal importing countries are Germany, Belgium, Switzerland, the Netherlands, Denmark, and the United States. Figure 5.6 shows volumes exported to different countries

in the last six years, revealing growth in demand in the last three years. The United States and Germany are the principal importing countries. These data do not distinguish between species of Chamaedorea, nor do they indicate where the leaves are extracted within Guatemala; they do, however, give an idea of the overseas demand for this product. What is certain in that almost all the xate marketed in the United States is C. oblongata. While both species are used in Europe, C. elegans is in greater demand.

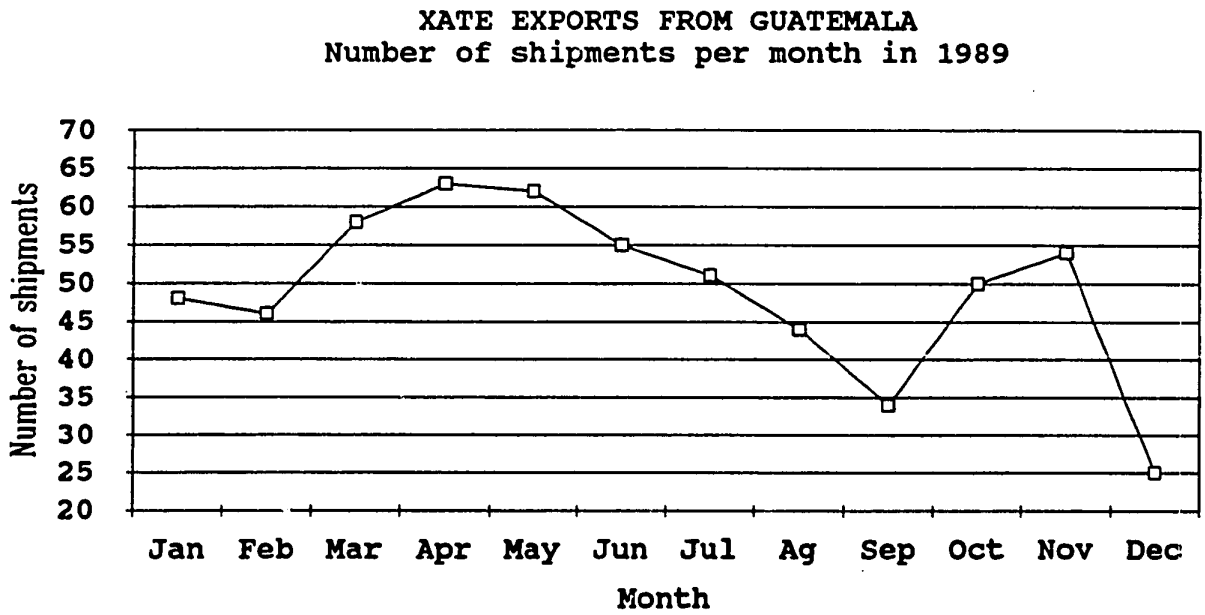

FIGURE 5.5

Exports of xate: number of shipments per month in 1989.

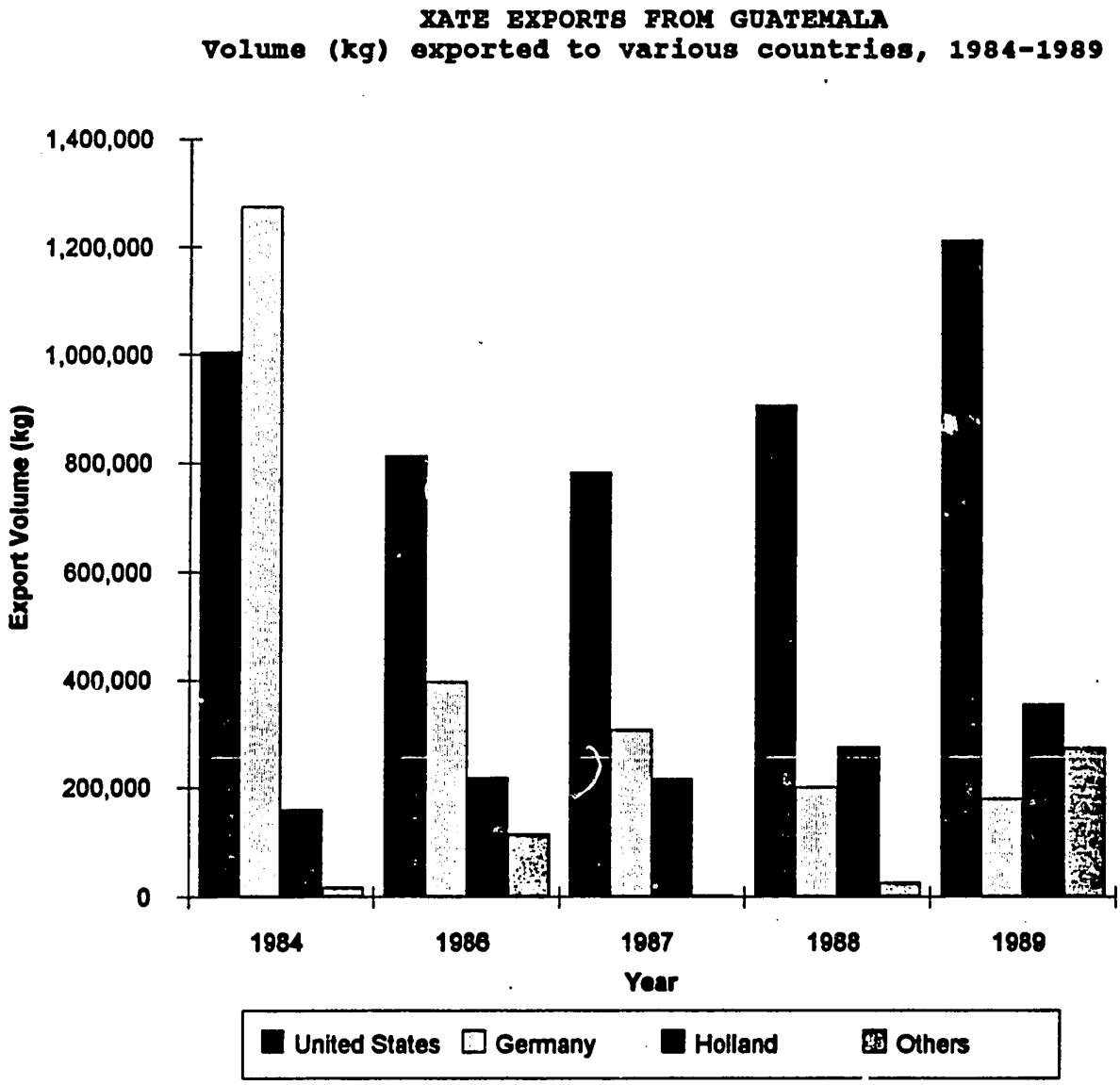

FIGURE 5.6

Exports of xate to the United States, Germany, the Netherlands, and other countries, 1984-1989.

5.4.2 Supply

Guatemala and Mexico are the principal countries supplying the world market (Heinzman and Reining 1990). In the period 1979 to 1987, Guatemala decreased its share of the U.S. market from 37% to 11%, while Mexico increased from 63 to 89%. Mexico dominates the U.S. market (C. oblongata) because the Mexican leaves are cheaper and of better quality and, reportedly, because a U.S. importer has monopoly control of Mexican supply. We have no data characterizing the European market. However, exporters state that Guatemala provides almost the entire supply to the European market, and this supply is dominated by C. elegans. Industry sources estimate that approximately 75% of the supply is extracted from Petén.

TABLE 5.2A
Estimated exports of C. elegans exported from Petén. This value is approximately 75% of the total volume exported from Guatemala.

YEAR	1987	1988	1989
75% OF VOLUME EXPORTED (kg)	267,750	249,375	425,250
NO. OF LEAVES (in millions)	89,250	83,125	141,750

Source: Field data, 1990; Gremial de Productos No-Tradicionales.
Assumptions: Leaves lost in selection: 50%; 70% of exports to Europe; average weight per leaf, C. elegans: 3.0 g; average yield: 2046 lvs/ha/yr (assumes 3 lvs/plant/yr).

TABLE 5.2B
Estimated exports of C. oblongata from the Petén.

YEAR	1987	1988	1989
75% of volume exported (kg)	707,250	781,875	1,089,750
No. of leaves (in millions)	70,250	78,188	108,975

Source: Field data, 1990; Gremial de Productos No-Tradicionales.
Assumptions: Leaves lost in selection: 50%; 100% of U.S. exports and 30% of European exports; weight per leaf C. oblongata: 10 g; yield: 2970 lvs/ha/yr (assumes 3 lvs/plant/yr).

5.4.3 Market Channels

The market for xate is made up of six agents: the harvester, the rural collector, the contractor, the exporter, the importer, and the florist.

There are four marketing channels. In channel one, the xatero sells to the rural collector, who is often a shop owner (tienda) in the communities. He or she, in turn, resells directly to exporters. In channel two, the xatero works directly for the exporting company. The owner of the exporting company contracts the worker, eliminating the contractor. Channel three is the most common. The xatero sells his product to the contractor, who, in turn, transports and resells it to the exporter. Channel four is the least frequent case. The rural collector sells to the contractor. In this case, the additional intermediate relationship reduces the gross benefits received by the xatero, though this also represents the lowest cost collection method: the xatero harvests near his home, eliminating the expenses of camp food and travel time. Similarly, the contractor avoids the transportation costs of moving the leaves from distant forest camps to a major road.

The harvester: This is the first link in the marketing chain. As discussed, the xateros, almost always men, harvest the product and prepare the leaves in bundles of 45. Two of these bundles, called manojos, make up a gruesa, which is the sales unit--approximately 90 leaves. The xatero can cut an average of 18 gruesas in a full day of harvesting, though volumes range from 10 to 40. Often, particularly in the larger camps, one xatero, the captaz, or "captain", keeps track of individual accounts, noting both the number of gruesas cut and the amount of food eaten by each man.

When the market began, one gruesa contained 144 leaves. Over time, xateros have slowly reduced the number of leaves per gruesa. Reductions both in leaf production by individual plants and in plant densities over time have made it more difficult to harvest a sufficient number of leaves. With increased harvesting difficulty, leaf extraction has become less economic: the xatero's time and walking costs, in searching for scarce leaves, have increased. To recoup this cost, the contractor must pay more for 144 leaves or pay the same for fewer leaves. The industry has settled on the latter solution, so xateros have gradually reduced the size of a gruesa over time.

Rural collector: At times there are community members who purchase xate. They generally own mules for transporting xate from the camps to the community. The collector may also provide food in the camp. More often, however, rural collectors purchase xate harvested around communities.

Contractor: Contractors enlist xateros, supply camp food, and transport the product to the exporters' warehouses. The contractor obtains double benefits: first, as a xate middleman and, second, by selling food in the camps at a profit. To be successful a

contractor generally has to own a truck and/or mules for transporting the leaves from harvesting camps to exporters' warehouses. Where mules are used, the contractor hires a mule driver, who has the responsibility of transporting supplies to distant forest camps and returning with harvested product. Every two to three days food is delivered to, and leaves are collected from, camps, either by mule or truck. While wilt-resistant, the leaves must be moved into the international market before they deteriorate.

The contractor sets up camps in different areas, the choice depending on access, the existence of water, and availability of the xate. One contractor may work several camps within the same area, such as, three or four camps along the same supply route, often an old logging road, for periods ranging from 30 to 60 days. When the xateros report that leaf availability has dropped off, the contractor transfers them to another camp.

All contractors must receive a license to transport leaves out of the Reserve. In 1990, there were 134 contractors in Petén working for seven different export companies. Table 5.3 shows the distribution of the contractor population in relation to the export company to which they resell the leaves.

TABLE 5.3

Number of Contractors per Exporting Company in 1990

COMPANY	No. of Contractors
Gersa	20
Maex	34
Follajes Tropicales	42
Arco Iris	3
Verdes Primaverales	10
Naturex	22
Follajes Mora	3
TOTAL	134

Source: CONAP

Table 5.4 shows the number of licenses issued in each district. These data show that in the first semester of 1990, 58% of the licenses were issued in the district of San Andres and La Libertad, both of which are in the Multiple Use Area of the Reserve. The number of licenses issued gives an indirect idea of the intensity of the harvest in the Reserve. Hence, the importance of the Multiple Use Area relative to other areas can be inferred from this data.

TABLE 5.4
Number of harvest and transport licenses issued by CONAP in each district of Petén.

Municipality	1989	1990*
Flores	65	105
San Andrés	134	163
San José	19	26
La Libertad	127	175
Melchor de Mencos	28	34
San Francisco	20	19
Santa Ana	2	16
Dolores1	14	16
Sayaxché	15	17
Poptún	11	16
TOTAL	435	587

Source: CONAP
* up to June, 1990

The average number of licenses issued monthly was 71 for 1989, and 104 for the first half of 1990. These figures indicate that the number of contractors increased substantially over the previous year. This increase may be due in part to rapid immigration of people and capital into the region from southern Guatemala. It may also be poor record keeping in a young bureaucracy. However, not all the contractors work during the entire year, or at the same intensity.

Exporter: There are at present 16 companies exporting xate, of which only seven work in Petén. The other companies export other native and cultivated species of Chamaedorea from other regions in the country. Of the exporting companies marketing xate from Petén, only two process the product in Petén; the other six prepare the leaves for export in Guatemala City.

Xate is delivered to the exporters' warehouses (xateras), in Santa Elena and San Benito, or is flown to warehouses in Guatemala City. The xate is selected and processed mostly by women. The size required for the leaves of C. elegans is 25 to 36 cm in length, and for C. oblongata, 46 to 56 cm. The other criterion in selection is the quality of the leaf; it must be bright green and free of spots. One person can select an average of 200 bundles a day; for each bundle selected she is paid Q0.05, a relatively good wage.

Some warehouse keepers report that for each gruesa that enters the warehouse, a minimum of 1.5 bundles of C. elegans and 2.5 of C. oblongata should leave the warehouse. That is, for each 90 leaves of C. elegans entering, 54 selected leaves should be exported, and for C. oblongata 66 leaves should be exported. Yet between 50 and 60% of the incoming leaves are usually discarded, so it appears that warehouse managers are not enforcing this minimum. Some leaves are damaged in transport; other leaves were unacceptable when harvested, an important point to which we return in our discussion of sustainability (Section 5.6).

After selection, tied bundles, which include 36 leaves for C. elegans and 23 leaves for C. oblongata, are rolled in paper to form a cylindrical package. The packages are stored in cold rooms at a temperature of 33 to 35° F for periods of one to six days. The stems are placed in trays of water in order to ensure freshness. Finally, the packages are examined and are ready for export.

Importer: When the packages of xate arrive in the United States, they go into Customs. The importer contracts an agent to pay a bond of $10,000 and obtain a license. The agent arranges for permits and inspections for each shipment, which are carried out by the USDA.

Once the shipment is inspected to ensure that it is free of insects and diseases, it may leave the customs warehouse.

The xate leaves are transported in refrigerated trucks and delivered to regional flower distributors and ultimately to florists.

5.4.4 Legal Requirements

As discussed in the background section, the National Council for Protected Areas (CONAP), is charged with enforcing rules and controls on the extraction of xate.

The xatero is currently not asked to meet any requirements. The contractor must apply in writing for an extraction and transportation license from CONAP and pay Q0.05 for each pound of extraction proposed in his application. The license is granted for a period of one month, stipulating the amount of xate to be extracted in that time. CONAP personnel do not verify the amount of xate extracted, so contractors often report less than they transport to evade payment. This also makes it impossible to quantify the amount of xate harvested, or from which region it is harvested, both important for the future management of forest production levels.

To export the leaves, the exporter must present the following to CONAP: registration of the individual or legal representative engaged in the xate trade; a certificate from CITES; a commercial invoice; a waybill; and receipts for the payment of taxes and revenue stamps. The exporter must also present a plant health certificate issued by the Directorate General of Agricultural Services and documentation issued by CONAP to the export department of the Bank of Guatemala.

Up to September 1990, exporters did not pay taxes on the exports they made, nor did Customs check the quantity in kilos of xate exported, an obvious advantage for exporters which probably has not changed.

To enter into the United States, xate is subject to inspections for the control of diseases by the Animal Plant Health Inspection Service (APHIS) of the USDA, the Plant Protection and Quarantine Division (PPQ). APHIS-PPQ inspectors examine between 2% and 7% of each shipment before allowing it to pass into the hands of the importer (Heinzman and Reining 1990). Determination of the requirements of European countries is beyond the scope of this report.

These are the requirements which must be met at each level of the xate industry. In brief, there is a lack of administrative control, both in customs and in the field, a result of the lack of technical personnel and financial resources necessary to control the 7,500 km^2 Multiple Use Area of the Reserve. We return to this point in Section 5.6.

5.5 Harvesting Benefits

5.5.1 Gross Benefits

Tables 5.5A and 5.5B illustrate the distribution of gross benefits within the xate industry. For example, xateros capture 19.6% of the gross benefits resulting from the export of C. elegans, and 10.8% of those resulting from the export of C. oblongata.

Despite the devaluation of the quetzal by 100% in the last four years, from Q2.50=$1.00 to Q5.00=$1.00, the nominal price for xate received by the contractors and harvesters has not changed in the same time period. In real terms the wage paid to collectors has fallen

precipitously. Exporters have realized greater net benefits over the last two or three years because they receive payment in hard currency but pay most or all their costs in local currency. The general result of reduced net benefits for xateros is an increase in harvesting intensity, and further reductions in plant population densities.

TABLE 5.5A
Distribution of gross benefits for C. elegans extraction

Industry Level	Sales price (per gruesa)	SUBMARGIN Absolute	SUBMARGIN Relative	MARGIN Absolute	MARGIN Relative
Exporter	Q 5.10	Q 3.70	72.55%	Q 4.10	80.39%
Contractor	Q 1.40	Q 0.40	7.84%		
Harvester	Q 1.00				

Source: Field data, 1990. Rate of exchange Q.5.00 = US$1.00.
Assumptions: 50% loss in selection; one gruesa = 90 leaves.

TABLE 5.5B
Distribution of gross benefits for C. oblongata

Industry Level	Sales price (per gruesa)	SUBMARGIN Absolute	SUBMARGIN Relative	MARGIN Absolute	MARGIN Relative
Exporter	Q 6.50	Q 5.50	84.62%	Q 5.80	89.23%
Contractor	Q 1.00	Q 0.30	4.62%		
Harvester	Q 0.70				

Source: Field data, 1990. Rate of exchange Q.5.00 = US$1.00.
Assumptions: 50% loss in selection; one gruesa = 90 leaves.

5.5.1 Costs and Benefits for Harvesters

Net daily benefits for harvesters average at least Q9.14. This figure assumes that the xatero receives a daily gross income of Q15.30; the xatero cuts one half C. elegans and one half C. oblongata; cuts an average of 18 gruesas a day; and that the price per gruesa for C. elegans is Q1.00, and for C. oblongata Q0.70. The xatero's average costs are Q.6.16 per day, which includes working equipment and food. Camp food is the xateros' highest cost, the prices being inflated by contractors, reflecting both transportation costs to camps and profit. For xateros that work forests near home, net benefits are higher because they avoid the added costs of purchasing food in camps.

5.5.2 Employment

The level of employment generated by the extraction of xate is difficult to determine accurately due to a lack of reliable export data. However, we can establish an approximate value. We assume that 75 % of exports originate in the northern Petén; that 70% of exports to Europe are C. elegans and 30% C. oblongata; that 100% of the exports to the U.S. are C. oblongata; and that 50% of the harvest is discarded during processing. We also assume that an average day of harvesting yields 600 leaves of each species. We assume that each leaf of C. elegans weighs approximately 3.0 gm; each leaf of C. oblongata weighs about 10.0 gm. Given these figures and assumptions, employment generated in 1989 by xate extraction was 208,937 working days. We arrive at this calculation in the following manner:

Assumptions:

141,750,000 leaves of C. elegans harvested in 1989
108,975,000 leaves of C. oblongata harvested in 1989

250,725,000 leaves of both species harvested in 1989

Therefore, 250,725,000 leaves / 1200 leaves/working day = 208,937 working days. Assuming 17 workdays per month and that the average worker spends three months per year collecting xate, about 4,100 people are employed. Since many of these people are primary providers in a household, it is safe to sayt that nearly 4,000 households are supported during this time by this activity.

5.6 Sustainability

The xate industry is one of the major sources of employment in northern Petén, and is the largest employer among forest product industries. An unknown, yet significant number of agricultural households supplement their income with xate harvesting--often it is the only source of cash income in rural areas of northern Petén. Without it, people are forced to exercise their only alternative, that of cutting forest for food production.

The popularity of the industry is a result of its simplicity and the lack of other employment alternatives. There are few barriers to entry and no special skills or equipment are necessary. Moreover, for most of the year, there is international demand for the leaves, a demand that has been growing in recent years. Given the large and increasing colonist population, collection of this common-property resource is widespread.

Such widespread collection appears to be leading to over-harvesting, particularly of the more highly valued C. elegans, and threatening the long-term viability of the resource base.

There is little incentive for collective management and every incentive to harvest as many leaves as possible. Inefficiencies, which combine to produce a great deal of waste plague the industry.

High levels of waste, which commonly exceed 50 percent, can be related to several factors. First, even if a leaf is not marketable, if it has fungal growth or is too young, the xatero will often cut it anyway. He is paid for quantity, not quality, and it is best to collect the leaf before another xatero does. Second, many xateros don't know what the leaves are used for. Third, contractors also not only place quantity over quality, but they also wish to keep xateros in the camps, profiting by selling them food at a substantial markup and, in many cases, maintaining effective control over a forest region and its resources, including both legal forest products and illegal ones, such as archaeological artifacts and animals. But the industry bias of quantity over quality begins with the exporter: it is cheaper to ensure a sufficient export volume by buying many leaves and selecting only the good ones than by purchasing higher-quality leaves at a higher price.

This dismal assessment of the industry's sustainability can be balanced with two important factors. First, plant densities are still quite high. Second, with the establishment of the Reserve and CONAP, and the assistance of several international agencies, the outlook for effective regulation and management of the Reserve is quite good. We emphasize that current industry inefficiencies and incentives for overharvesting originated in an essentially unregulated environment.

The calculations presented below, as well as the summary recommendation for managing the xate industry, provide an important initial strategy for both attempting to reduce

harvesting impacts and to ensure the continued critical benefits this resource provides the region's inhabitants.

5.6.1 Potential Yields and the Forest Area Needed to Supply International Demand

We first calculate the potential yields per hectare in the three different areas. Potential yields are based on average plant densities of harvested size classes; i.e. > 31 cm in height for C. elegans; and > 41 cm for C. oblongata. The widely held view in the industry is that four leaves can be harvested from each plant annually. Actual leaf production will depend on factors such as the climate, the soil, and the level of harvest itself. We conservatively assume each plant can annually produce two leaves. Table 5.6 presents potential average yields for each area.

TABLE 5.6
Average potential yield (leaves per hectare per year)
of C. elegans and C. oblongata in three areas of the Petén.

	Chamaedorea elegans		Chamaedorea oblongata	
	density* (leaves/ha)	average yield** (leaves/ha/yr)	density* (leaves/ha)	average yield** (leaves/ha/yr)
Tikal	1,017	2,034	1,951	3,902
Yaxhá	799	1,598	771	1,542
Uaxactún	565	1,130	1,209	2,418
Average of Yaxhá and Uaxactún	682	1,364	990	1,980

Source: Field data, 1990.
* Assumes that only the larger size classes are harvested.
** Assumes an average yield of two leaves/plant/yr.

The lowest yield for C. elegans is in Uaxactún and for C. oblongata in Yaxhá, both significantly lower in comparison to Tikal. Studies in other regions (Galvez et. al. 1990) indicate yields can range between 1,116 and 1,521 leaves per hectare per year for both species. These data are from an area of high human population with historically greater harvesting pressure and are likely inflated as they assume a yield of four leaves per year. These data underscore the reduced potential economic value of forests near permanent populations.

Next we calculate the forest area needed to meet international demand, a value that is more difficult to determine accurately for several reasons. First, export data are unreliable. Second, the percentage of Guatemalan exports that originate in the Petén, estimated at 75%, are not accurately known. Third, we use population densities from two areas that may not be representative of other areas. Because our surveys were conducted relatively close to population centers whose inhabitants have probably had a substantial impact on nearby forests, we may be reporting density and yields that are not representative of more remote areas. Past overharvesting near communities has eliminated many plant populations. Xateros and contractors report much higher daily harvests per person in more remote areas, indicating higher density. Fourth, we report plant densities in one basic forest type, upland forest, which grades into other forest types, particularly ones without xate, over short distances. So while we can estimate the area of upland forest necessary to produce a given volume of leaves, it is difficult to estimate how much of this forest type exists in the Multiple Use Area and Buffer. Even so, the method presented here, while not completely accurate, is precise enough to establish baselines. In the future, with better forest vegetation maps,

subregional harvesting data, and export data -- all the focus of planned and current research -- it will be possible to establish how much forest is needed, to locate productive forest, and to regulate harvesting impacts through limited access, concessions, and/or rotations.

At present, with certain assumptions, we provide a range of values for the forest area needed to supply international demand by considering exports in the years 1987-1989 (Tables 5.7A and 5.7B). We assume 75% of exports originate in northern Petén; 70% of exports to Europe are C. elegans and 30% C. oblongata; 100% of the exports to the U.S. are C. oblongata; and 50% of the harvest is discarded during processing. For the potential annual yield per hectare for each species, we average the values for Uaxactún and Yaxhá, as presented in Tables 5.5.

TABLE 5.7A
Forest Area Necessary to Maintain a Probable Export Volume of C. elegans

	YEAR		
	1987	1988	1989
75% OF VOLUME EXPORTED (kg)	267,750	249,375	425,250
NO. OF LEAVES	89,250,000	83,125,000	141,750,000
FOREST AREA (km^2)	1,308	1,218	2,078

Source: Field data, 1990; Gremial de Productos No-Tradicionales.
Assumptions: Leaves lost in selection: 50%; 70% of exports to Europe; average weight per leaf, C. elegans: 3.0 g; average yield: 1,364 leaves/ha/yr (assumes 2 leaves/plant/yr).

TABLE 5.7B
Forest Area Necessary to Maintain a
Probable Export Volume of C. oblongata

YEAR	1987	1988	1989
75% OF VOLUME EXPORTED (KG)	707,250	781,875	1,089.750
NO. OF LEAVES	70,250,000	78,188,000	108,975,000
FOREST AREA (KM^2)	710	790	1,101

Source: Field data, 1990; Gremial de Productos No-Tradicionales.
Assumptions: Leaves lost in selection: 50%; 100% of U.S. exports and 30% of European exports; weight per leaf C. oblongata: 10 g; yield: 1,980 leaves/ha/yr (assumes 2 leaves/plant/yr).

Tables 5.7A and 5.7B must be interpreted cautiously, for all the reasons noted above. In general, however, the data do confirm the opinions of exporters who argue that C. elegans populations are being more heavily harvested; while C. oblongata populations are relatively healthy. Again, we underscore the fact that harvesting occurs not only in the 7,500 km2 Multiple Use Area, but in protected areas such as Tikal National Park and in the Buffer Zone--essentially anywhere the plants grow. Moreover, our calculations hypothetically assume a harvest level of two leaves per plant per year, a level we consider a sustainable rate of harvest based on current knowledge. Actual harvests are likely to be higher: xateros take all leaves except those significantly damaged by insect herbivory or those overgrown with lichens and mosses.

Looking to the future, forested regions beyond the Reserve's boundaries are not likely to remain forested. Extraction will become increasingly concentrated in the Multiple Use Area and the eight core protected areas. But, these core areas will become increasingly inaccessible as the enforcement abilities of CONAP improve. The result will be intensified harvesting of the Multiple Use area.

Without the xate industry, it is easy to assume there would be considerably less intact forest than at present. This is because xate and other NTFPs provide an attractive economic alternative for many inhabitants of the region, lessening their need to generate all their income from farming. The same logic indicates that the NTFP industries must survive, albeit in a more efficient form if forest conservation is to continue. Yet, the xate industry is the least sustainable and most problematic of the non timber forest industries.

5.7 Recommendations

- Reduce leaf waste through pricing and regulation. Decreasing the number of leaves discarded during processing requires that more high quality leaves arrive at the processing warehouses. In turn, this demands that fewer, higher quality leaves be harvested and damage during transport be reduced. This will entail a higher price paid to xateros, and the need to shift harvest from quantity to quality. For this to happen exporters will have to pay more for the fewer, higher quality leaves that contractors deliver. To be feasible, control will have to take place in the warehouses, and penalties will have to be consistently levied if waste exceeds a certain level.

- Improve wages for harvesters; halt the decline in real wages due to devaluation of the quetzal. Currently, regulatory mechanisms dictating benefit distribution across the industry exist for chicle; similar legally enforced distribution could be established in the xate industry. If costs of selection and transportation can be reduced because of reduced leave flow, it should be possible to increase the price xateros receive for their leaves without increasing the export price.

- Establish a series of defoliation experiments, with controls and replication will be established. Germination and transplanting experiments should also be conducted. These studies should be done in conjunction with the research discussed in the executive summary.

CHAPTER 6: ALLSPICE

Introduction

Allspice, locally called pimienta gorda, is the dried fruit of a common mid-canopy, evergreen tree, Pimenta dioica (L.) Merrill. It is one of the few widely-traded species native to the Americas and is found from southern Mexico to Panama and throughout the Caribbean Islands (Leon 1987).

There are two basic internationally traded allspice products: the fruit, which are generally dried and ground or distilled for oil, and the leaves, which are also distilled for oil. The ground fruit is used as a flavoring and curing agent in processed meats and bakery products, and also as a condiment for domestic culinary use. The oil is used along with the ground spice in meat products, as well as in fruit-based products and colognes (Purseglove et al. 1980). Because the oil is not produced in Guatemala, this discussion will focus only on the production of dried fruit.

In this chapter, we provide a botanical description of P. dioica, followed by a description of its ecological association and data describing regeneration, importance values, and harvesting techniques, all of which set the context for a discussion of harvesting impacts. We also discuss processing, market structure, distribution of gross and net benefits, and existing regulatory structures. We analyze the sustainability of current harvesting levels, calculating the forest area necessary to meet international demand. We conclude by providing a basic natural forest management strategy for the industry.

6.1 Botanical Classification and Description

The common names for the fruit of Pimenta dioica include: pimienta gorda; peensia (Cobán); pimienta de Chiapas; pens (Quekchí) and ixnabacuc (Petén, Maya), all in Guatemala (MacVaugh 1963); piment in Germany, France, and Denmark; kryddpeppar in Sweden; pepe di Giamaica in Italy; pimenta da Jamaica in Portugal; bahar in the USSR; and orusupaisu in Japan (Rosengarten Jr., 1973).

The English name allspice is a result of its aroma, which combines nutmeg, cinnamon, and cloves.

Allspice is a mid-canopy tree notable for a pleasant aroma that comes from all parts. It reaches 20 to 25 meters in height and between 30 and 50 cm in diameter. It has a straight to arcuate slender bole, with smooth, pale brown to grayish bark that peels away from the bole in thin layers. As is the case with the bole, the branches are hard, growing upward and splitting into other thinner branches (Orellana 1979).

Its leaves are abundant, simply opposite, 10 to 20 cm long in most cases, and the length of the leaves is 2 to 3 times their width. The upper side is smooth and bright dark green; the underside is clear with yellow points (Orellana 1979).

The flowers are grouped in very branchy panicles, 6 to 12 cm long. The stamens are like hairs and are very abundant. The corolla is made up of four white petals. The ovary is divided into two cavities with 1 to 2 ovules in each. The flowers are bisexual, but many male trees produce only a few infertile flowers. Thus, male trees produce little fruit, though their leaves contain more oil than those trees that flower abundantly (Rosengarten 1973).

The fruit is round and verrucose with oily convex glands. Generally two seeds are

compressed laterally, and the embryo is in the form of a double spiral (Leon 1987).

6.2 Ecology

In Guatemala allspice is found on limestone, at altitudes of 350 m or less above sea level (MacVaugh 1963). Above 460 m it is affected by fungal diseases which diminish production (Adams 1972). Allspice develops well in poor soil and often on steep slopes, provided high altitude and excess precipitation are not limiting factors (Rivera 1978). In the Reserve, allspice is commonly encountered on well-drained, shallow, stony soil, that is, in regions of upland forest as described in Chapter Three. It is also generally found on Maya mounds (Brokaw 1990).

P. dioica populations occur almost exclusively in groupings. These groupings (called manchas or spots) are often comprised of individuals of similar height and DBH, suggesting that regeneration occurs in the wake of forest disturbance. For example, one recent treefall hosted up to 20 juvenile plants (height < 1 m). Another site suggested how such regeneration may look after a period of years. A decaying bole, the remains of a windthrow from some years past, was flanked on either side by 12 individuals, each four to five meters in height.

6.2.1 The Habit and Flowering of Allspice

Allspice occupies an intermediate position in the forest canopy. The crown remains small as the plant tries to gain height during its first years of growth, broadening in a sufficiently large gap. Height at maturity is about 5 meters, though diameters remain small, genrally

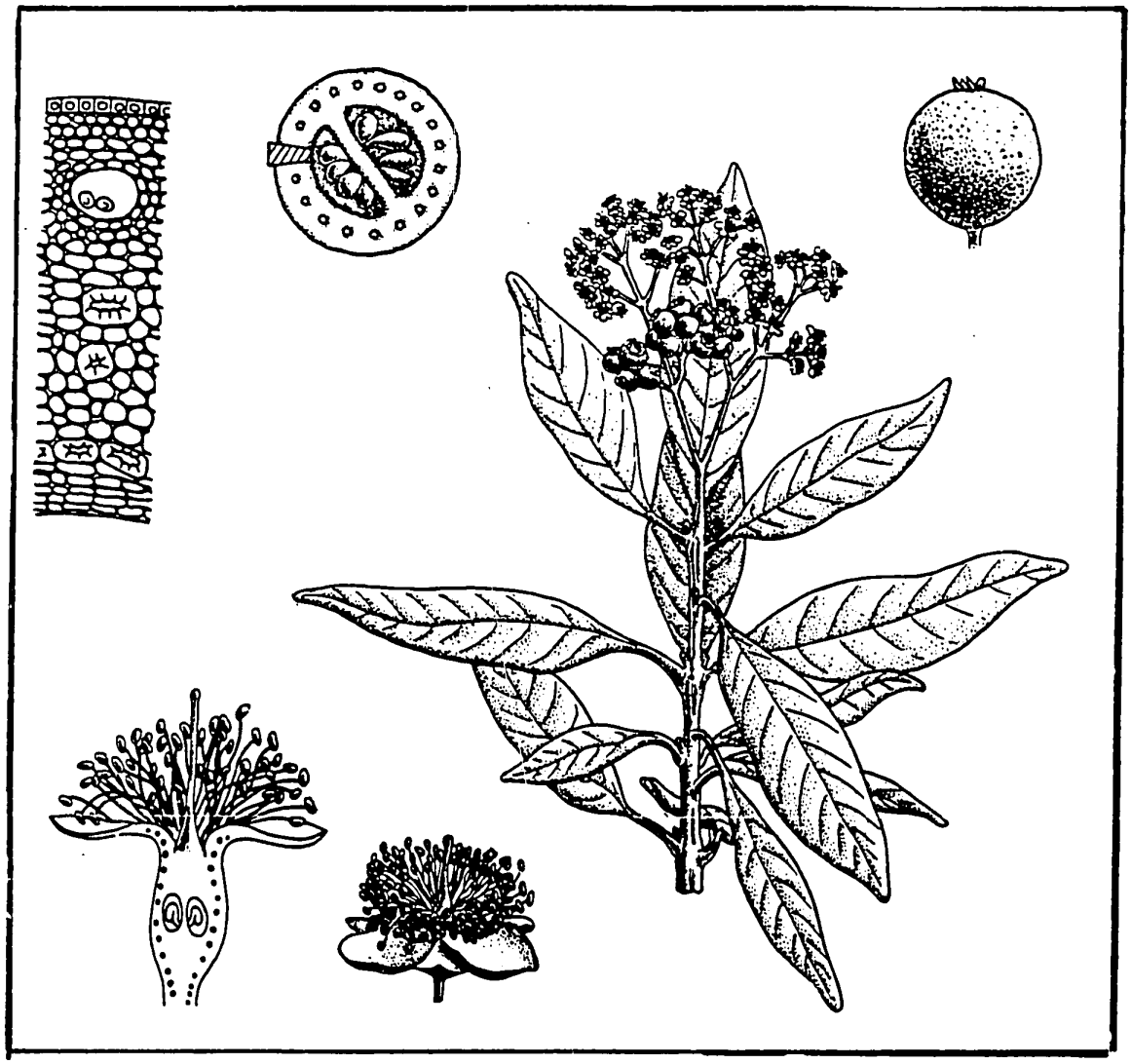

FIGURE 6.1

Botanical Drawing of P. dioica

When it has gained sufficient space, the tree begins to develop its diameter more than its height, and the bole begins to become more arcuate, often growing vertically at the base and becoming nearly horizontal near the crown. Rising vertically from the laterally growing bole, secondary branches reach into the upper canopy.

In plantations, the recommended ratio of male to female trees is 1:9, respectively, a ratio achieved by using vegetative propagation or seed selection. A random sampling of over 100 trees (DBH > 7 cm) during fruiting resulted in a ratio of 7:3. MacVaugh (1963) reports a ratio among natural forest populations of 1:1. Male individuals were assumed to be those with no flowers. It may be, however, that hail storms destroyed a great quantity of flowers prior to our investigation, reducing the number of visibly female trees. It may also be that fruiting trees experience increased mortality when harvested relative to nonfruiting individuals with the result that there is an increase in the number of nonfruiting male trees.

6.2.2 Basal Area, Population Density, Frequency and Importance Value

Field data on basal area, population density, and frequency, both absolute and relative, as well as importance values are presented for three of the regions studied: Carmelita, Uaxactún, and Yaxhá (Table 6.1).

The Uaxactún region has both significantly greater basal areas and number of trees per hectare relative to the transect data taken from the regions of Carmelita and Yaxhá. P. dioica populations near Uaxactún also have a higher relative frequency than encountered near Carmelita. Relative data were not acquired for Yaxhá.

Absolute densities near Carmelita and Yaxhá are not significantly different, although

Yaxhá has a slightly greater population density.

TABLE 6.1
Basal Area, Density and Frequency of P. dioica in Petén.

Region	Basal Area (m^2)	Density. (ind./ha)	Freq.	Rel. Basal Area	Rel. Density	Rel. Freq.	Importance Value	N
Carmelita								
Mean	0.27	9.0	0.50	0.01	0.03	0.18	0.21	24
Standard Dev.	0.27	5.6	0.51	0.01	0.02			
Standard Error	0.06	1.14	0.10	0.00	0.00			
Uaxactún								
Mean	1.31	31.0	0.91	0.05	0.08	0.32	0.45	45
Standard Dev.	1.04	6.1	0.29	0.04	0.03			
Standard Error	0.16	0.9	0.04	0.00	0.00			
Yaxhá								
Mean	0.31	12.0	0.62	Relative data were not obtained for this area				56
Standard Dev.	0.30	5.8	0.49					
Standard Error	0.04	0.79	0.06					

Source: Field work, 1990.

6.2.3 Regeneration

Regeneration data are also presented for each region and grouped in three ranges, categorized by height. In summary, Uaxactún has more regeneration, although there is no significant difference for the majority of comparisons (Figure 6.2). The only exception is in the smallest category (0-1 m), where densities near Uaxactún are significantly higher than for the other two regions.

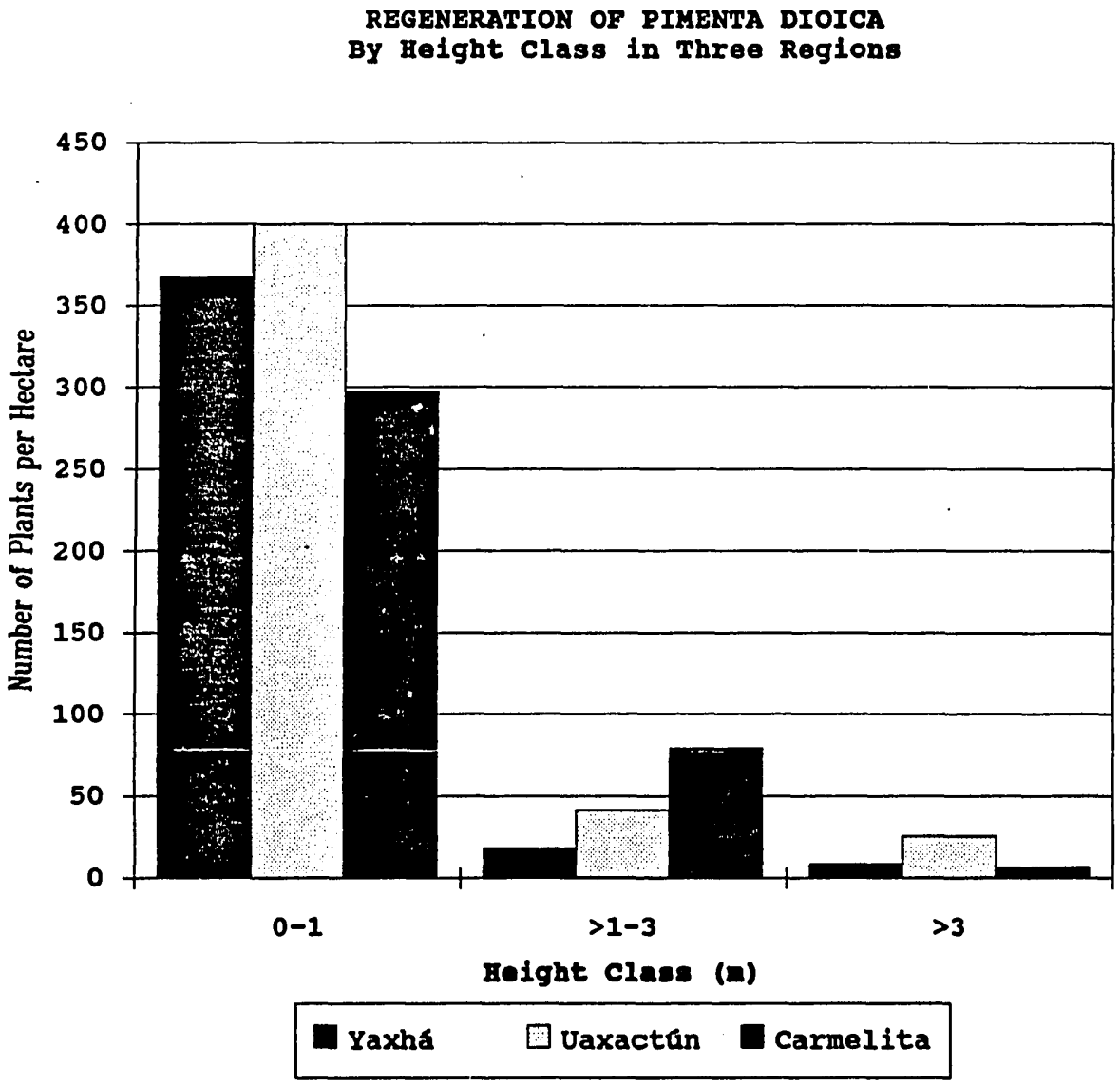

FIGURE 6.2

P. dioica regeneration by height class in three regions of northern Petén.

6.2.4 Comparison with other economically important tree species

The importance value (IV) is used by botanists and ecologists as a relative index of the importance of tree species. The IV does not use units: it is the sum of the relative frequency, the relative density, and the relative basal area across all plots surveyed. The highest possible for the importance value is thus 3.0.

TABLE 6.2
Comparison of allspice (Pimienta) with ramón (B. alicastrun) and Chicozapote (M. zapota)

Region	Species	Basal Area (m^2)	Density (Ind./ha)	Freq.	Rel. Basal Area (m^2)	Rel. Density	Rel. Freq.	Importance Value
Carmelita	Chicozapote	2.10	47	0.96	0.23	0.12	0.36	0.70
	Ramón	3.70	4	0.88	0.17	0.12	0.36	0.65
	Pimienta	0.26	9	0.50	0.01	0.03	0.18	0.21
	Other species	11.56	327	1.00	0.56	0.73	0.43	1.72
Uaxactún	Chicozapote	4.35	33	0.93	0.16	0.08	0.33	0.58
	Ramón	5.26	39	0.89	0.20	0.11	0.31	0.62
	Pimienta	1.31	31	0.91	0.05	0.09	0.32	0.45
	Other species	14.94	318	1.00	0.56	0.72	0.37	1.6
Yaxhá	Chicozapote	4.33	23	0.30				
	Ramón	3.12	21	0.80	Relative data are not			
	Pimienta	0.31	12	0.62	available for this area			
	Other species			1.00				

Source: Field work, 1990.

The IV for P. dioica is less than those for two other common forest trees, chicozapote (Manilkara zapota) and ramón (Brosimum alicastrum). This is less the case for the Uaxactún region, where P. dioica densities were highest. The differences in the IV are due principally to the greater bole size of both ramón and chicozapote. The high value of the sum of the IVs for these three species reveals that they are important components of the forest communities in which they occur, underscoring the economic importance of these forest resources.

6.2.5 Size Class Distribution

The size class distribution is typical of an uneven aged forest: the number of individuals decreases as DBH increases. Figure 6.3 depicts the diameter size class distribution of a random population of P. dioica near Carmelita, a population representative of transect data from other regions. The diameters of smaller classes (5-15 cm DBH) include the greatest number of individuals (55-75%). In general, a decrease in the number of individuals per size class is stabilized after 20 cm diameter, and there are few trees which grow beyond 35 cm, although individuals with diameters over 55 cm were encountered.

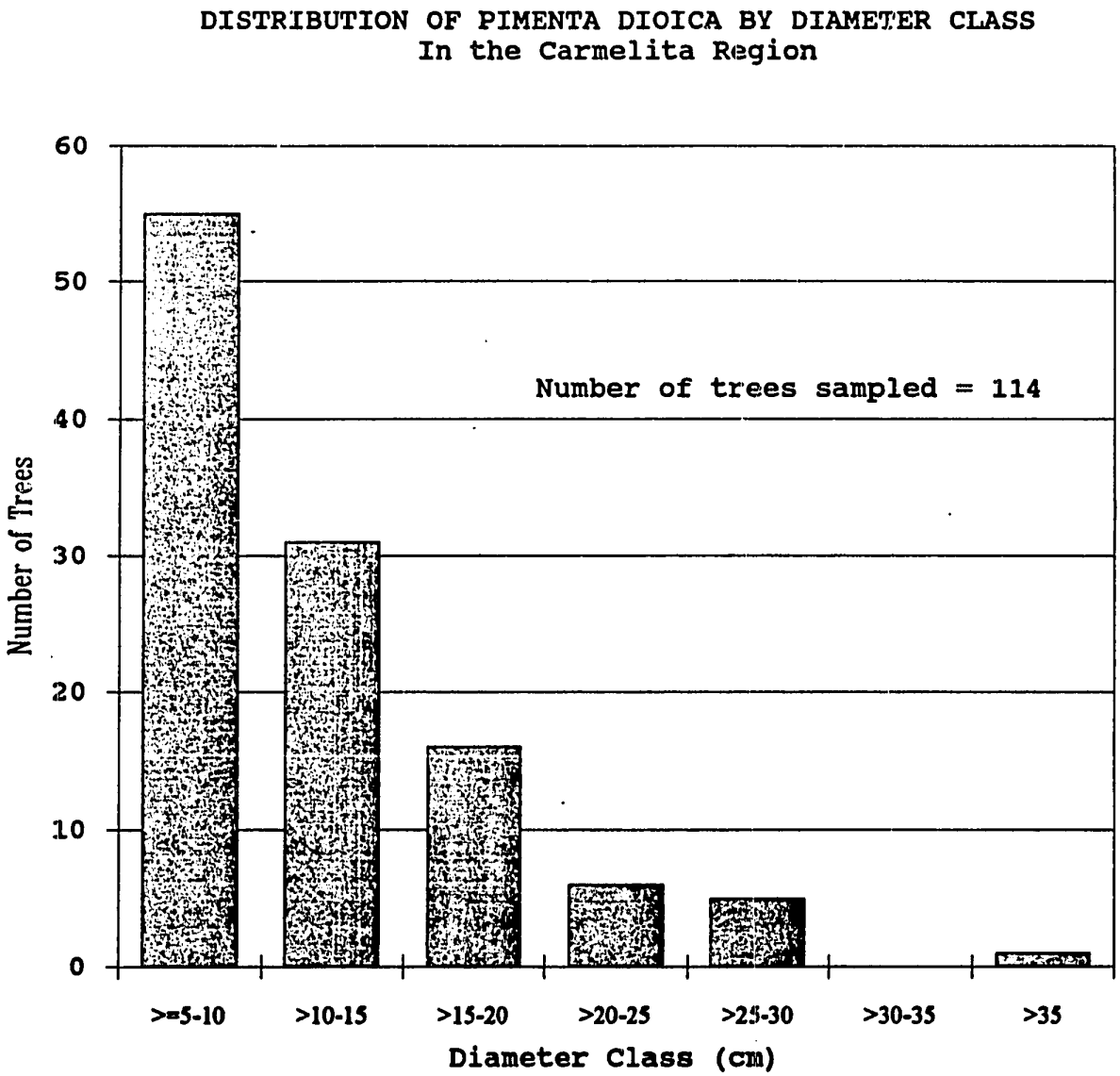

FIGURE 6.3

Distribution of *Pimenta dioica* by diameter class in the Carmelita region.

6.3 Harvesting and Processing

6.3.1. Technique

The equipment needed to harvest allspice consists of a pair of climbing spurs with belts, rope, machete and file, a bag, and a plastic sheet.

The process includes the following stages:

Stage 1: Climb and Tie. Climbing spikes (like those used to climb telephone poles) are used to climb the tree. Sometimes when the tree is not very thick, the rope is not used; the harvester, called a pimientero, holds on with his hands, kicking the spikes into the tree as he climbs toward the crown. When the tree is thick, a rope is tied around both the tree and the man, who leans away from the bole, holding himself with the spikes set into the bark of the tree. When the main branches are reached, and depending on the degree of difficulty, the pimientero ties himself to the tree for safety.

Stage 2: Thinning. Fruit-bearing secondary branches are cut with a machete, and let to fall to the ground below. Often pimenteros take care to leave the apical part of the tree so that it will not die. But the tree is essentially coppiced, with little of the crown remaining.

Stage 3: Cutting and Cleaning. Upon his descent, the pimentero joins with his fellow workers and begins to cut and separate small sections of the fruit-laden branches. The fruit is then stripped from the branches and placed on a plastic sheet. All impurities--leaves, branches, and vegetable matter--are removed before putting the fruit into bags.

The pimentero carries the fruit to the camp or toward other trees that will be harvested. Long distances are covered every day, often 10 or more kilometers. In camp, a person in charge of receiving and weighing the product records each harvester's production. This

person also accounts for each harvester's food consumption, deducting it from the harvester's wage.

Allspice fruit can be dried over fire, in the sun, or with hot air by means of large mechanical driers. The first two low-technology systems are the most common in capital-scarce Petén. Figure 6.3A illustrates the sun-drying method.

To dry the fruit over the fire it is necessary to build a tapexo. This consists of raising a log platform one meter above the ground, four or more meters long and less than one meter wide. A metal screen with openings of one to two mm is placed on top. Along one length a heat-retaining clay and log wall is built from the floor to the platform.

The platform is at times placed over a ditch about one meter deep, eliminating the need for the wall. This construction, locally called an oven (horno), offers the advantage of greatly reducing firewood requirements, though construction is more labor intensive. Both types are protected from rain with a thatch roof.

For drying, two people are required, one to dry and one to collect firewood. The green fruit is spread over the screen. Below, on the ground or in the ditch, large logs are slowly burned. The person doing the drying must constantly move the fruit with a wooden shovel.

Drying allspice over fire is done in the camps as soon as possible after the fruit has been received, for three reasons. First, moist allspice ferments and decomposes very quickly. Second, the camps are usually far away from roads suitable for motor vehicles, making it necessary to use mules for transporting the berries. Dried berries weigh 60% less than undried berries, greatly reducing the number of mules needed, and hence transportation costs. Third, fire dries berries in 1-2 days; sun-drying often requires up to 10 days . In

addition, fruiting and harvesting occur during the rainy season: both cloud cover and rain conspire against effective sun-drying. Some people argue that sun-drying produces a higher quality product than fire drying, though opinions differ. Others argue that quality is not affected either way. In any case, the price does not vary according to type of drying but rather according to size.

The dry product is transported by the contractors to Santa Elena or to San Benito, where it is delivered to the exporters. The exporters usually spread the allspice in concrete yards to homogenize and complete drying. There are two ways of knowing when the product is dry: 1) a handful is taken and shaken near the ear. If ready, the dried seeds will rattle inside of the hardened berry. 2) The fruit is bitten and, if ready, will split easily in two.

6.4 Harvesting Impacts

The effects of coppicing individuals of P. dioica range from a reduction in the rate of growth and fruit production to mortality. Production decreases because each tree harvested will not bear fruit again for four to six years, the time necessary to form a new canopy, flower, and fruit. On plantations, production occurs annually, a result of harvesting techniques that harvest only fruit-laden, tertiary branches.

As already suggested, decreasing the number of females through harvesting-induced mortality increases the ratio of males to females. It is also possible that increased harvesting will reduce regeneration, both by removing a source of seeds and by reducing the ability of the plant to produce fruit because of the loss of so much leaf area. Yet, while pimenteros do report some mortality among harvested individuals, it is very low, a view substantiated by

FIGURE 6.3A

Allspice being sundried in a small town. This method of drying can only be used if the allspice is harvested a short distance from town. Otherwise the berries must be dried over a fire to reduce weight before being brought out of remote camps.

the fact that we encountered few dead individuals.

That harvesting impacts are low may also be reflected by transect data from Uaxactún. Despite decades of harvesting, plant populations have significantly higher population densities, relative frequencies, basal areas, and regeneration (0-1 m size class) relative to other areas studied. There are several possible explanations. First, Uaxactún harvesting levels are not high enough to reduce plant population densities or productivity. Second, original densities in the Uaxactún region were higher. Third, harvesting impacts are greater in the other two regions. Based on the observations of long-time pimenteros, we favor the first explanation, that harvesting levels are not high enough to significantly impact the population, though further study is needed to test this hypothesis.

Currently, the greatest impact stems from harvesting by recent colonists. Often from the south of Guatemala, they are unfamiliar with tree climbing. Instead of risking the hazards of climbing the slender, smooth bole of P. dioica, they fell trees in order to access the fruit-laden canopy.

Some birds of the Psittacide family (parrots, parakeets, etc.) and the toucan (Ramphastos sulfuratus) also feed on the fruit of this plant, but there is no information as to the intrinsic dependency of these birds on this food source.

6.5 Market Structure

6.5.1 Supply

The ancient Maya used allspice to embalm the bodies of people held in esteem. It is suspected that they also used it as a medicinal plant and to flavor certain foods. Allspice

fruit are currently used by people in the region to season food, the leaves are used to make tea, and the wood is sometimes used in construction.

According to people long engaged in the extraction of allspice, commercial exploitation in the Petén began in 1959. The United States began importing Guatemalan allspice in 1954, possibly production from the Petén, or possibly plantation production (Rodriguez 1969).

Mean annual exports of allspice from Jamaica, the world's largest producer, vary between 3000 and 4000 metric tons, with a value of $5 to $7 million. This represents about 70% of global production (prior to World War II Jamaica supplied 90%).

Jamaican allspice, because of its taste, appearance, and size, is considered the highest quality and commands the best price. The remaining 30% of world production comes from, in order of importance, Guatemala, Mexico and to a lesser extent, Belize, Honduras, Brazil and the Leeward Islands (Centro 1987, Rosengarten 1973).

The Petén is not the only source of allspice in Guatemala. Plantation production occurs in the departments of Alta Verapaz, Santa Rosa, Suchitepequez, Quetzaltenango, and San Marcos. Both industry representatives and the literature report that the greatest production, approximately 70%, comes from natural forest production in northern Petén (Digesa 1979, Orellana 1979).

Exports of allspice from Guatemala have increased in the last few years, the principal buyer being the United States (USDA 1983). Exports in 1985 were 301,501 kg, increasing slightly in 1986 and reaching 416,833 kg in 1989.

It is clear that Guatemalan reporting practices are highly inconsistent with US import data. For example, in 1988, the USDA indicates that 61.1 metric tons of allspice, worth

$94,800, was imported from Guatemala. The same year Guatemala reported a shipment of 16.1 metric tons. In 1989, the USDA reports 184.2 metric tons, while the Guatemalan data lists exports to the U.S. of 274.4 metric tons (USDA 1990).

6.5.2 Demand

Importing countries are almost exclusively industrialized. The most important buyers are the former Soviet Union, the United States, and Germany (Centro 1988). In the last 30 years there have been certain fundamental changes in the world market for allspice which have affected demand. Most importantly, the use of the spice as a preservative has been reduced with the growth of refrigeration and cold storage. In particular, the international fishing fleet, which was one of the main markets, no longer uses allspice as a preserving substance. The former Soviet Union is an exception, still using allspice as a fish preservative.

There are no ready substitutes for allspice in either ground or essential oil form. This is particularly important in the meat canning, meat processing, and bakery industries, which accounted for 65 - 70% of the market for allspice in 1980. Thus, "there is no reason to suppose that world wide consumption of [allspice] will decline in the long run....there is no reason to suppose that the future growth in the market will be much less than the growth in its principal application, namely the market for prepared foods" (Purseglove et al. 1981).

TABLE 6.3
Total Guatemalan exports of allspice to selected countries, 1985-1989

Year	Country	Kilograms
1985	Cyprus	83,000
	United States	71,156
	Germany	41,552
	Others	105,333
	TOTAL	301,541
1986	United States	169,592
	Germany	130,862
	Saudi Arabia	38,675
	Others	55,449
	TOTAL	394,578
1987	United States	123,301
	Netherlands	23,364
	Canada	10,000
	Others	7,849
	TOTAL	164,514
1988	Lebanon	101,320
	Saudi Arabia	40,500
	United States	61,100
	Others	87,501
	TOTAL	290,421
1989	United States	184,200
	Cyprus	108,608
	Germany	89,732
	Others	34,293
	TOTAL	416,833

Sources: Summary, Guatemalan Plant Quarantine Department 1983-1989; Field data, 1990; United States Department of Agriculture, Foreign Agricultural Service (USDA 1990).

Countries which have bought allspice from Guatemala in the last five years are the United States, Belgium, Jordan, Israel, Germany, the Netherlands, Saudi Arabia, Finland, Dubai, Kuwait, Cyprus, El Salvador, Nicaragua, Canada, Denmark, Honduras, England, Lebanon, and Costa Rica.

6.5.3 International Competition and Pricing

International production of allspice occurs in the months of June to October, depending on the particular environmental conditions of countries such as Mexico, Guatemala, and Jamaica. Jamaica starts production in June, preceding Guatemala and fixing the future price received by Guatemalan producers. Guatemala must sell its production before Jamaica saturates the market, which occurs in September (Representatives of Multiexport, Exportaciones Multiples, S.A., Pers. Comm. 1990). Prices fluctuate with market speculation, as allspice futures--pre-harvest speculative prices traded on the stock exchange--are an international commodity. Both the size of the Soviet fish catch and the Jamaican harvest have the greatest affect on the price. In some years, the price is so low that the fruit remains uncollected. In other years, low prices allow for some harvest, though only through specific market channels. Table 6.4 illustrates New York spot market prices for Guatemalan allspice.

Table 6.4
Approximate Average Annual New York Spot Prices for Guatemalan Allspice

Year	Price ($/lb)	Year	Price ($/lb)
1980	0.84	1986	0.93
1981	0.98	1987	0.98
1982	1.01	1988	0.84
1983	1.11*	1989	0.80
1984	1.17*	1990	0.83*
1985	1.09		

* Some months are missing, so prices are based on the average of available months.

Source: USDA 1990.

6.5.4 Market Channels

There are three marketing channels for allspice. Channel 1 is the principal channel, particularly in years when the international price is high, thus engaging the interest of large contractors (Figure 6.4). When production levels or prices are low, channel 2, production around communities, accounts for the greatest volume because camp-based production is not profitable. Channel 3 is the least important.

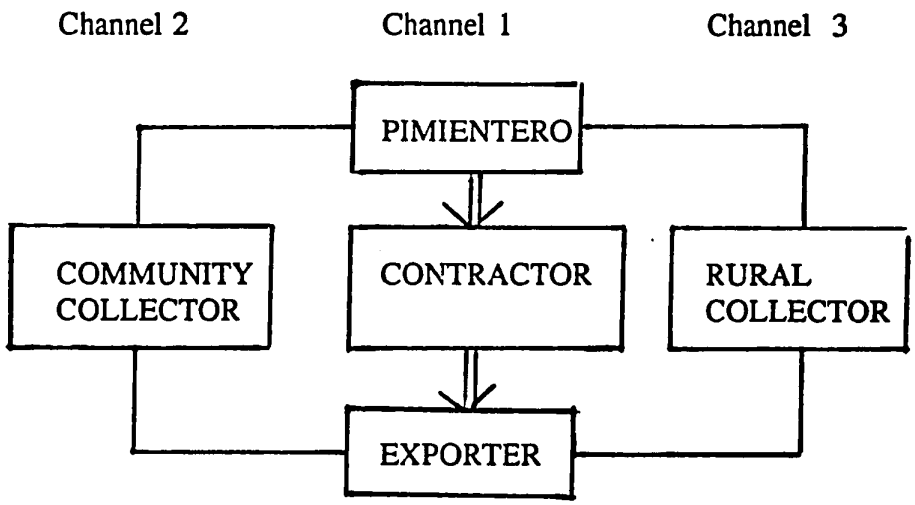

FIGURE 6.4
Structure of the Allspice Industry

The pimentero harvests and transports the fruit from the trees to the camp or community. The pimentero delivers the product green and wet, and the product is measured by weight. There are two types of [illegible] lost are contracted: they enter into agreements with the contractors and are taken to the forest areas where they set up camps with about 20 people or more, remaining there for at least 20 days. Often, these individuals are also chicleros,

contracted by businessmen who work both allspice and chicle. The reason for this is environmental: P. dioica harvesting occurs during fruiting, from mid-July to the end of August and, in some years, into September. Chicle extraction begins in September. The same camps and transportation infrastructure can be used, thereby cutting costs for both harvesters and contractors.

The second type of pimentero is independent, usually an inhabitant of one of the Reserve communities, working nearby forests. For example, working as an independent harvester is more typical of the Uaxactún region. It is more accessible by higher quality roads and it is flanked by hills, and thus upland forest. Finally, harvesters receive better prices because contractors do not have transportation expenses from distant forest camps.

Around communities, often other family members, such as children and women, participate in harvesting. While the man cuts the branches into small sections, the other members of the family remove the fruit. For camp-based production, the pimenteros often work in groups of two to three for more efficient harvesting.

The contractor makes agreements with several harvesters, transports them to the camp by truck, or to the point where forest trails lead to camps. He stocks the camps with food, and buys the camp's production, paying persons with the necessary expertise to dry the allspice and monitor each individual pimentero's production. The agreement is generally for one month, the contractor often advancing money to pimenteros prior to harvesting. The contractor takes the product to exporters in Santa Elena and San Benito.

The exporter buys the allspice from contractors, often arranging their licenses and paying their export taxes, and advancing cash for their operations.

The community collector lives in a town inside the Reserve. The business relationship is quite simple: independent pimenteros come to his or her house to sell; the allspice is weighed and the pimentero paid. There is no contract in these cases. The community collector sees to the drying, sometimes over fire, sometimes in the sun, while waiting for the arrival of a buyer.

The rural collector has functions similar to those of the contractor, but on a smaller scale, and he usually transports the product by mule. Moreover, he dries the product himself.

6.5.5 Legal Requirements

CONAP is the license-issuing authority to contractors. A license is necessary to transport allspice out of the Reserve.

The steps to obtain a license are:

- present documentation to CONAP to be registered as a contractor;
- fill out an application for export of wild flora and fauna; and
- present to the Bank of Guatemala, together with the above documents, specific information on the product, such as quantity, species, form, weight, place where extracted, export destination, customs exit point, and date when export will be made.

6.6 Harvesting Benefits

6.6.1 Employment

Table 6.5
Average allspice yields per day per person in northern Petén.

Source	Sample Size	Weight green kg (lbs)	Weight dry* kg (lbs)
Contractors' records and field measurements (1990)	140	14.6 (32.2)	5.8 (12.9)**
Interviews with harvesters (1990)	60	21.7 (47.8)	8.7 (19.1)**

* Estimated ratio of green quantities to dry quantities: 2.5:1. This ratio is based on interviews and surveys of contractors records. Actual weight loss in drying was not measured due to time constraints.

** Estimated quantities.

Table 6.5 provides data for the daily average production per person. The year of the study, 1990, was considered a bad year for the production of allspice probably as a result of hail or rain during flowering. For this reason, pimenteros and contractors agree, the data obtained from records and direct measurements are lower than those for interviews. The average of the two--18.1 kgs/day of green berries--provides a more representative value for the average daily production per person.

In 1989, Guatemala exported 416,833 kgs. We assume, as indicated by exporters, that 70% of the production came from the Reserve. Given the average daily harvest of 18.1 kgs green, we can calculate the level of employment provided by the industry in 1989 as follows:

416,833 kgs x 0.70 = 312,625 kgs

312,515 kgs dry x 2.5 (ratio of green to dry berries) = 781,562 kgs green

781,562 kgs green berries/18.1 kgs green berries/day = 43,180 person-days

If the harvesting period lasts two months and a person works 17 days a month, then we estimate that about 1,270 people were employed in the Reserve, each harvesting an average of 615 kgs of green fruit over the two month period. This number probably underestimates total employment because often whole families are involved the extraction process, but only one representative of that family or group actually turns in the berries.

6.6.2 Gross and Net Benefits

Table 6.6 presents the gross and net benefits and costs incurred at each level of the industry, noting the percentage of benefits received at each level.

TABLE 6.6
Detailed gross costs and benefits of allspice extraction at various levels in the extraction network.

	INDUSTRY LEVEL				
	Harvester[1]		Contractor[2]	Urban Collector[2]	Exporter[2]
COSTS	Independent	Contracted			
Equipment	0.70	0.70	2.00	1.00	--
Food	1.50	5.50	--	--	--
Personnel	--	--	6.00	6.00	2.00
Transport	--	--	15.00	--	3.50
Packing	--	--	--	--	10.00
Taxes	--	--	--	--	3.00
Other (10%)	0.22	0.62	2.30	0.70	1.85
Amount paid for product	--	--	120.00	180.00	225.00
TOTAL COSTS	2.44	6.82	145.30	187.70	245.35
GROSS BENEFITS	22.00	16.00	225.00	225.00	300.00
NET BENEFITS	19.54	9.18	79.70[3]	37.30	54.65
	(Average = 14.36)				

Source: Field data, 1990. Q5.00 = $US1.00.
[1] Costs and benefits per day; average daily harvest of 18.1 kg (40 lbs)
[2] Costs and benefits per quintal (45.4 kg; 100 lbs)
[3] Does not consider profit made from selling food in camps

6.7 Sustainability

Ecologically, harvesting impacts appear low. This is probably more a result of relatively low harvest levels than low impacts on each individual. Economically, allspice is the least important internationally traded NTFP. Yet, harvesting occurs at a time of year when xate

demand is lowest, offering an important source of employment and household income. In years of high international prices, the allspice industry is closely integrated with chicle production, cutting costs in both industries. In years of low prices, allspice provides important income for households in the Reserve's communities. In sum, the industry's importance is best understood within the annual cycle of household income generating activities for households.

If the market provides sufficient demand, growth in exports is likely to be ecologically sustainable. Of course, additional research will have to be conducted and management practices monitored to determine a sustainable level of harvest. The following discussion presents important data and recommendations for future management of P. dioica populations and regulating the industry.

6.7.1 Potential Yields and Forest Area Needed to Supply International Demand

We obtained a value of 2.3 kg dry as the average yield per tree from 40 trees during the 1990 season (Table 6.7). This value is 44% of the production levels obtained from grafted trees in plantations in Jamaica, and approximately three to six times the annual production of plantation trees in Jamaica, which ranges from 0.4 to 0.9 kg dry per tree. We assume that the data from Rosengarten (1973) is the average annual yield per tree (Table 6.7).

TABLE 6.7
Average allspice yield per tree in northern Petén and in Jamaican plantations.

Source	Sample Size	Quantity green kg (lbs)	Quantity dry kg (lbs)
Petén average production per tree every 5 years*	40	5.7 (12.5)	2.3 (5.0)
Petén average production per tree averaged over 5 years	n/a	1.15 (2.5)	0.45 (1.0)
Jamaica production**	n/a	3.3 (7.3)	1.15 (2.5)
Average annual production of 50-year-old grafted trees in Jamaica***	35	13 (28.6)	5.2 (11.4)
Average annual production of young trees over 5 years old, Jamaica***	60	1.1-2.3 (2.4-5.1)	0.4-0.9 (1.0-2.0)

Sources: * Rosengarten. 1973
** Purseglove et al. 1981. Dry weight is assumed to be 40% of reported green weight.
*** We assume that a female tree can be coppiced every five years for berries

The average yield per hectare for each of the three regions studied is presented in Table 6.8. Densities range from 9 to 31 trees per hectare in the three regions for trees greater than or equal to 5 cm DBH. We assume a ratio between male and female individuals of 6:4, which is the average of our field data and of values from the literature (see Section 6.2.1). For our purposes, we use a yield of 2.0 kg dry/tree, a value 13% less than the 2.3 kg average yield obtained in the field. Finally, assuming that only 20% bear fruit in any given year (5-year rotation) and that only trees greater than 10 cm DBH are harvested, we obtain

an annual yield ranging from 0.8 to 3.3 kg/ha of dry fruit, for a weighted average of 1.8 kg/ha/yr.

TABLE 6.8
Average yield per hectare in the three regions and the forest area needed to supply international demand of 312,625 kg in 1989.

Region	Density per ha DBH	% > 10 cm	Yield dry kg/ha/yr (lb/ha/yr)	Forest area needed to supply 312,625 kg (km^2)
Carmelita	9.0	54%	0.8 (1.7)	3,908
Uaxactún	31.0	67%	3.3 (7.3)	947
Yaxhá	12.0	64%	1.2 (2.7)	2,605
Weighted Average	17.3	64%	1.8 (3.9)	1,737

Source: Field data, 1990.

Assumptions: Yield of 2.0 kg/tree/5 years; 40% female trees; only trees of DBH > 10 cm are harvested; 75% of exports come from Petén; 1989 export data.

Table 6.8 also presents a range of values for the area of upland forest needed to supply international demand, assuming that 75% of the allspice exported came from the Reserve. As with xate, we must be cautious in drawing conclusions. We do not know how much forest containing P. dioica exists. Even so, increased exports could be promoted without substantially harming the population. This assumes that harvesting practices are improved and that year-to-year monitoring programs are implemented, as recommended below.

The forest areas estimated in Table 6.8 reflect present methods of extraction. If these methods are improved so that each tree can be harvested more frequently than every five

years, harvests could increase without bringing additional forest into production.

6.8 Recommendations

- Find new markets for Petén allspice. Based on our field data, this resource currently faces little danger of overexploitation, so production could increase significantly. Of course, production still must be carefully monitored and new harvesting and processing techniques implemented. Much more information is still needed about population densities, production levels, etc, as described in needed research, above.

- Explore alternatives to current extraction techniques. Total coppicing of female trees is the current harvesting technique. We recommend that the production systems in Jamaica and Mexico be assessed for different harvesting techniques and that these improvements be passed on to harvesters and contractors through some kind of training course.

- Develop methods to extract the essential oils from the allspice leaves, thereby using male trees as well. Steam distillation techniques can be relatively simple. Jamaica is the only major producer of this essential oil. Secondary processing of allspice should be investigated, with emphasis on the production of essential oils. Essential oil production allows use of leaves, including the leaves of male trees, so the leaves of coppiced branches could be used, as could a larger percentage of the trees overall.

- Improve the wages and working conditions of the forest harvester. Like the xatero, and unlike the chiclero, pimenteros have suffered as a result of the devaluation of the Quetzal. In addition, must be improved and the harvester must be more directly involved in management decisions regarding these and other forest resources.

- Improve the value of the product on world markets. The sale of allspice produced in the Petén should be better coordinated with production in other countries, and with the demands of large buyers to improve prices. It may be necessary to build storage facilities. Spice quality could also be improved with some simple changes in drying and sorting techniques, such as reducing the practice of drying allspice berries over an open fire. Guatemalan allspice, about 75% of which comes from wild stands in the northern Petén, is of much lower quality than Jamaican or Mexican allspice. The problem is that the Guatemalan berries are variable in size and color while often having a smokey taste and smell to them, a result of being dried over an open fire. Most of the product from Jamaica and Mexico is dried in the sun, usually on concrete patios or plastic mats. One idea, therefore, is to improve the drying methods in the field in the Petén and to increase the uniformity of the berries by improving sorting techniques.

CHAPTER 7: CHICLE

"The Northern Petén contains the richest sapodilla forest in the world."

--C.S. Lundell, Vegetation of the Petén, 1937

Introduction

In the forests of Petén, Manilkara zapota (L.) van Royen is a dominant forest tree that is exploited for a chewing gum base called chicle. This sticky white latex is extracted from incisions made on the bole and main branches.

Historically, the extraction of chicle has been a very important source of employment in Petén, second only to agricultural production. Prior to 1970, chicle exports generated greater revenues in the region than any other activity. Hence, chicle, and the men who harvest the latex, the chicleros, and their families, together are a critical historical force behind the current day forest society of the Maya Biosphere Reserve region. Tapping trees for the latiferous resin is a rainy season activity, beginning at the end of the allspice harvesting season in September and ending in January or February. Chicle tapping is the most lucrative of the non timber forest products, a fact reflected in a highly organized market, long-established government regulation, high profits and the pride of the chiclero culture, the chicleros being the most skilled of forest workers.

In this chapter, we provide a botanical description of M. zapota, a general description of its ecological association, and observations on its variability and physiology. Data on density, age and size class distribution, regeneration, and importance values are also presented. Harvesting techniques are described, with a detailed account of processing,

providing a context for discussing harvesting impacts. The industry's history and current market structure, including cooperatives and labor unions, regulatory efforts, and distribution of harvesting benefits are outlined. We discuss the sustainability of the harvest, calculating the area of forest needed for current demand. We conclude with a basic NFM strategy for ensuring the future viability of the industry.

7.1 Botanical Classification and Description

Chicozapote is the common name given to M. zapota (Sapotaceae) in the Petén, a forest native from Mexico to Costa Rica. It is also called mui (Quekchí), tsaput (Quiché), ya (Maya), and sapodilla. M. zapota reaches up to 40 m high with a small and asymmetric crown. The bark is brown and coarse. Internally it is pink, fibrous, with abundant, sticky milky white exudate (chicle). The rot-resistant wood is creamy pink to red in color, and is very hard. The leaves are dark green, bright on the upper side and pale green on the underside, 5 to 12 cm long and 3.5 to 5.5. cm wide. Solitary flowers appear on the leaf axils, and they have a calyx with six sepals. The corolla is white, approximately 10 mm high, with six stamens the same length as the petals, and the gynaeceum is made up of an upper ovary of 10 to 20 ovules. The fruit is a berry cf variable form, from ellipsoidal to almost spherical, with juicy, fleshy endocarp, and very sweet (Figure 7.1) (Standley 1958).

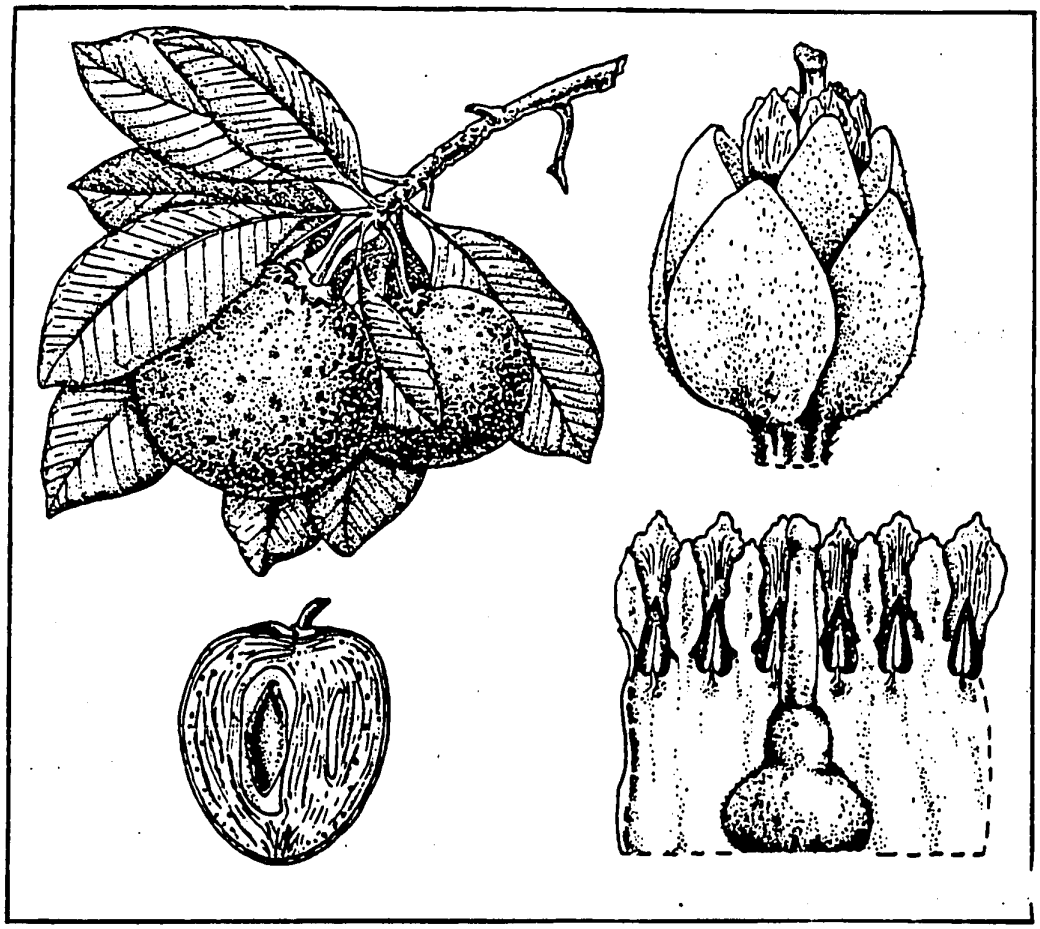

FIGURE 7.1

Botanical drawing of Manilkara zapota

7.1.1 Intraspecific Variability

Variability plays an important role in the availability of the latex, as variations in both the yields per tree and quality and consistency of the latex are common.

Among populations in Petén, it is possible to distinguish three or four varieties (Leon 1987; informants), although given the characteristics of Sapotaceae, they may well be different species. Chicleros distinguish the varieties by the size and form of the fruit, color and taste of the mesocarp of the fruit, color of the wood, and color and consistency of the latex. For example, one encounters large trees (DBH > 1.0 m) that have not been tapped. Such individuals are called "zapote mula" because they produce very little latex, perhaps a result of either physiological variability (different capacities of assimilation, translocation, photosynthesis, transpiration, etc.) or speciation. A. Jorgeson (pers. comm, 1991) notes, however, that trees of such large diameter are unusual in Quintana Roo, she did not encounter any large untapped trees.

From the industry's perspective, there are two very distinct types of chicozapote trees in Petén: those that produce first quality chicle, which is extracted almost exclusively from northern Petén and thus the Reserve; and those that produce second quality, or chiquibul, which is extracted in southern Petén. In recent years there has been no market for the lower quality latex, called Crown Gum in neighboring Belize. It may be that the latex comes from a distinct species, *Manilkara chicle*.

7.1.2 Season of Harvest

Chicle yields depend on precipitation. In southern Petén it rains almost all year, making it possible to tap the chiquibul tree during the 12 months of the year. In northern Petén, the rainy season is between eight and nine months long. Extraction is limited to the last six or seven months of this period, with the most intensive harvesting occurring from October to January.

More specifically, the latex is available when climatic conditions are favorable: when relative humidity is high, when it is very cloudy, when the air is calm and temperatures low, and when soil moisture is high--all rainy season conditions. Together these characteristics cause a swelling in the system of latex-conducting cells. That is, increased availability of water results in increased turgidity, or internal cell pressure. Such increases in pressure are balanced by the plant's ability to expel water out of the leaves, a process called transpiration. When air temperatures are low, relative humidity high, and there is no wind, the tree loses less water via transpiration. Under these conditions cell pressure builds, increasing turgidity, which in turn produces a measurable increase in the diameter of the tree. Karling (1934) reports that the DBH of the chicozapote tree expands and contracts daily. The greatest expansion is at 6:00 a.m., after a night of cool temperatures, while the greatest contraction occurs at 5:00 p.m, after a day of warmer temperatures. Such fluctuations may also be keyed to day-time increases in photosynthesis, hence use of water and nutrients. The key point here is that cells with higher turgidity yield more latex. This observation is corroborated by chicleros, who say that the highest yields occur from 5:30 a.m. to 7:00 a.m.

7.2 Ecology

7.2.1 Population Density

Data for plant population densities are presented for three areas of intensive tapping: Uaxactún, Yaxhá, and Carmelita. See Figure 2.1 for location of study sites.

Transects near Yaxhá reveal it to be an area with the lowest density of trees per hectare. Transects near Carmelita showed significantly higher densities, with Uaxactún falling in between.

TABLE 7.1
Comparison of density and basal areas in the three locations studied.

Area	Density (plants/ha)	Basal area (m^2/ha)
Uaxactún	32.8	4.4
Yaxhá	23.2	4.3
Carmelita	47.0	5.0

Source: Field data, 1990.

Chicleros maintain that the northern part of the Reserve has always been more rich in densities of M. zapota. There are two possible explanations for this increase in density with distance northward. First, if we assume that soils, topography, forest associations, and other edaphic factors are similar throughout Petén, precipitation, which decreases with distance north, may account for the variation in population density. This hypothesis is supported by the observation that M. zapota does not occur in the southern and western areas of Petén, where wetter conditions predominate. The southern species, which may be M. chicle or a variety of M. zapota, as noted, is distinct in that it produces lower quality latex. This

pattern of increased quality and quantity of latex with distance north also occurs in Belize. In addition, southern Quintana Roo and Campeche as well as northwestern Belize are major producers of first class chicle.

A second possible explanation for the increases in population densities of M. zapota in the north is land-use history. Lundell (1937) notes that exploitation and subsequent mortality of this species was most prominent in more easily accessible areas, a phenomenon we see very clearly in populations of Chamaedorea spp. palms. Further north, the accessibility of forest resources diminishes and costs of extraction increase. These less accessible areas may exhibit more intact, higher density, populations. In addition, as discussed in Chapter Two, the high densities of M. zapota may be a botanical artifact of ancient Maya land use.

Whether increases in M. zapota depend on edaphic or cultural factors, our data suggest that chicle production, hence potential forest value, also increases as one moves north , an observation confirmed by chicleros.

7.2.2 Basal Area

Table 7.1 also presents data on basal areas. There is no significant difference between the data for Uaxactún and Yaxhá. Basal area measured in Carmelita is significantly greater than that in Uaxactún and Yaxhá. The Yaxhá area has a lower population density, but more individuals occur in the higher diameter classes, which leads to a similarity between the mean basal areas. The smaller number of individuals in the smaller size classes is cause for concern, as discussed below.

7.2.3 Size Class Distribution and Regeneration

Like P. dioica, M. zapota size class distribution exhibits characteristics expected for a random sample from an uneven aged forest, with the number of individual trees decreasing as DBH increases (Figures 7.2A, B, and C). We present size class data for all three areas, noting the percentage of harvested individuals within each size class. While the number of individuals per size class in Uaxactún steadily declines with an increase in diameter, the smallest size class in both Yaxhá and Carmelita has many fewer individuals than expected. This may be the result of field measurements, particularly the inability to identify younger, smaller diameter trees. These figures also indicate the what percentage of the trees in each size class exhibit evidence of tapping. Historically only larger trees were tapped. The law controlling chicle exploitation, established in 1959, states that only trees with a DBH > 30 cm (12 in.) may be tapped (Schwartz 1990). Currently, almost all trees above 20 cm DBH are tapped, this diameter being the widely held cut-off point among harvesters.

It appears that the seeds of M. zapota germinate in the low-light conditions of a closed canopy. This is a strategy distinct from P. dioica, which appears to be a light gap species. Chicozapote individuals grow slowly, becoming short and bushy until a light gap develops, at which point vertical growth accelerates (Peter Alcorn, pers. comm.). Figure 7.3 presents regeneration data for each of the three regions studied, placing juvenile individuals within each of three size classes.

7.2.4 Importance Value

The Importance Value (IV), as noted in Chapter 4, is a dimensionless number that considers the relative basal area, the relative density, and the relative frequency of a given species. M. zapota is a common forest tree, and likely exerts significant control on the energy flow of the forest. For transects near Carmelita, the IV is 44.86 and near Uaxactún, 35.76 out of a possible 300, a high value. Relative data were not recorded for Yaxhá. According to Holdridge (1980), chicozapote is indicative of this life zone.

DISTRIBUTION OF MANILKARA ZAPOTA BY DIAMETER CLASS
In the Uaxactún Region

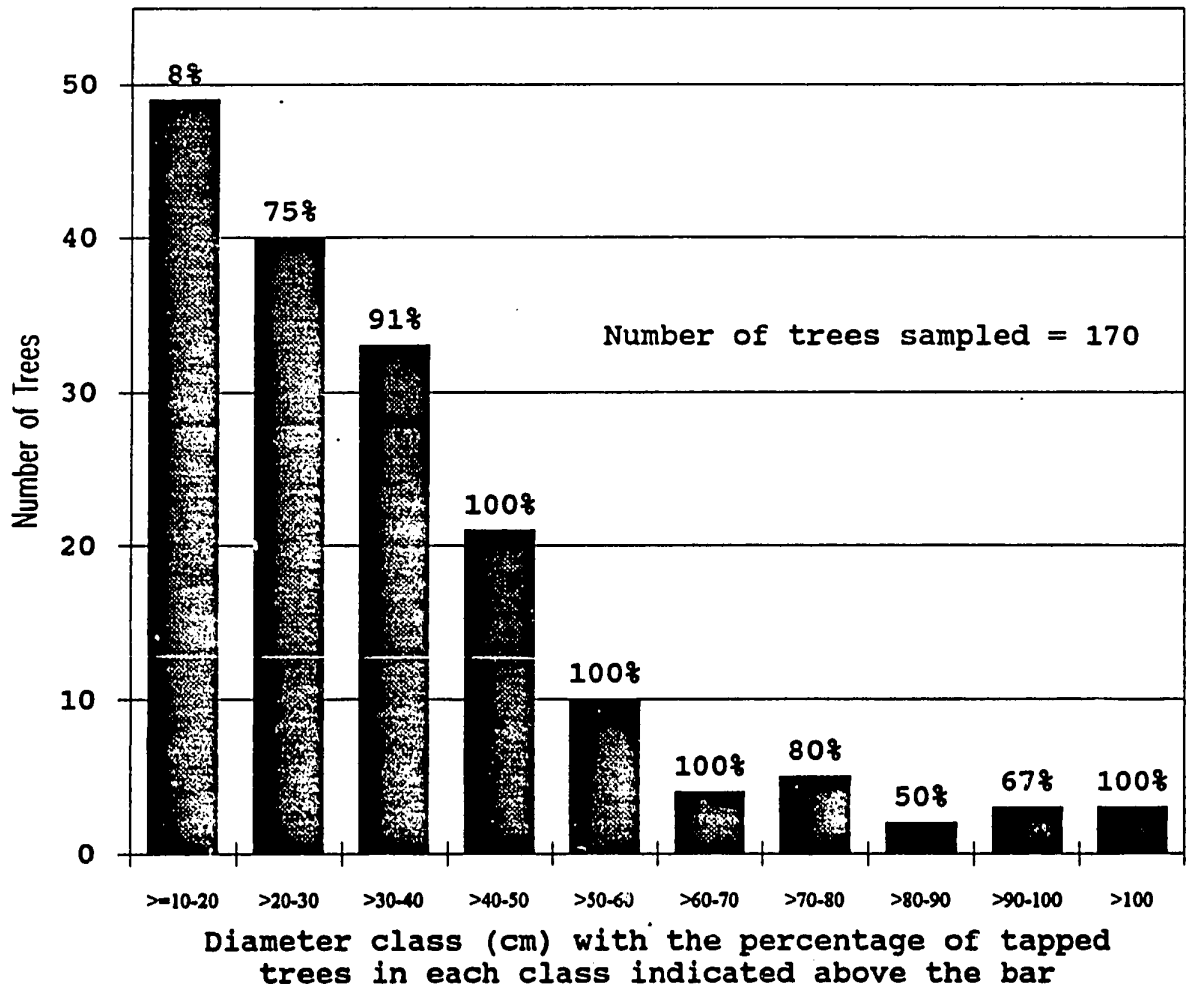

FIGURE 7.2A

Distribution of *M. zapota* by diameter class in the Uaxactún region. The percentage of tapped trees in each size class is indicated above the bar.

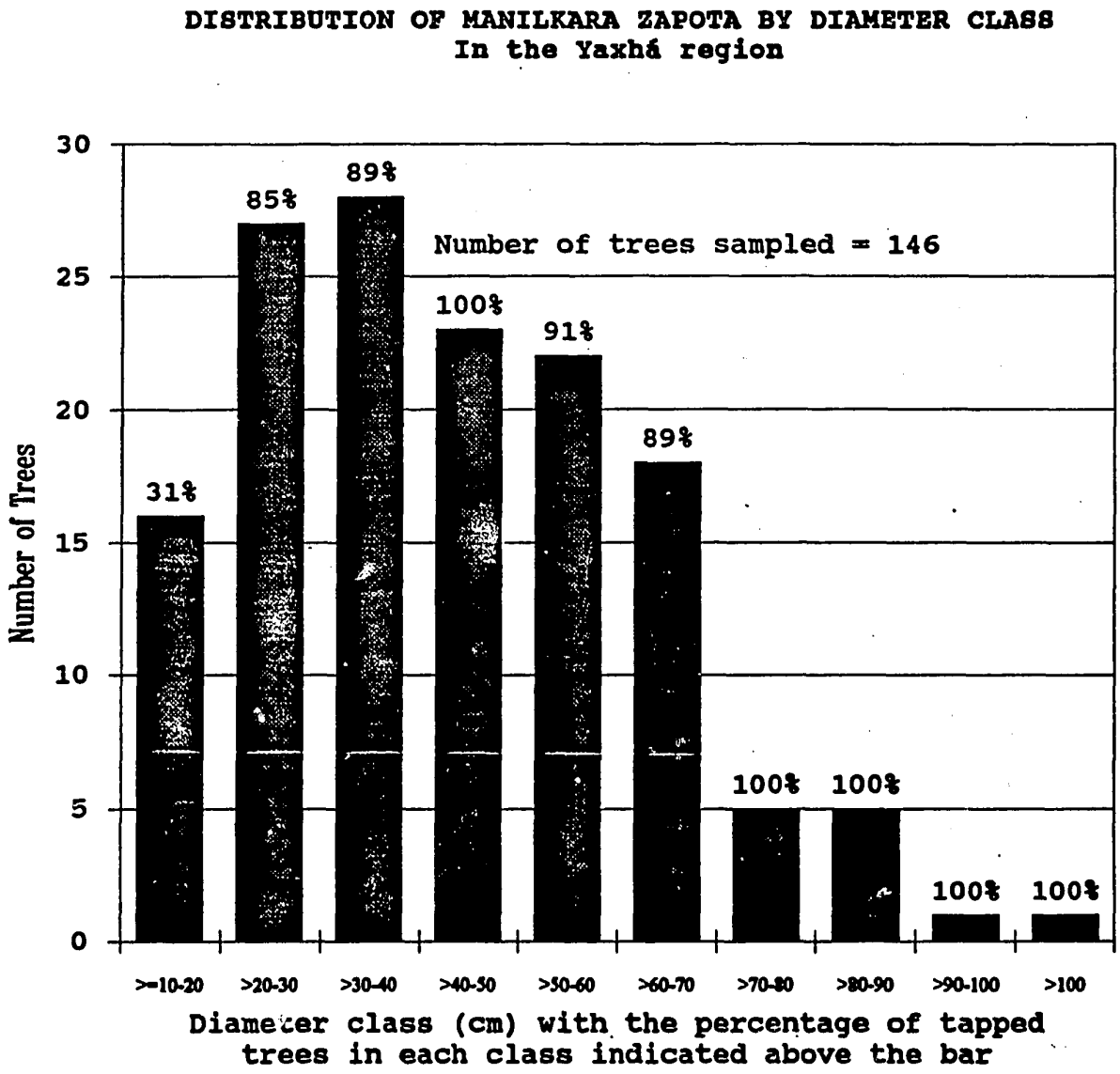

FIGURE 7.2B

Distribution of *M. zapota* by diameter class in the Yaxhá region. The percentage of tapped trees in each class is indicated above the bar.

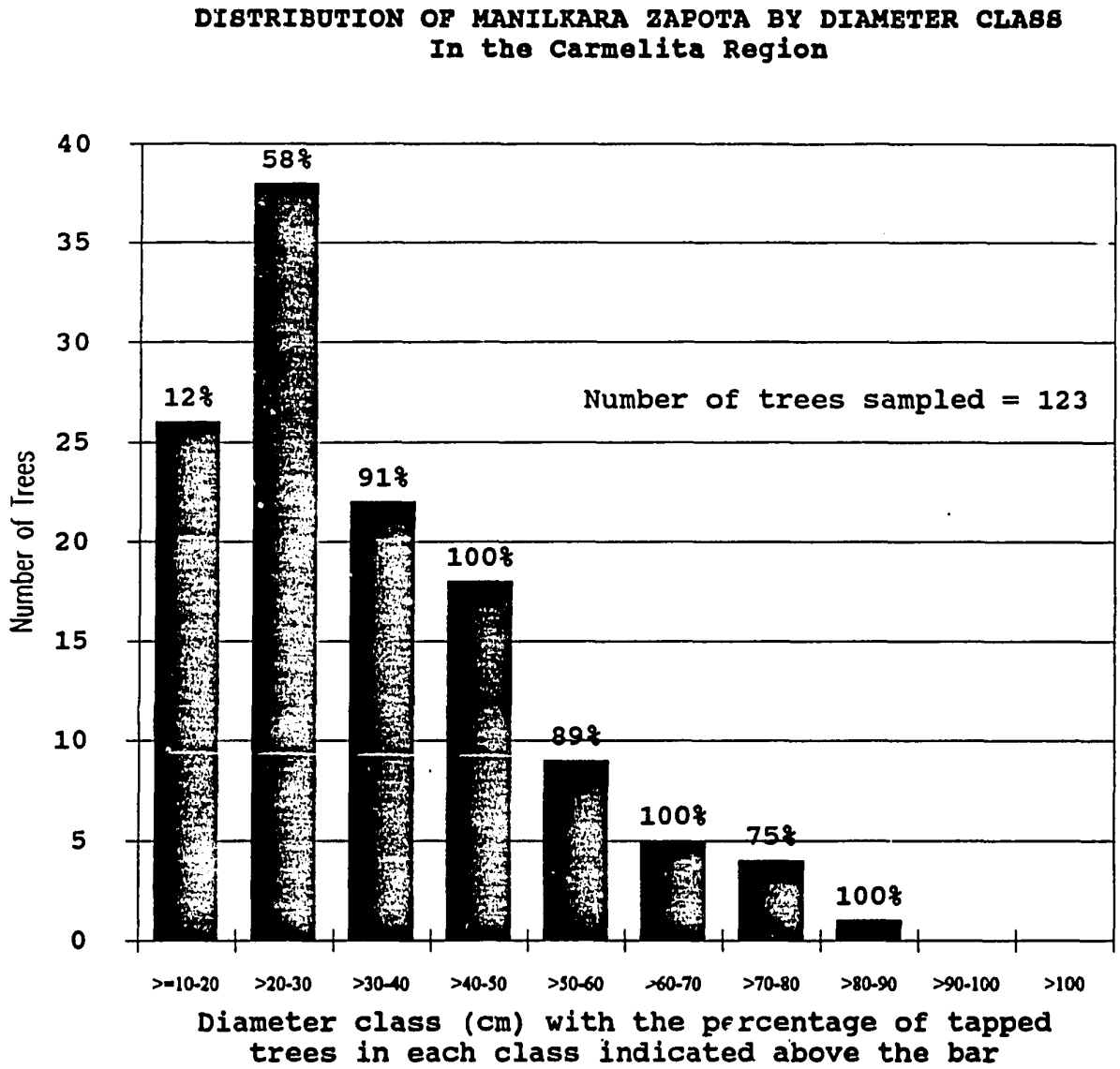

FIGURE 7.2C

Distribution of *M. zapota* by diameter class in the Carmelita region. The percentage of tapped trees in each class is indicated above the bar.

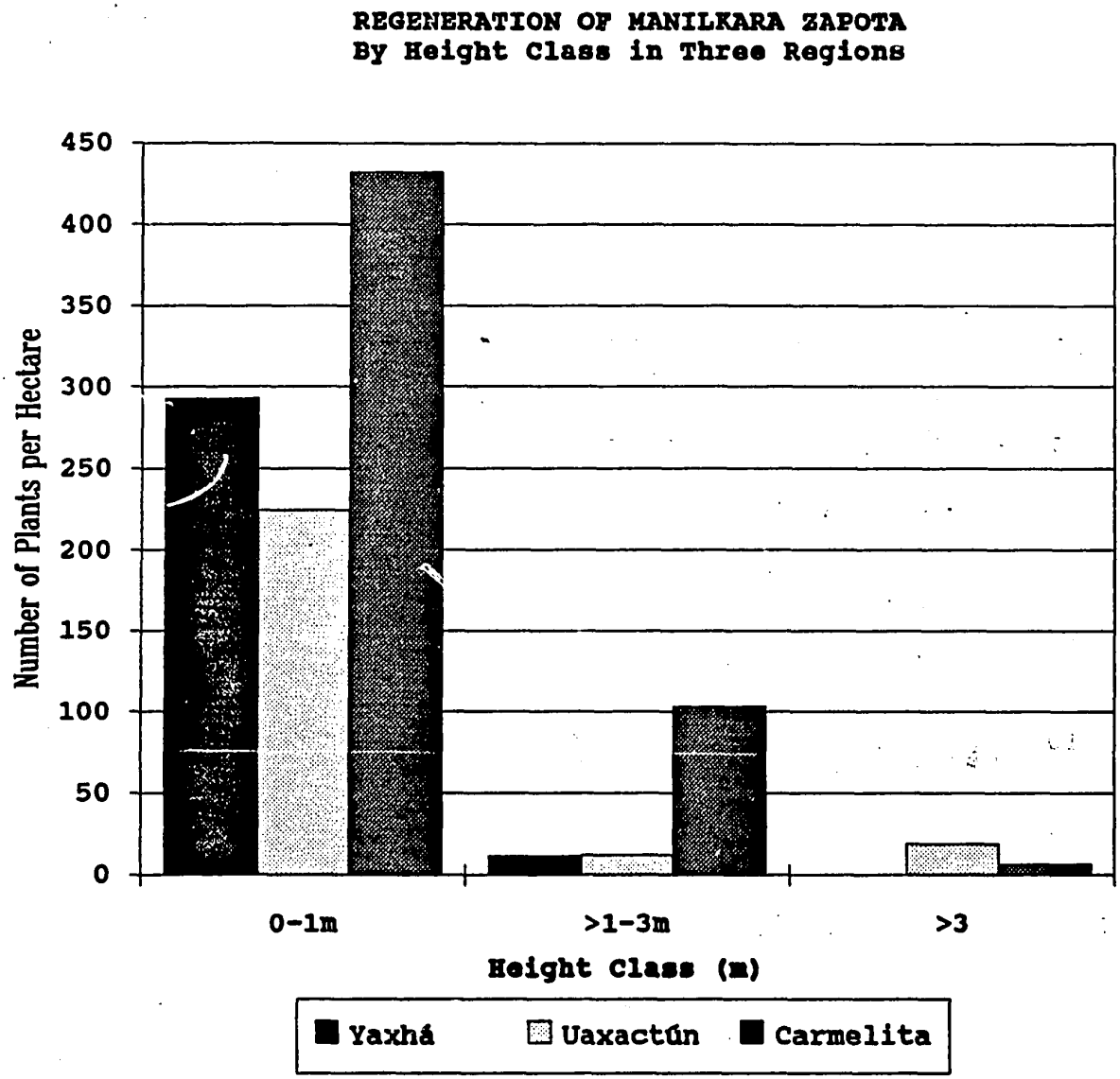

FIGURE 7.3

Regeneration of *M. zapota* by height class in three regions of northern Petén.

7.3 Harvesting and Processing

Harvesting activity regularly begins in July, with the search for and contracting of chicleros, mainly in the Departments of Alta Verapaz, Baja Verapaz, and Petén. The signing of the contract between the chicleros and the contractor stipulates the quantity of chicle for which the chiclero is responsible. The contractor often advances the chiclero between Q 100.00 and Q 800.00, which they leave with their families while they are in the forest. The contractor may instead agree to pay mensualidades, monthly payments to the family or do both. The amount of money in each case depends on the skill, responsibility, and reputation of the individual chiclero.

There are two basic types of chicleros. First, and most common, are contracted harvesters. Second, are individual harvesters, who extract latex without any previous commitment to the contractor. They sell the chicle to whoever pays the best price.

The contractor is a businessman who contracts a group of chicleros, the total number depending on his or her quota. Quotas were previously allocated by FYDEP and at present are issued by CONAP. There are two types of contractors: cooperative contractors, numbering 35, who are grouped in a contractors' cooperative called Itzalandia; and independent contractors, numbering approximately 26.

In addition to cash advances, the contractor provides camp food, cigarettes, medicines, and the equipment necessary for the season, which is later discounted from the amount paid to the chiclero. There are some chicleros who buy their equipment themselves, avoiding the contractor's markup, which can amount up to 55% of a contractors profit (Schwartz 1990). Contractors transport the finished blocks of chicle from the forest to a central CONAP

warehouse currently located in San Benito.

Often, subcontractors, who generally live in Uaxactún and Carmelita, collect chicle. Having no quota with CONAP, they arrange for the production of chicle under the quota of a contractor, purchasing from independent chicleros.

To initiate production, the camp foreman (capataz) selects a camp location, the choice based on water availability and forest-use history. Areas tapped within the previous five years are not yet ready for another cycle of harvesting. Time since the last harvest is determined by visual inspection of the characteristic criss-crossing scars on the main stem of the tree. The number of years between harvests has important implications for harvesting impacts and sustained-yield management. We return to this point below (Section 7.4).

Forest camps for the extraction of chicle are often large, having up to 50 men, and are more organized than camps used for other extractive activities. The person in-charge of the capataz supervises the camp's installation, which includes building a kitchen, chicle warehouse, and latex-cooking facilities. The infrastructure of the camp is rustic but comfortable, all materials originating from the surrounding forest.

The capataz is responsible for provision of food and for keeping the accounts of each chiclero's harvest and camp expenses. He also monitors the processing of the chicle into solid blocks. Ultimately, the quantity and quality of production are his responsibility, for which he is paid a certain amount per unit of latex.

In order to collect the latex, chicleros set out from camp at sunrise in pairs, so that they can help each other in case of problems, though harvesting itself is an individual concern. They carry with them the tools of their craft, which include climbing spurs, belts for spurs, a

large rubber bag and several smaller collecting bags, files, grindstone, machetes, and a very thick rope.

The chiclero locates a tree with certain specific characteristics. First, the tree cannot have been tapped within the last four years. Second, the chiclero inspects the color of the latex. Either white or slightly purple latex indicates that the tree is a good producer. Pale pink latex indicates a poor producing tree. If, after an initial cut of the machete, a large amount of latex flows for a few minutes, then suddenly is replaced by a transparent exudate, the tree is deemed a poor producer.

Third, the chiclero inspects the latex-bearing cells located just inside the bark (in the outer cambium). They must be thick; when fine, production is less.

If the tree is deemed adequate, the chiclero determines from the viscosity of the latex the depth and angle of his cuts in order to best tap the tree. He then cleans the area around the tree, to prevent branches or vines from hampering his work. Though unintentional, this is an example of natural forest management: competitive growth is cleared away from an economically valuable species.

An incision is made in the base of the bole, about 25 cm above the ground. Here a paraffin-sealed cloth bag with a capacity for approximately 2.5 kg of latex is placed. Bags were once sealed with the natural rubber latex of Castilla elastica. The chiclero puts on his climbing spurs and begins the climb. He works the tree from the base to the first major branches, often at a height of 18-20 m. Jorgenson (pers. comm. 1991) notes that chicleros never work above 15m in Quintana Roo, though trees are generally shorter in Quintana Roo. He holds his weight by inserting his climbing spurs into the bark of the tree and by

holding/wrapping a rope around both the tree and his waist by leaning away from the bole.

Incisions along the bole are made with strong and carefully delivered blows from a finely sharpened machete. First, a downward glancing cut at an angle of 45-75 degrees shaves away the bark and intersects the latex-bearing cells. A second cut is made perpendicular to the tree, intersecting the base of the first cut. A wedge of wood falls away, leaving an exposed surface that drains latex downward. Each successive series of cuts intersect, forming a system of grooves that guide the gravity-drained latex down the bole towards the collection bag. Figure 7.3A illustrates the tapping process.

The time it takes the chiclero to tap a tree varies greatly, depending on chiclero skill and the diameter of the tree, and ranges from 30 minutes to 3-1/2 hours. The number of trees tapped per day similarly depends on their size and chiclero skill. If the trees are large (DBH > 50 cm), 6 or 8 are tapped; if small, between 12 and 20 are tapped. In the case of mixed diameters, between 8 and 13 trees a day are tapped. Jorgenson (pers. comm 1991) measured a maximum tap time of 1.5 hours and a maximum of 12 trees tapped per day in Quintana Roo.

Latex yields range from 0.2-2.3 kg (0.5-5.0 lb) per tree, though accounts of up to 7 kg (15.4 lb) are not uncommon. This high weight may be due to water in the bags. In any event, trees with a yield greater than 2.7-3.6 kg (6-8 lb) are very scarce. Chicleros report an average yield per tree of approximately 0.9 kg (2 lbs), an observation confirmed by extensive tapping experiments conducted in the 1930s (Karling 1940). We have not confirmed this quantity with actual field experiments. Jorgenson (pers. comm 1991) observed an average yield of 0.5 kg/tree in Quintana Roo. Again, however, chicozapote trees in Quintana Roo

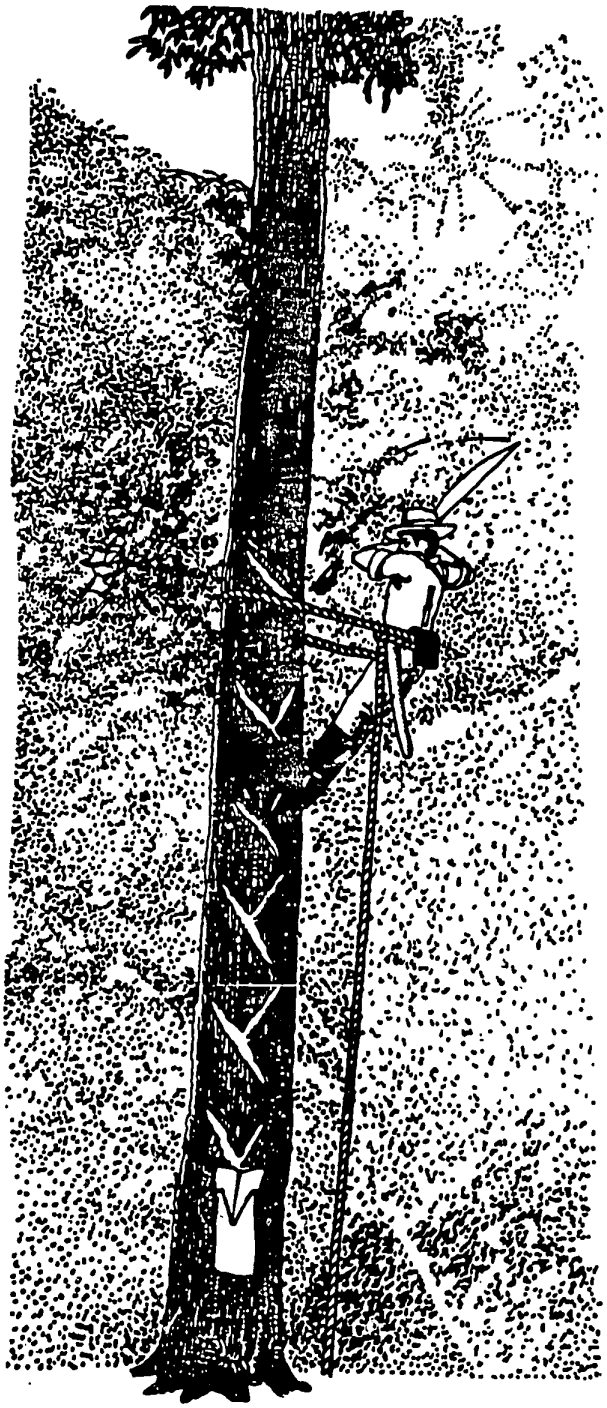

FIGURE 7.3A

Chiclero tapping a sapodilla or chicozapote tree (Manilkara zapota). The latex flows through the zig-zagging cuts to a wax-lined bag. The bags are collected a day or two after tapping.

are generally thinner and shorter than those in Petén, factors which would substantially affect the latex yield.

The following day, the chiclero returns to each of the tapped trees to collect the latex-filled bags, pouring the contents of each into a bigger bag. He then continues to tap more trees as he did the day before.

In the evening, before sunset, the chiclero returns to camp carrying the latex and places it in a container for subsequent cooking. Normally, Saturdays and Sundays are set aside for this. The equipment required to cook the latex consists of a metal pan that is placed over the fire, a round, smooth wooden rod, approximately 1.5 m long, wooden molds, molding soap, and burlap bags, all supplied by the contractor.

The latex is deposited in the pan and after about one hour it begins to boil. As water evaporates, the latex thickens. Once gelled, it is removed carefully from the bottom of the pan to prevent it from becoming burned. The consistency is checked in various ways. One way is to place some of the latex into a bucket of clear water. If the product stains the water, it needs more cooking. The precise water content commanded by the international market is 27%; that by CONAP is 30%, as some moisture is lost while the chicle awaits export. An experienced cook achieves this by visual inspection. The raw latex is approximately 80 percent water, though the percentage varies depending on climatic conditions just prior to tapping. The loss in weight due to cooking is approximately 50 percent.

When sufficient water has been expelled from the latex, it is taken from the fire and left to cool. Palm leaves (Sabal morrisiana) and wet burlap sacks are arranged on the ground.

When the chicle is cool, two persons wet and soap their hands, and place the chicle on the bags. They form it into wooden frames, pressing down with their hands and smoothing the outer surface with soap.

The blocks are then stamped for identification (Figure 7.4), one stamp with the initials of the chiclero, one with the initials of the capataz, and a third with the initials of the contractor. The stamps, called the "devil's key", are made from a plant of the genus Dioscorea spp., known locally as cocolmeca.

Certain species have been used to adulterate the latex of M. zapota (Table 7.2). Some adulterants are no longer used, a result of strict quality control by the Japanese companies which import the product. More importantly, the quality of the latex is maintained by the pride of the chiclero culture, which promotes quality among individuals and discourages the use of adulterants that detract f om the entire camp's production quaiity. Tests in the warehouse confirm the remarkably high quality of the latex

Not all species diminish the quality of the latex. Table 7.2 also lists three species; Ficus lundellii, Bumelia mayana, Stemmademia donnell-smithii, which can in fact be used at present because they improve both the consistency and color of the final product. The contribution of these species to the volume exported is insignificant.

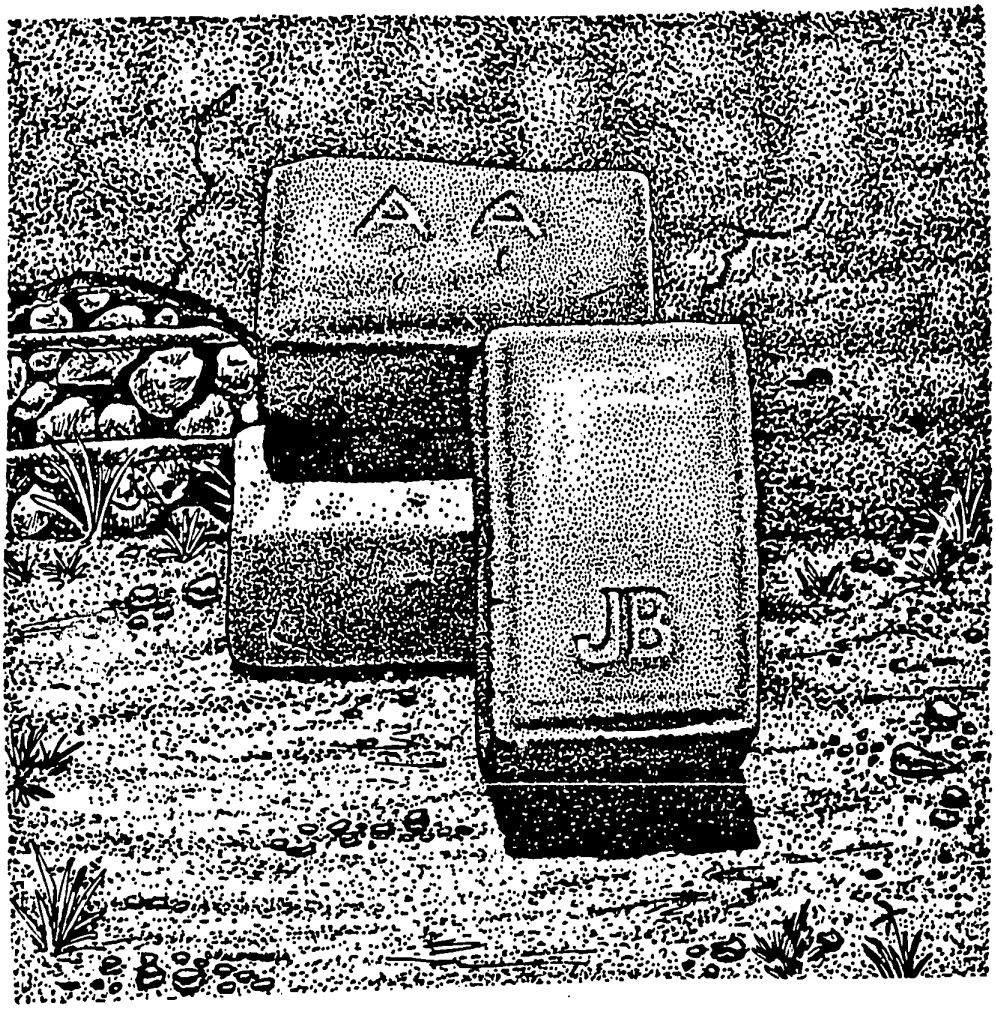

FIGURE 7.4
Finished blocks of chicle with the impression of the collector's stamp

TABLE 7.2
Species used to adulterate chicle

Species	Family	Common Name
HISTORICALLY USED ADULTERANTS		
Manilkara chicle?	Sapotaceae	zapote macho
Calocarpum viridae	Sapotaceae	ingerto
Dipholis stevensonii	Sapotaceae	zapote faisán
Pouteria amygdalina	Sapotaceae	silión
Castilla elastica	Moraceae	hule
Brosimum utile	Moraceae	palo de leche
Brosimum alicastrum	Moraceae	ramón
Pouteria durlandii	Sapotaceae	sapotillo
Pouteria sp.	Sapotaceae	sapotillo hoja fina
Sebastiania sp.	Euphorbiaceae	chechén blanco
Pseudolmedia sp.	Euphorbiaceae	manax
CURRENTLY USED ADULTERANTS		
Ficus lundellii	Moraceae	kopo
Bumelia mayana	Sapotaceae	avalo
Stemmademia donnell-smithii	Apocynaceae	cojón de caballo

Sources: Common names: chicleros, Vander Laan (1927); scientific names: Standley and Williams (1967), Galvez et al. (1990), and Brokaw et al. (1990).

7.4 Harvesting Impacts

Often, well over 60% of the downed trees encountered in the forest are the decaying boles of M. zapota, a percentage of the total number of dead trees far greater than the relative percentage of living trees. This probably reflects both the ability of the wood to resist decay and its high importance value. We also believe that some increased mortality resulting from harvesting also contributes to the relatively large number of dead trees.

Harvesting chicle is hard work. Resting on tree spikes, cantilevered away from the bole with a single rope around his waist, the chiclero must deliver hundreds of powerful blows to an average tree. This requires great skill. Such skill is learned by young men who apprentice with older chicleros for a season prior to harvesting on their own.

Even so, from a physiological perspective, the harvesting method is crude. The depth of cutting is shallow, but difficult to control. Often the incision penetrates beyond the outer latex-bearing cells into the tissues that transport water and nutrients (cambium). This is especially the case where the cuts overlap.

A strangling effect is produced, restricting the conducting tissues. As a barrier is formed to the upward movement of water and nutrients to the crowns of the trees, the rate of photosynthesis is reduced, resulting in partial or complete mortality. In addition, weakened trees are likely to be more susceptible to wind-throw. Moreover, the incisions leave the tree susceptible to attack by microorganisms (fungi, bacteria), borer insects, and dessication, all of which inhibit the function of the vascular tissues.

Chicleros note that the effects of tapping vary greatly from tree to tree. Karling (1940) makes a similar observation, noting that trees have been brutally tapped two or three trees, survive while a tree lightly tapped one time dies. The research of both Karling and Lundell (1934), which included the systematic tapping of thousands of trees, argues that mortality from tapping is approximately 5%; chicleros generally agree, though they note that the actual loss may be higher.

Many chicleros are expert woodsmen, being part of a forest culture that has harvested the latex of the chicozapote, among other forest resources destined for commercial use, for over

60 years. They note that populations have decreased, indicating that mortality can result from tapping. Such mortality is exacerbated by the species slow growth rate, a rate that is highest during the rainy season when tapping occurs. We hypothesize that the diameters of M. zapota populations, like plant densities, have decreased over the more than 100 years of exploitation.

Yields have similarly declined. During the period 1900-1920, average seasonal yields per chiclero ranged from 18-23 quintals. Today, average seasonal yields range from 5-10 quintals (Schwartz 1990).

A final harvesting impact is seen in the effects of tapping on reproduction. The reproductive cycle of the plant is interrupted; it is widely held that tapped trees do not fruit. The only fruit encountered during field surveys was in Tikal National Park, where tapping has not occurred for over 20 years. The reduction in the length of time between harvests, once as high as 15 years, has gradually been reduced to about five years. This reduction probably exacerbates all of the impacts discussed above. Although not all trees are harvested every five years, chicleros state that it is profitable to harvest every five years. Nonetheless, overall chicozapote density remains relatively high in northern Petén. With improved resource management it should be possible to continue extraction indefinitely. This issue is discussed in greater depth below as part of the sustainability of resource extraction.

7.5 Market Structure

7.5.1 History of Exploitation

The exploitation of M. zapota dates to the Maya civilization, as seen in the use of

chicozapote for structural supports in Tikal, Uaxactún, and other archeological sites.

Apart from its use for the production of chicle, the bark of the chicozapote, mixed with the bark of matterio (Aspidosperma megalocarpon), is used against malaria. The sap of the chicozapote is used to reduce blisters and swelling (Mendieta R.M. and del Amo Silvia, 1981). Intestinal parasites are expelled with a tea made from the seed of the tree. In the case of open wounds, the latex can function as a protective patch (Alvarez 1989).

Although felling chicozapote trees is prohibited, the wood is considered ideal for the manufacture of railway ties, bridges, piers, and fence posts. Chicozapote wall panelling is widely used in hotel construction in the region.

Commercial exploitation of the tree for latex in Petén probably began around the year 1890. The first known document on chicle was written in 1895 (Schwartz, pers. comm.). However the latex had been known long before commercial exploitation began in the Petén. Woodcutters and rubber tappers (huleros) chewed it to ease their thirst while working. Each year when they returned from the forest, they gave their families and friends little blocks of chicle in the form of animals, hearts, and other shapes as Christmas presents.

The latex was exported from the Yucatán to the U.S. as early as 1866 (Schwartz 1990). In 1889, North American demand spurred businessmen from Belize, then British Honduras, to use their existing relationships with rubber contractors to exploit the chicozapote tree commercially (Sosa 1970). Because the commercial elite of Flores maintained stronger ties with Belize than with more distant Guatemala City, production during the early years was bought by Belizean businessmen. In the 1920s, US businesses shifted from the use of Belizean intermediaries to a direct presence in the form of Wrigley and the Chicle

Development Corporation. These two companies maintained production centers in the region until 1949.

Early in the trade, the chiclero received between $8 and $10 per quintal (100 lbs; 45.5 kgs) in the field and between $16 and $20 per quintal brought to Flores. It was then transported by mule to the Belize River, and floated to Belize City for ocean transport to the U.S. and Canada. Prices paid in Belize City were between $32 and $40 per quintal. It was also transported north, up the San Pedro River to Mexico. Chicleros became the best paid workers in the entire region (Vander Laan 1927). As a result, the chicle culture grew rapidly, forming the basis for the region's current-day forest society.

Chicle production has fluctuated from its earliest years. Early data are not reliable, though we have presented it for comparison in future research in Table 7.3. The data from 1919 is reproduced from Schwartz (1990, 149), who states that reliable records first appear in 1927. The harvest of the latex occurs as early as August in one year and ends as late as February in the next year. For this reason, exports for one season occur two consecutive years, though within a time span of a few months.

In 1904, the amount exported was 62,273 kgs (1,375 quintals; 137,000 lbs), and it remained more or less stable until 1911, when export climbed to 407,181 kgs (8,958 quintals; 895,800 lbs). Later, in 1917, there was a drop in exports to 89,772 kgs (1,975 quintals; 197,498 lbs), possibly as a result of World War I.

Starting in 1920, exports began a rapid climb, becoming Guatemala's third most important export, though still a distant third to bananas and coffee (Schwartz 1990). Production experienced some decline during the economic depression of 1929-1933.

TABLE 7.3

Exports of chicle from 1904 to 1992*, except for the periods 1925 through 1927 and 1950 through 1952. Amounts in hundreds of thousands of pounds.

Year	Amount	Year	Amount	Year	Amount
1903/04	1.38	1936/37	12.92	1968/69	16.94
1904/05	2.16	1937/38	13.73	1969/70	17.25
1905/06	1.74	1938/39	23.27	1970/71	16.61
1906/07	2.23	1939/40	15.05	1971/72	13.36
1907/08	1.95	1940/41	28.31	1972/73	20.00
1908/09	2.34	1941/42	36.77	1973/74	12.65
1909/10	3.33	1942/43	32.89	1974/75	19.38
1910/11	4.92	1943/44	34.00	1975/76	8.64
1911/12	8.96	1944/45	42.00	1976/77	13.57
1912/13	4.05	1945/46	39.00	1977/78	13.11
1913/14	7.42	1946/47	38.00	1978/79	15.62
1914/15	7.55	1947/48	36.96	1979/80	8.35
1915/16	4.25	1948/49	27.00	1980/81	5.48
1916/17	1.95	1949/50	16.00	1981/82	7.50
1917/18	6.08	1950/51	26.80	1982/83	7.50
1918/19	5.59	1951/52	25.00	1983/84	3.44
1919/20*	8.46	1953/54	7.80	1984/85	7.42
1920/21	8.22	1954/55	24.00	1985/86	4.00
1921/22	10.91	1955/56	15.50	1986/87	4.00
1922/23	7.34	1956/57	17.00	1987/88	4.00
1923/24	9.16	1957/58	26.80	1988/89	8.00
1927/28	13.90	1958/59	23.20	1989/90	8.00
1928/29	10.02	1959/60	13.62	1990/91	10.00
1929/30	18.35	1960/61	25.24	1991/92	10.85
1930/31	11.99	1961/62	19.55		
1931/32	6.41	1962/63	13.68		
1932/33	3.44	1963/64	13.01		
1933/34	4.14	1965/66	22.24		
1934/35	5.28	1966/67	18.08		
1935/36	5.93	1967/68	21.45		

Sources: 1904-1924, Van der Laan 1927
1928-1985, Schwartz 1990.
1985-1988, FYDEP internal records
1989-1992, CONAP internal records

* Schwartz 1990 indicates that only one tenth this amount was harvested in this season.

Production peaked during the years 1942 and 1948, with a maximum level in 1944/45 with 1,909,091 kgs (42,000 quintals; 4,200,000 lbs), over four times the level of the 1990 harvest.

In 1934, the export-minded Ubico government closed the border with Belize in order to control the flow of both chicle and timber. During this time, the construction of landing strips throughout the northern Petén was financed in order to transport the chicle south. The landing strips gave rise to permanent communities, two of which, Carmelita and Uaxactún, still exist and are the largest population centers within the Maya Biosphere Reserve.

In 1949, both U.S. companies withdrew from Petén, probably for the following reasons: competition from petrochemical based synthetics--although lower in quality, taste, and consistency, these products are cheaper and are free from impurities; competition from Brazilian chicle, which although lower in quality, was subsidized by the Brazilian government; a highly variable international market; the creation of trade unions during the Arevalo government; and proposed taxes on chicle exports.

The trade union was formed in 1949 and was recognized officially in 1951. Its complete name is "Sindicato de Chicleros y Madereros del Petén" (Suchilma). It was created to protect the worker and his family against common disease, accidents, and to protect him in legal affairs. Though still in existence, the union has been widely ineffective, a result of the difficulties of organizing over such a large remote region as much as from political opposition to unionization.

As a result of the drop in international demand, Petén suffered one of its worst economic collapses. As a result, in 1951 the President of the Republic ordered the recently created

Petén Development Institute (INFOP) to buy 90,909 kgs (2,000 quintals; 200,000 lbs) and store them for later sale to the United States. The American companies resumed their purchase of chicle with the condition that contracts be negotiated and guaranteed by INFOP, reinforcing the government's role as the principal source of financing and mediator for the harvesting and export of chicle, a relationship that continues to the present.

The Petén Promotion and Development Corporation (FYDEP) replaced INFOP by Decree 1286 issued on July 22, 1959. Article 19 of this law says: "FYDEP shall, without the need to call for tenders, enter into contracts for the extraction and exploitation of first-class chicle and chiquibul with private persons or entities, which contracts may not exceed one year, and shall finance or contract financing for the exploitations which it may authorize." Together with FYDEP, a consortium of chicle contractors was organized to try to coordinate the drawing up of regulations for the exploitation of chicle. The result was a law that controlled the extraction of the latex and the distribution of benefits from its sale.

Up to 1973 the United States was the only importer, a role that began to decrease in 1974 as sales increased to Japan. Japan later absorbed the entire production.

A contractors' cooperative, Consotio de Empresarios de Chicle de Petén was established in 1959 with the idea of creating one single body to handle chicle exploitation. Prior to its dissolution in 1990, FYDEP signed contracts with international buyers for 363,636 kgs (8,000 quintals; 800,000 lbs). Itzalandia, the present name for the cooperative, received a quota of 195,455 kgs (4,300 quintales; 430,000 lbs), which was distributed among its members. Quotas for the remaining 168,182 kgs (3,700 quintals; 370,000 lbs) were distributed among independent contractors. The actual distribution is made based on the

reputation of the contractor, particularly his ability to capitalize the extraction and production process. Corruption and patronage also play an important role in dictating who gets what.

In 1980, demand fell considerably, with 1983 as the year of lowest production since exports began, with 51,651 kgs (1,136 quintals; 113,600 lbs). On May 31, 1990, FYDEP was liquidated, and responsibility for chicle extraction was handed over to CONAP.

There are at present two Japanese companies, Mitsui and Sumitomo, buying all production, and according to Jorgenson, Korea and Italy are buying chicle from Mexico. In the 1989-1990 season the Japanese companies paid approximately $160.00 per quintal ($3.52/kg), for 363,636 kg (8,000 quintals; 800,000 pounds). In the 1990-1991 season, the demand increased a little, to 522,727 kgs (11,500 quintals; 1,150,000 pounds), of which 87% was for Mitsui, the remainder going to Sumitomo. Both companies paid $175.00 per quintal ($3.85/kg). A debt of 29,545 kgs (650 quintals; 65,000 lbs) to Sumitomo from the previous year was paid for at the old price. It is unclear if all 11,500 quintals were in fact supplied during the 1990/91 season. The actual quantity supplied may have been about 10,000 quintals.

7.5.2 Market Channels

There are several key players in the harvest and marketing of chicle. At the harvesting level, there are both contract and independent harvesters. Contract harvesters produce the bulk of the chicle. These harvesters sell to either an independent contractor, a cooperative contractor, or the chiclero union. Sometimes a subcontractor will be used to transport product and supplies to and from the main contractor. In turn, the contractors then sell to CONAP who sells to the exporters, most recently Japanese trading companies.

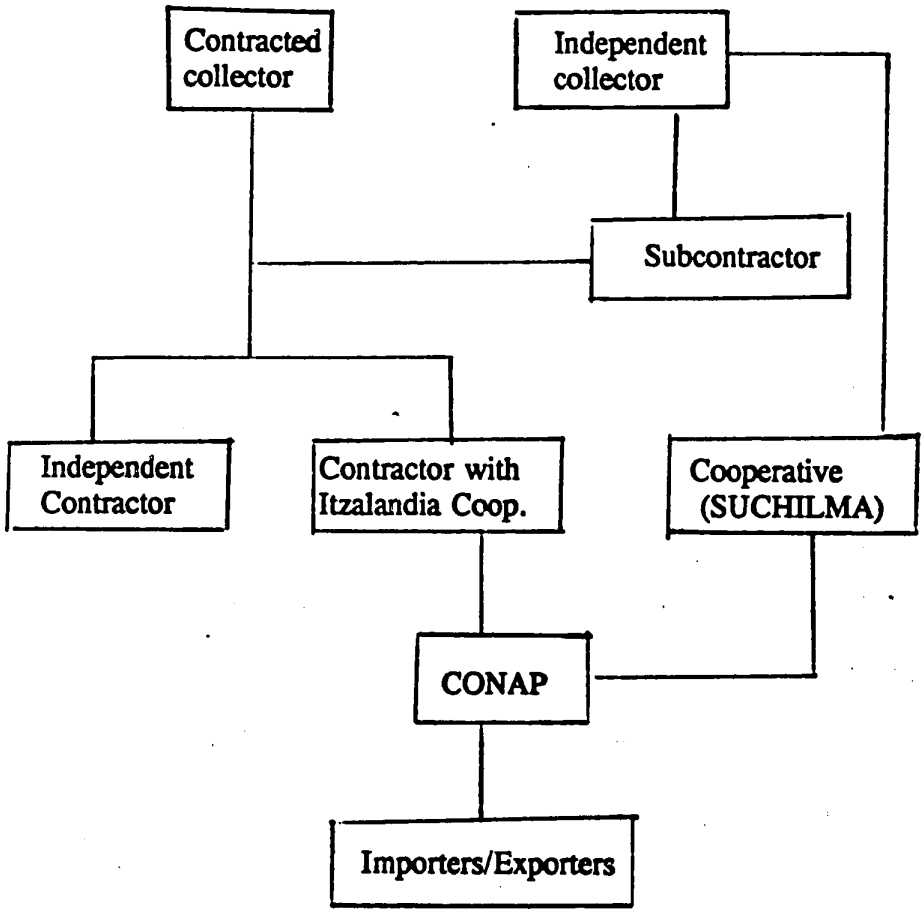

Figure 7.5
Market Structure of the Chicle Industry

The two most important or most frequently followed marketing channels are:

a) Contract harvester -- individual contractor -- CONAP --exporters; and

b) Contract harvester -- cooperative contractor -- CONAP --exporters

7.6 Harvesting Benefits

7.6.1 Employment

Demand in the 1991-92 season was about 454,545 kgs (10,000 quintals). We estimate that each chiclero harvests an average of eight trees a day, each of which yield about 0.9 kg (2 lbs) of raw latex, for a total of 7.2 kg of raw latex per day. The raw latex loses about 50% of its weight on cooking and thus yields 3.6 kgs of processed product per work day. From this we calculate that,

454,545 kgs processed latex / 3.6 kgs processed latex/work day = 126,263 work days.

Stated differently, to meet an international demand of 10,000 quintales, 126,263 work days are needed. This level of demand provides full-time employment, assuming the industry standard of 17 days of actual harvesting each month for six months, for about 1,240 people. Additional employment is available to the muleteers who transport the finished blocks and others who serve as camp cooks, warehouse personnel, and so on.

7.6.2 Distribution of Benefits

In 1979, Decree 79-79 was enacted. Article 1 of this Decree states that: "For each quintal of first-class chicle or chiquibul exported ... FYDEP (today CONAP) shall apply the following percentages:" (Table 7.4)

TABLE 7.4
Distribution of Benefits from Chicle Extracted in Petén

	% per unit	Subtotals
a) exclusive FYDEP funds	11	11%
b) consignment funds		
- Municipal tax	5	
- Social Welfare & Benefits	1	6%
c) operation expenditure		
- air & overland freight	10	
- packing & handling	4	14
d) payment to entrepreneur	26	26
e) payment to worker	43	43
f) the price benefit received by FYDEP by reason of humidity will be paid totally to the chiclero		
Total	100%	100%

Source: Decree 79-79, Municipality Archives, Flores.

Article 2 decrees: "Five percent of the consignment funds are allocated to the municipalities. FYDEP will distribute 3% to the producing municipalities and 2% among all the other municipalities of the department of the Petén in equal parts. Suchilma will receive 1% of the total price per quintal of chicle contracted, and the funds shall be allocated for social welfare and benefits."

Following the liquidation of FYDEP, Government Order 523-90 was issued. Article 2 of this Order provides: "The National Council for Protected Areas (CONAP) shall be

responsible for the coordination, exploitation and sale of chicle, and shall settle the accounts of cutters, entrepreneurs, municipalities and others for the 1989 harvest with resources from the sale of chicle. In the case of future harvests, there shall be created a trust under CONAP administration and according to the regulations issued by the Executive Branch for its operations."

7.6.3 Chiclero Expenditure and Benefits

Table 7.5 shows the 1990 prices for all relevant costs and the equipment used by a chiclero, taking into account the useful life of each item. This provides not only an accurate accounting of what the chicleros costs are, but important insight into the daily workings of the industry.

TABLE 7.5
Chiclero Expenditures per Day

	Unit Price (Q)	Total	Useful life (years)	Value per day (Q)
rubber covered bag	17.50	17.50	5	0.009
15 small collecting bags	1.75	26.25	5	0.014
1 large collecting bag	9.80	9.80	5	0.005
3 files	11.20	33.60	7 months	0.160
1 grindstone	7.00	7.00	7 months	0.033
1 chicle machete	45.00	45.00	3	0.041
1 machete	30.00	30.00	3	0.027
1 pair of spurs	65.00	65.00	5	0.035
2 pairs of spur belts	4.55	4.55	1	0.035
3 lbs. paraffin	4.55	13.65	1	0.037
10 lbs. rope	8.10	81.00	1	0.221
2 burlap sacks	12.20	24.40	2	0.033
2 pairs boots	15.00	30.00	1	0.082
2 pairs trousers	25.00	50.00	1	0.136
2 shirts	15.00	30.00	1	0.082
1 hammock	45.00	45.00	4	0.030
1 mosquito net				
Monthly payment to cook	20.00	140.00	7 months	0.666
Monthly payment, laundry	5.00	35.00	7 months	0.166
Food in kitchen	50.00	350.00	7 months	1.666
Personal groceries	50.00	350.00	7 months	1.666
TOTAL DAILY COSTS				5.180

Source: Chicleros; field data, 1990. Q5.00 = US$1.00.

The average gross daily benefits received by the chiclero, assuming a harvest of 3.6 kgs (13 lbs) with an export value of, in 1990, $3.85/kg, an exchange rate of US$1.00 = Q5.00, are Q48.84. Hence, the average daily net benefit is Q42.40. As noted, the average gross daily wage for rural labor during 1990 varied from Q5.00 to Q10.00.

7.7 Sustainability of the Chicle Industry

Chicle harvesting has played a key role in the region's history. As Schwartz (1990) notes: "For most of this century, the economic well-being of most Peteneros and of their communities was based largely on a single activity--the production of chicle for overseas export." The benefits of current harvesting continue as an important component of the employment strategies of many Reserve region inhabitants: for those who harvest chicle, it is their most important source of income.

Harvesting impacts exist, but determining the actual mortality or percentage reduction in diameter size, reproduction, and latex production remains the subject of future investigation. We note that current harvest levels are about one-fourth the level during the industry's peak some 40-50 years ago. This suggests that harvesting can be increased, and certain aspects of the international market indicate such an increase is occurring, in particular the growth in natural food products. That past harvesting levels were higher says nothing at all, however, about sustainability. In this discussion we discuss how impacts, specifically mortality, must be considered in establishing a sustainable harvest level.

7.7.1 Potential Yields and the Forest Area Needed to Supply International Demand

In order to calculate the area of upland forest necessary to meet international demand, several variables must be considered. They are the rest time between harvests, the percentage of the population harvested, the mean yield per tree, and the population density.

There are a wide range of views on how long a tree must "rest" between tappings. Older chicleros, when reflecting on their past, note that it was common to wait up to 15 years

before returning to the same tree. The current practice is about five years, though more research is need to document this conclusively. The rest time has changed for two reasons. First, high-yield, relatively untapped stands are nonexistent and plant population densities have been reduced. Second, the increasing importance of a cash economy has resulted in greater economic expectations among harvesters. The exact rest period is necessary to ensure, across a population, a sustainable level of production is uncertain. We present a range, calculating the area of forest needed for rest periods of five and eight years.

Table 7.6 presents an estimate of the forest area needed to supply international demand for chicle. The calculations assume that only trees 30 cm and larger in diameter are tapped, though chicleros generally begin to tap trees when they reach 20 cm in diameter (Figures 7.2A, B, and C). In order to calculate the forest area needed, we assume each tree produces 0.91 kg (2.0 lb) of latex, which, when cooked, weighs 0.46 kg (1.0 lb), a weight loss of 50%. We make the calculations based on exports of 522,727 kg or 11,500 quintals, a value 15% greater than that now exported annually.

The greater the rest time allowed for each tree, the greater the area of forest needed to meet international demand. As Table 7.6 indicates, the estimated amount of forest needed to supply 11,500 quintals ranges from 3,075 km^2 to 4,752 km^2. Returning to an important point made earlier, we note that the extent of productive forest is unknown. Nonetheless, our experience, interviews, and existing vegetation maps suggest that of the 7,500 sq km Multiple Use Area, at least 3,000-4,000 km^2 are chicle-producing forest. The buffer zone around the Reserve is also available for chicle production.

A sample calculation for the computation of forest area needed is as follows:

Yield (kg/ha/yr) = 47 trees/ha * 0.48 (% > 30 cm DBH) * 0.2 (# of trees available annually under a five year rotation) * 0.9 kg/tree (raw yield) * 0.5 (reduction on cooking) = 2.0 kg/ha/yr of processed latex

Forest Area Needed (km^2) = 522,727 kg/2.0 kg/ha/yr * 1 km^2/100 ha = 2,614 km^2

TABLE 7.6
Area of forest needed to supply international demand for chicle based on production of 11,500 quintals (522,727 kg).

Area	Density per ha	% > 30 cm DBH	Forest Rotation of five years: Yield** kg/ha/yr (lb/ha/yr)	Forest Rotation of five years: Forest Area (km^2)	Forest Rotation of eight years: Yield** kg/ha/yr (lb/ha/yr)	Forest Rotation of eight years: Forest Area (km^2)
Carmelita	47	48%	2.0 (4.4)	2,614	1.3 (2.9)	4,021
Uaxactún	33	48%	1.4 (3.1)	3,734	0.9 (2.0)	5,808
Yaxhá	23	71%	1.5 (3.2)	3,485	0.9 (2.0)	5,808
Average	34.3	55%*	1.7 (3.7)	3,075	1.1 (2.3)	4,752

Source: Field data, 1990.

* Weighted average.
** Assumes % > 30 cm DBH and loss of weight on cooking in calculation.

Assumptions: Processed yield of 0.46 kg, i.e. 1 lb. per tree; processed weight is 50% of harvested weight; only trees of DBH > 30 cm harvested; no adulterants are used.

Based on a rotation time of five years, this level of production seems feasible based on current estimates of available forest. Based upon a rest time of eight years, however, it appears that exports cannot be sustainably increased. Additionally, continued exports, as is the case with allspice production, must be accompanied by certain regulatory changes and better characterization of harvesting impacts. As these studies and improved regulation provide more information, the estimate of productive forest and the amount of chicle this forest is capable of producing will be further refined.

7.8 Recommendations

- Investigate growth rates and mortality of trees in different size classes. Studies should include a variety of tapping regimes (time between tapping, tapping methods), with controls and replications. While current harvesting techniques result in mortality, they are, according to the work of Karling and Lundell, the best available. However, little or no work on tapping methods has been done since that of Karling and Lundell in the 1930s. Therefore new tapping techniques should be investigated. Methods to improve regeneration and growth should also be investigated.

- Initiate research to answer or clarify the following questions (per A. Jorgenson):
  - How many chicleros are there in Petén?
  - Do all chicleros extract about the same amount of chicle?
  - Do all chicleros harvest chicle throughout the entire harvesting season?
  - Do chicleros really wait the five to seven years they say are necessary for the trees to

recover?

- o How do chicleros know how many years have passed since the last tapping?
- o Is there a significant difference between the yield of zapote "rojo" and "blanco"?
- o Do chicleros intentionally or unintentionally manage chicle trees to improve regeneration and productivity?

o Reduce population decline due to tapping mortality. The long-established chiclero culture reinforces many values that promote sustainability. The pride of the chiclero, the importance of apprenticing, a long regulatory history, and strong industry organization all combine to provide a collective concern for the condition of the resource. These characteristics should be enhanced and formalized to produce a training regimen that will improve the consistency and quality of tapping. Periodic training of this sort will also permit new techniques to be introduced and that Research as described above will also aid in reducing mortality.

o Cap chicle production at 12,000 qq (1,200,000 lbs.; 545,455 kgs) per year. Until more information is available, we should assume that this is the maximum sustainable yield from the Area Uso Multiple of the Reserve.

o Implement a basic regulatory strategy for chicle extraction. A basic regulatory strategy can be implemented immediately, one that ensures a minimum rest time for trees between harvests. The basic idea is to establish forest rotations, restricting the use of camps in specific forest regions for a period of time deemed necessary for the sufficient recuperation

of a given M. zapota population. We suggest a minimum rotation time of seven years based on yield data and very rough estimates of the number of chicozapote trees in the Area Uso Multiple. Future research will identify a rotation cycle that provides a sustained-yield of latex, taking into account mortality, diminished productivity, fruiting, regeneration, and annual growth. We caution that sustainability raises not only ecological questions, but equally important social and economic questions. Any value for rotations that is experimentally derived must be carefully balanced with the needs and expectations of the region's inhabitants, as well as with the demands of the international market.

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