Jacob

CHAMAEDOREA (XATE) IN THE GREATER MAYA MOUNTAINS AND THE CHIQUIBUL FOREST RESERVE, BELIZE: AN ECONOMIC ASSESSMENT OF A NON-TIMBER FOREST PRODUCT[1]

SAMUEL G. M. BRIDGEWATER, PHILIPPA PICKLES, NANCY C. GARWOOD, MALCOLM PENN, RICHARD M. BATEMAN, HOLLY PORTER MORGAN, NICHOLAS WICKS, NICODEMOUS BOL

Samuel G. M. Bridgewater (*Natural History Museum, Cromwell Road, London, SW7 5BD, UK; email: s.bridgewater@nhm.ac.uk*). Philippa Pickles (*BMT Cordah Ltd., Pentlands Science Park, Edinburgh, EH26 OPZ*), Nancy C. Garwood (*Department of Plant Biology, Southern Illinois University, Carbondale, IL 62901, USA*), Malcolm Penn (*Natural History Museum, Cromwell Road, London, SW7 SBD, UK*), Richard M. Bateman (*Natural History Museum, Cromwell Road, London, SW75BD, UK*), Holly Porter Morgan (*The New York Botanical Garden, Institute of Systematic Botany, New York, 10458-5126, USA*), Nicholas Wicks (*Ya'axchi Conservation Trust, Punta Gorda, Toledo District, Belize*), and Nicodemus Bol (*Earthwatch Institute, San Antonio Road, foe Taylor Creek Bridge, Punta Gorda Town, Belize*).
CHAMAEDOREA (XATE) IN THE GREATER MAYA MOUNTAINS AND THE CHIQUIBUL FOREST RESERVE, BELIZE: AN ECONOMIC ASSESSMENT OF A NON-TIMBER FOREST PRODUCT. *Economic Botany* 60(3):265-283, 2006. *Of the twelve species of Chamaedorea palm recorded for Belize, three are of international economic value because their cut leaves (xate) are traded in the floricultural industry. Traditionally, Belize has not harvested xate, the industry being based in Mexico and Guatemala. However, a decline in wild xate stocks in these countries means Guatemalan leaf harvesters now illegally harvest xate in Belize. To assess the local abundance of the Belizean* Chamaedorea *resource, its economic value, and the extent to which it has been illegally harvested, 209 plots measuring* 20 *meters (m) by* 20 *m were established in the Greater Maya Mountains (GMM) in western Belize, which includes the Chiquibul Forest Reserve (CFR). We estimate that* 37.8 *million leaves with a value of U.S. $0.3 million to xateros have been extracted from the CFR. The standing export value is calculated as U.S.* $1.8 *million for the CFR and U.S. $5 million for the GMM.*

Key Words: *Chamaedorea,* xate, Belize, economic botany, sustainable harvesting.

INTRODUCTION

This paper makes an economic assessment of the *Chamaedorea* leaf (xate) resource of the forests of Belize's Greater Maya Mountains (GMM). In particular, it provides data on the Chiquibul Forest Reserve (CFR). The forests of this region lie adjacent to the Guatemalan border and so have been the focus of recent illegal harvesting of this non-timber forest product (NTFP) by Guatemalan xateros (xate leaf-cutters) who harvest the leaves of certain *Chamaedorea* palm species for the international floricultural industry. The western border of Belize is not clearly demarcated and crosses a contiguous forest area between the two countries. However, satellite images of the border show marked deforestation on the Guatemalan side, with relatively little clearance on the Belizean side. A number of Guatemalan communities lie close to the border, within easy reach of the CFR, and human pressure within the forest tends to come from across the border. In contrast, access to the forest area via Belize is more problematic. There are no communities within the forested area of the GMM; the nearest set-

[1] Received 10 October 2005; accepted on 15 March 2006.

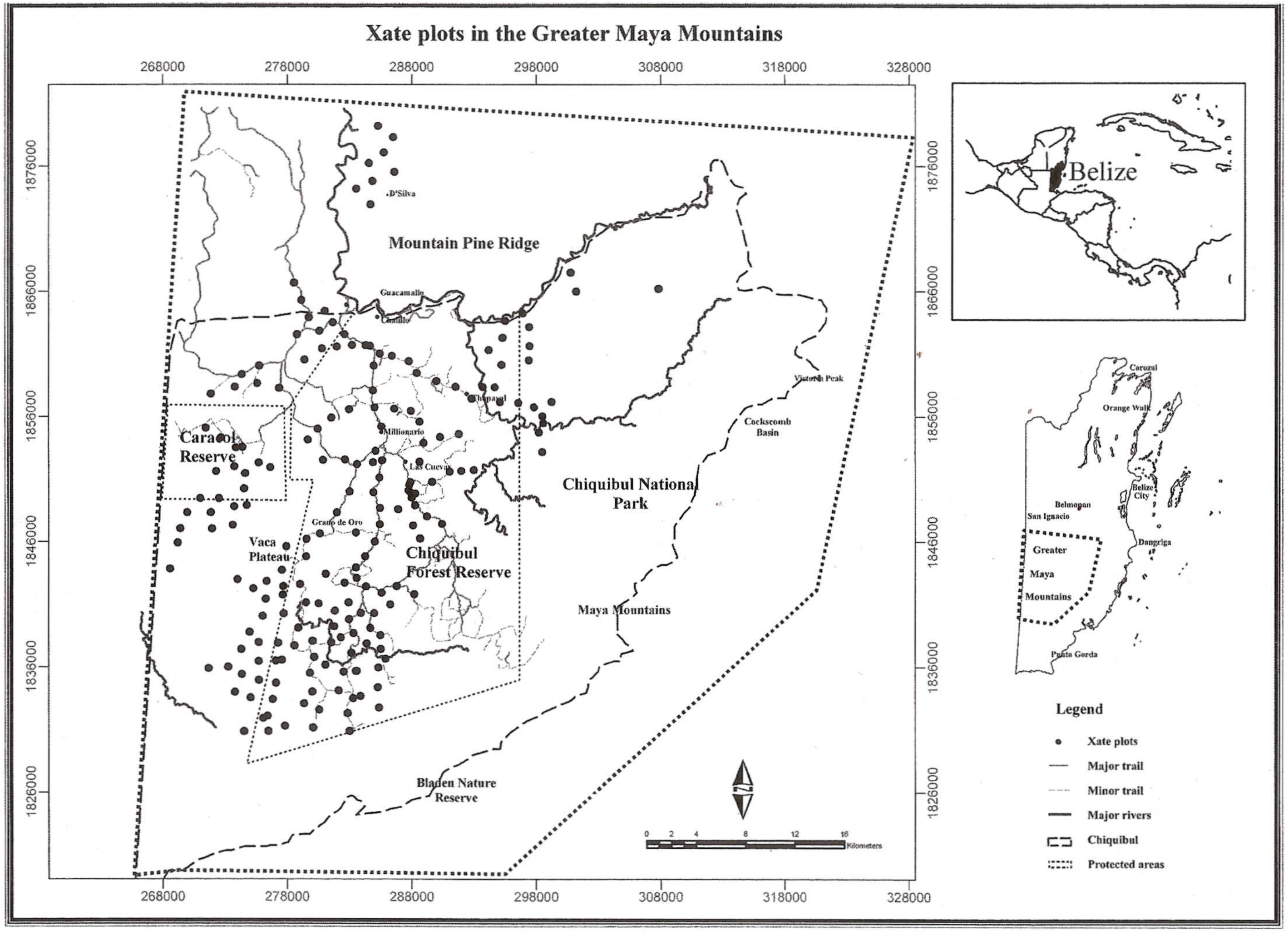

Fig. 1. Map of Belize showing the location of the Chiquibul Forest Reserve within the Greater Maya Mountains and the 209 survey sites.

tlement is approximately one hour away by vehicle.

Comprising 329,000 hectares (ha) (Penn et al. 2004), the region of the GMM represents Belize's largest forest area and is one of the areas in Belize of greatest potential economic value of xate, The CFR covers an area of 59,822 ha and lies wholly within the GMM. Its border on the southwest, east, and south is the Chiquibul National Park, on the northwest edge, the border is the Caracol Archaeological Reserve (CAR), and on the north side, it is the Mountain Pine Ridge (Figure 1). The CFR is managed for conservation, timber production, and non-timber forest products (NTFPs), while the CNP is managed for conservation, with no economic activities currently permitted. There has been a recent desire to establish a Belizean xate industry, but lack of data on the xate resource has hindered its development (Government of Belize, 2004). Legislation permits extraction of NTFPs from the CFR. The first xate harvesting license for this area was issued by the Belize Forest Department in 2005, but this has not been activated. Therefore, all harvesting of leaf in the Chiquibul and the GMM has been and continues to be illegal.

We provide abundance and economic data for *C. ernesti-augustii* H. A. Wendl., *C. oblongata* Mart., and *C. elegans* Mart., the three species present within the CFR whose leaves are of regional commercial significance. We also assess the extent to which the *Chamaedorea* resource has been illegally harvested. The significance of the findings is discussed within the framework of regional economics of the xate industry. We give a review of the key factors that need to be addressed if Belize is to establish its own sustainable industry.

BACKGROUND

Chamaedorea is the largest palm genus in the Neotropics, comprising between 80 and 100 species (Henderson et al. 1995; Hodel 1992). A recent molecular phylogenetic study (Thomas et al. 2006) showed that the genus is a natural group, but suggested that further species-level studies are desirable. *Chamaedorea* occurs as an important understorey component in rain forest and cloud forest from Central Mexico to Bolivia, and the genus has attracted much interest due to its considerable economic and social value (Castillo Mont et al. 1994; Endress et al. 2004; Rodel 1992; Oyama 1992; Vovides and Garcia Bielma 1994). Although there are several traditional uses for *Chamaedorea* species in Central America, the striking appearance and resistance to wilting of some species have attracted international floricultural and horticultural interest. Their trade as houseplants and as a source of foliage for flower arrangements has grown into a global industry over the past 50 years (CEC 2002; Rodel 1992).

According to The World Conservation Union (IUCN), *Chamaedorea* are among the world's most endangered palms, with around 75 percent of the species threatened (Walter and Gillett 1998). Of the twelve species found in Belize, three are considered under threat (Table 1). The biggest threat to wild *Chamaedorea* populations in Central America is the destruction of their rainforest habitat (Johnson 1997; Vovides and Garcia Bielma 1994). In Belize, this deforestation has been largely due to clearance for development (expansion oftowns and road construction) and agriculture (mainly citrus, sugar cane, bananas, and milpa farmin~).

A second threat to *Chamaedorea* is the large-scale exportation of xate leaf and seed, which began in the 1950s and has since progressively increased (CEC 2002; Nations 1992; Vovides and Garcia Bielma 1994). The resulting over-harvesting has diminished some *Chamaedorea* populations (Endress et al. 2004; Radachowsky et al. 2004; Oyama 1992). In general, species harvested for their leaves (e.g., *C. ernesti-augustii)* have fared better than those harvested for their seeds (e.g., *C. tenella* H. Wendl.) or stems (e.g., *C. elatior* Mart.) (Mendoza and Oyama 1999). Regional over-harvesting of leaves has been exacerbated because xateros are paid by the number of leaves collected rather than the quality of harvested leaves. The industry is extremely wasteful; an estimated 60 to 70 percent of the collected leaves end up being discarded because they do not meet the exacting requirements of the export industry (Radachowsky et al. 2004; Grant 2004, pers. comm.).

Cut leaf from *Chamaedorea* is now one of northern Central America's most important NTFPs (CEC 2002). For example, xate exports from the Maya Biosphere Reserve (MBR) in the Selva Maya (Guatemala) were worth more than U.S. $4 million in 2000 (Alianza Para Un Mundo Justo 2003). This is comparable in economic value to the timber harvest in the region, which was estimated at between U.S. $3.5 million and

U.S. $5 million in 2003 (Chemonics International 2003). Vovides and Garcia Bielma (1994) stated that the total palm foliage market for the region exceeded U.S. $30 million per year. The harvesting of xate leaf is the principal source of income for local communities in some areas, such as the cutting of *C. radicalis* Mart. within the El Cielo Biosphere Reserve in Mexico (Jimenez Perez et al. 1999), and the harvesting of *C. oblongata, C. elegans, C. neurochlamys* and *C. emesti-augustii* in the MBR of Guatemala (Radachowsky et al. 2004). However, the majority of the world's xate leaf originates from Central Mexico (CEC 2002; Heinzman and Reining 1988).

In the Peten region of Guatemala, xate is usually harvested in conjunction with other NTFPs such as chicle (the latex of *Manilkara zapota* (L.) P. Royen, which is used in some brands of chewing gum) and the food flavoring allspice (*Pimienta dioica* (L.) Merr.). The sorting of harvested xate leaf also provides employment in national processing centers outside of collection regions, and the total xate harvest provides an estimated 6,000 to 10,000 seasonal and full-time jobs in Guatemala (FIPA and USAlD 2002; Rainforest Alliance 2004) and over 10,000 people in Mexico (Vovides and Garcia BielrrS.a1994).

The village of Carmelita (Peten) provides an example of how the xate industry operates in Guatemala. This community has a 45-year forest concession to harvest timber and NTFPs in a 54,000-hectare area of the Maya Biosphere Reserve (MBR), with the village's harvesters holding communal rights. The Carmelita Cooperative manages its dedicated forest area, and ca. 50 xateros are involved cutting xate leaf and selling it to ca. 10 contractors. Xateros bundle harvested leaves in groups of (usually) 40, with two such bundles (80 leaves) forming what is locally known as a "gruesa." This is the standard market unit of trade. Although such cooperatives are sometimes heralded as being models of sustainable harvesting, local xateros in Carmelita are reporting a decrease in xate stocks (Radachowsky et al. 2004; Trujillo 2004, pers. comm.). This has prompted interest in enrichment planting. In total, throughout the MBR there are ca. 13 xate firms operating and ca. 250 xate contractors. The Consejo Nacional de Areas Protegidas (CONAP), the government qgency responsible for regulating and controlling the xate industry, has established harvesting regulations to improve management practices. These include that only two leaves should be cut per plant per year, and that these should only be of high quality (Radachowsky et al. 2004). However, there is only one NTFP technician in CONAP, and monitoring of concessions is therefore impossible. The harvesting of xate has been described by some CONAP officials as being "xate mining," even in areas reported to be using sustainable management..

Cut leaf has been harvested from the wild since the beginning of the commercial xate industry. In recent years, there has been a trend toward plantations, due to the favorable economics of such large-scale intensive enterprises relative to the decreased yields of xate obtained from the wild due to long-term over-harvesting (Endress et al. 2004; Oyarna 1990). In addition, with loca1 yields in decline, individual xate collectors (xateros) in Guatemala have been illegally crossing into Belize, a country where xate has not traditionally been utilized as a NTFP and where the high-value species *C. emesti-augustii* is found in high abundance. No communities live within the Chiquibul National Park or Forest Reserve. The only permanent residence is the Las Cuevas Research Station. The staff at the Las Cuevas Research Station first observed xatero activities within the reserve in 2000, and since that time, leaf harvesting has been recorded at ever further distances from the Guatemalan border within the area. There is now a constant observed xatero presence in the Chiquibul, suggesting that the problem is acute, and a network of small foot trails and recently established larger horse tracks act as the primary routes feeding across the border into Guatemala. The smaller trails feed into a small number of larger tracks as the border is approached, much like the tributaries of a river.

METHODOLOGY

STUDY SITE

The CFR, which lies within the GMM (Figure 1), was first designated as a forest reserve in 1956 when it covered an area of 184,925.9 ha. In 1991, part of the reserve was reclassified as the Chiquibul National Park and the Caracol Archaeological Reserve. The current area of the CFR is 59,822 ha.

A review of the history of classification of vegetation types within the GMM and the CFR can be found in Penn et al. (2004). This work also provided a detailed vegetation classification scheme for the region. A contrasting classification was suggested by Meerman and Sabido (2001), which forms part of a nationwide ecosystems map. Both drew heavily on remote sensing techniques, and modified, adapted, and improved the earlier vegetation classifications prepared by Wright et al. (1959) and Iremonger and Brokaw (1995). Both recent classifications (Meerman and Sabido 2001; Penn et al. 2004) show that the majority of the CFR supports tropical broadleaf forest.

The region has a subtropical and strongly seasonal climate, with a marked dry season between February and June. Annual precipitation is ca. 1,500 millimeters in the northern part of the reserve (Johnson and Chaffey 1973). It is underlain largely by metamorphosed mudstone and shale. During the Cretaceous period, limestone was laid down over much of the area, although it has since been weathered in many areas (Bateson and Hall 1977).

RESOURCE ASSESSMENT

During 2003 and 2004, 209 plots measuring 20 meters (m) by 20 m were surveyed within forested regions of the GMM to assess the local abundance of xate and the impact of illegal harvesting. Of these, 123 were sited within the CFR, 63 within the surrounding Chiquibul National Park (CNP), 12 within the Caracol Archaeological Reserve (CAR), and 11 within the broadleaf forests on the western portion of the Mountain Pine Ridge (MPR). Given the great size of the study area, a systematic sampling method was chosen, although a degree of pragmatism was adopted due to the inhospitable terrain of many areas. In much of the CFR, few areas are very far from old logging tracks and newer xatero trails and, in such areas, these were used as transects. Elsewhere, transects followed compass directions. Where possible, plots were placed at 1.5 kilometer (km) intervals along the transects, together sampling a wide variety of topographical locations. Dependent on the toss of a coin, at each site the sample plot was established 50 m either left or right of the global positioning system (GPS) location from the direction of the transect walked to r~ach the site. Coverage of the CFR was especially good, although some areas of the CNP were inaccessible and not so well sampled (Figure 1). The region inventoried covered an area of approximately 40 km by 30 km stretching from the MPR in the north to the Maya Divide in the south and from the Guatemalan border in the west to the Raspaculo River in the east (Figure 1). Universal Transverse Mercator (UTM) GPS coordinates (World Geodetic System or WGS Zone 17) were recorded for each site. Within each plot, all *Chamaedorea* palms greater than 20 centimeters (cm) in height were identified to species level and the following data were recorded for each plant: number of leaves; number of cut leaves (easily ascertained as cut petioles); and number of high quality (unblemished), commercially valuable leaves. lllegal xateros currently operating in the CFR cut both high-quality and low-quality blemished leaves of low commercial value, as they are paid by quantity rather than quality of leaves. However, as only unblemished leaves have high value in the export market, any potential future Belizean wild-harvested xate industry should be based on harvesters being paid by quality.

ECONOMIC ASSESSMENT

A literature review on the economics of xate was conducted to obtain a historical and regional perspective on the xate industry. Information on local supply chains and economics was gathered via semi-structured interviews undertaken with those involved in the xate trade in Belize and Guatemala. This survey included Guatemalan xateros (interviewed in Guatemala and in Belize, where they were operating illegally), xate buyers in the Peten, and several nongovernmental organizations (NGOs) attempting to establish commercial xate plantations in Guatemala. Alianza para un Mundo Justo (AMJ) and the Asociaci6n Coordinadora Indfgena y Campesina de Agroforesteria Comunitaria Centroamericana (ACICAFOC) were the two primary NGOs interviewed. For those informants who did not wish to be identified (mosily illegal xateros), confidentiality and anonymity were assured. Data obtained from the resource and economic assessments were combined to estimate the extent and monetary value of the illegal harvesting in the Chiquibul Forest.

RESULTS

RESOURCE ASSESSMENT (GREATER MAYA MOUNTAINS)

Of the 209 plots sampled across the GMM, 22 (11 percent) ~ontained no *Chamaedorea*.

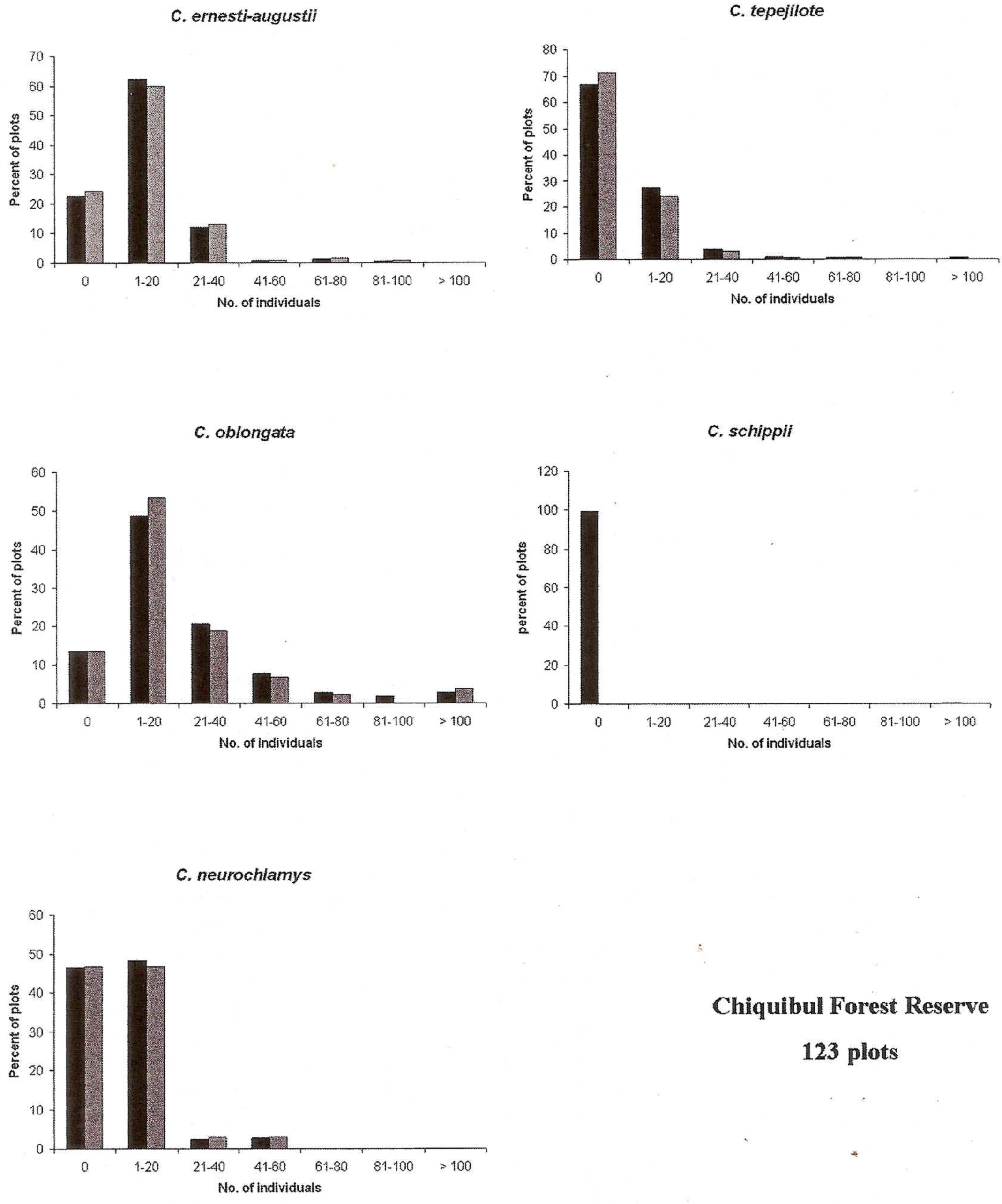

Fig. 2. Abundance of five *Chamaedorea* species in the Greater Maya Mountains and the Chiquibul Forest Reserve.

Five *Chamaedorea* species were found in the plots (Table 1). Of the 8,495 palms measured, 1,900 (22 percent) were C. *ernesti-augustii* (fishtail), 4,637 (55 percent) were C. *oblongata,* 1,037 (12 percent) were C. *neurochlamys,* 791 (9 percent) were C. *tepejilote* Liebm., and 159 (2 percent) were C. *schippii* Burrett. In addition, C. *elegans* was encountered outside the survey plots in rare, but locally abundant populations. The abundance of each *Chamaedorea* species is shown in Figure 2. Average number of palms per plot was less than 10 for C. *ernesti-augustii,* C. *neurochlamys* Burrett, C. *tepejilote* and C. *schippii,* but more than 20 palms per plot for C. *oblongata* (Table 2). The highest and lowest densities recorded for each species per plot were C. *oblongata (208/0),* C. *ernesti-augustii (84/0),* C. *neurochlamys (79/0),* C. *tepejilote (104/0),* and C. *schippii (159/0).*

The only species harvested was fishtail. Of the 161 plots (77 percent) in which this species was noted, 138 plots (86 percent) had been harvested. Of the 1,900 fishtail palms in the plots, 1,423 palms (75 percent) had been cut. In the 22 unharvested plots, the average number of leaves per plant was six, but this dropped to 2.9 in the harvested plots. The average number of cut leaves per plant was 2.5. In comparison, C. *oblongata* was recorded in 181 (87 percent) plots, with an average leaf number of 3.6. Although traded internationally, no harvested individuals were noted of this species. In terms of commercial leaf, the average number of high quality "unblemished" leaves per plot for C. *ernesti-augustii* and C. *oblongata* were 4.7 and 11, respectively. The maximum number of commercial leaves recorded per plot was 34 for C. *ernesti-augustii* and 128 for C. *oblongata.* However, only 16 plots (9 percent) had more than 15 commercial leaves of C. *ernesti-augustii,* whereas 49 plots (26 percent) had more than 15 commercial leaves of C. *oblongata.*

TABLE 1: *CHAMAEDOREA* SPECIES IN BELIZE, THE GREATER MAYA MOUNTAINS AND THE CHIQUIBUL FOREST RESERVE: CONSERVATION STATUS AND ABUNDANCE.

	IUCN Red List category (Waiter & Oillett 1998)	Xate species	Presence in Greater Maya mountains	Abundance in survey plots in Greater Maya Mountains	Presence in the Chiquibul Forest Reserve	Abundance in survey plors in the Chiquibul Forest Reserve
C. *adscendens* (Dammer) Burret	vulnerable		0	0	0	0
C. *arenbergiana* H. A. Wendl.	not listed		0	0	0	0
C. *elegans* Mart.	not listed	**	+	0	+	0
C. *ernesti-augustii* H. A. Wendl.	not listed	**	++	1900	++	1,211
C. *geonomiformis* H. A. Wendl.	indeterminate		0	0	0	0
C. *schippi* Burret	vulnerable		+	159	+	0
C. *neurochlamys* Burrett	not listed		++	1037	++	709
C. *oblongata* Mart.	not listed	**	++	4637	++	2,858
C. *pinnatifrons* (Jacq.f.) Oerstedt	not listed		0	0	0	0
C. *seifrizii* Burret	vulnerable		0	0	0	0
C. *tepejilote* Liebm.	not listed	*	++	791	++	423
C. *woodsoniana* L. H. Bailey	not listed		0	0	0	0
Total		4 spp.	6 spp.	8,495 plants	6 spp.	5,167 plants

Xate species: **, most important; *, less important.
Presence in the Greater Maya Mountains and the Chiquibul Forest: ++ abundant; + rare, 0 not known.
Abundance total number of stems in 209 plots (20 X 20 m; Greater Maya Mountains) and 123 plots (20 X 20 m; Chiquibul Forest Reserve).
† C. *neurochlamys* is sometimes included within the C. *pinnatifrons* complex (Henderson et al., 1995), but recent molecular work (Thomas et al. 2006) supports Hodel's (1992) separation of the two species.

TABLE 2: DENSITY, HARVESTING AND COMMERCIAL LEAF DATA FOR *CHAMAEDOREA* IN THE GREATER MAYA MOUNTAINS (GMM) AND THE CHIQUIBUL FOREST RESERVE (CFR)

	Average number per 20 X 20 m plot (N = 209 plots for GMM; N ~ 128 for CFR)										Average number cut leaves per plant		Average number of individuals per hectare	
	Individuals		Cut plants		Leaves		Cut leaves		Commercially valuable leaves					
Species	GMM	CFR	GMM	CFR	GMM	CFR	GMM	CFR	GMM	CFR	GMM	CFR	GMM	CFR
C. *emesti-augustii*	9.1	9.1	6.8	7.4	28.9	28.1	22.8	25.1	4.7	4.7	2.5	2.8	228	228
C. *oblongata*	22.1	21.5	0	0	80.4	77	0	0	11.0	11.4	0	0	553	538
C. *neurochlamys*	5.0	5.3	0	0	24.8	25.4	0	0	N.A.	N.A.	0	0	125	133
C. *tepejilote*	3.8	3.2	0	0	15	14	0	0	N.A.	N.A.	0	0	95	80
C. *schipii*	0.8	0	0	0	1.9	0	0	0	N.A.	N.A.	0	0	20	0

N.A. = not applicable.

RESOURCE ASSESSMENT (CHIQUIBUL FOREST RESERVE)

Results of this data subset (123 sites) were almost identical to those obtained for the GMM (209 sites), and are summarized in Tables 1 and 2.

ECONOMIC ASSESSMENT

The range of prices paid to xateros, according to figures obtained from interviews with xateros and others involved in the industry (including buyers), varied from V.S. $0.30 to *V.S. $1.70* for 100 leaves (Table 3). Average values from informants and other sources were *V.S. $0.77* for C. *ernesti-augustii,* but only *V.S.* $0.45 for C. *elegans* and *V.S.* $0.41 for C. *oblongata* (Table 3). However, prices fluctuate constantly, and the prices currently paid to harvesters for fishtail is increasing. Although not included in Table 3, one xatero reported being able to sell 100 leaves for *V.S.* $3.00. However, sometimes xateros inflate the prices they receive when questioned, and as this figure is several orders of magnitude higher than all the others, it was excluded. Information from interviewees indicated that several factors affect the price of a leaf, including identity, leaf size, seasonal demand, country of origin, and export destination. The recent high prices quoted for fishtail reflect its status as the species most in demand. Care should be taken when considering these figures because xateros talk in terms of "handfuls," "bunches," "bundles," and "sacks." Although an

TABLE 3: THE PRICE A HARVESTER OR PRODUCER RECEIVES FOR XATÉ.

		Price Paid to Harvesters/Producers (V.S. $/100 leaves)		
	Location (Data source) Species	C. *elegans*	C. *ernesti-augustii*	C. *oblongata*
Personal Communication	Carmelita, Guatemala (Trujillo 2004, pers. comm.)	0.30	—	0.30
	Peten, Guatemala (Grant 2004, pers. comm.	—	1.00	—
	Peten, Guatemala (Guzman 2004, pers. comm.)	—	—	0.36
	Guatemala (du P100y 2004, pers. comm., citing figures from the NGO ACICAFOC)	0.39	0.49	0.42
	Union Maya Itza plantation, Guatemala (Mesh 2004, pers. comm.)	0.34	1.70	0.34
	Average (mean)	0.34	1.06	0.36
Literature Review	FIPNAID (2002), Guatemala	0.28	0.41	0.28
	CEC (2002), Mexico	1.02	0.60	0.69
	Ramirez (2002), Mexico	0.35	0.44	0.38
	Average (mean)	0.55	0.48	0.45
	Overall Average (mean)	0.45	0.77	0.41

attempt has been made to quantify these non-standard measures, each term means a different number of leaves to different people.

The biggest markets for xate continue to be the United States and Europe, primarily Holland and Germany (CEC 2002), although there is also significant demand from Japan and Russia. Fresh markets also are emerging in the new European Union (EU) countries, such as Poland (Alianza para un Mundo Justo 2003; Grant 2004, pers. comm.). Different markets favor different species of *Charnaedorea,* although market trends vary through time. In the past, Europe has preferred C. *elegans* whereas the United States has favored C. *oblongata* (Castillo Mont 1999; Nations 1992). However, C. *ernesti-augustii(fish-*tail palm) has become more popular in recent years and is now the main species exported to Europe from Guatemala (CREM 2002). The majority of Guatemala's exports, however, are destined for the USA (CREM 2002); from 1990 to 1998 annual exports more than doubled, reaching U.S. $5.6 million. However, in recent years they have dropped (to U.S. $4.2 million in 2001), due to a decline in the readily available resource (Alianza para un Mundo Justo 2003).

EXTENT AND VALUE OF ILLEGAL HARVESTING (CHIQUIBUL FOREST RESERVE)

We estimate that there are approximately 13.5 million fishtail palms in the CFR, based on an average number of 9.1 fishtails per 20 x 20 m plot (Table 2), equivalent to 228 palms per ha, and a forested area of 59,022 ha for the CFR. Pine savanna, which covers 800 ha (1.5 percent) of the CFR (Penn et al. 2004), has been excluded from our calculations. Using the average of 2.8 cut leaves per plant from the survey plots (Table 2) and an average price of U.S. $0.77 per 100 leaves (Table 3), we estimate that 37.8 million leaves of fishtail, worth just under U.S. $0.3 million to the harvesters alone, have been removed from the CFR since illegal harvesting began. Although when xate harvesting began in the CFR is not known with certainty, harvesting has occurred for at least we years (Bol 2004, pers. comm.). A rough estimate suggests that about 7.6 million leaves, worth U.S. $58,500 (using average prices), have been harvested annually over the last five years. Factoring in the resale value of the commercially valuable leaves (60 percent of leaves harvested by the xateros are blemished and discarded) would further increase the economic impact of xate on local economies. In early 2005, for example, an export bunch of 15 fishtail leaves had a value of ca. U.S. $4.00 (Grant 2004, pers. comm.). This is over 34 times the value received by xateros.

We estimate the current value to xateros of the standing crop of commercially valuable xate leaves in the CFR for C. *ernesti-augustii* and C. *oblongtata* in 2004 as ca. U.S. $122,000, if average prices are used. Of this amount, C. *ernesti-augustii* would contribute U.S. $53,400: its leaves have higher value (U.S. $0.77 average/lOO, as shown in Table 3) but are less abundant (4.7 commercial leaves/plot, as shown in Table 2, which is equivalent to 117.5 leaves/ha). *Chamaedorea oblongata* would contribute ca. U.S. $69,000. Its leaves have lower value (U.S. $0.411100, as shown in Table 3) but are more abundant (11.4 commercial leaves/plot, as shown in Table 2, and is equivalent to 285 leaves/ha). Assuming all harvested leaves survived transportation, the current standing export value of the fishtail resource across the CFR is estimated at U.S. $1.8 million (based on an export value of U.S. $4.00 per IS leaves, as shown in Table 3).

ABUNDANCE AND VALUE OF XATE (GREATER MAYA MOUNTAINS)

The region of the GMM covers an area of 329,100 ha (Penn et al. 2004). As the sampling over the GMM was less complete for than for the CFR alone, only preliminary estimates of xate abundance and value are attempted here. Much of the GMM does not support vegetation suitable for *Chamaedorea* (Table 4). For example, 34,200 ha of the region are covered by disturbed open vegetation, savanna, pine ridge or milpa (Penn et al. 2004). Estimating *Cham{ledorea* resource levels across the region is complicated further by the fact that much of the western portion of the Chiquibul National Park lies on relatively acid soils and so is un-!ikely to contmn the lime-loving fishtail.

We estimate that only 160,800 ha of the GMM are suitable for *Chamaedorea* growth (Table 4). If so, we calculate that approximately 36.6 million fishtail palms and 88.8 million C. *oblongata* occur in the GMM. These calculations are based on an average number of 9.1 fishtails per 20 x 20 m plot, equivalent to 228

TABLE 4: VEGETATION TYPES OF THE GREATER MAYA MOUNTAINS AND THE PROBABLE OCCURRENCE OF XATE WITHIN THEM.

Class Number	Class Description (based on Penn et al. 2004)	Area (hectares)	Definite or probable presence of commercial xaté species
Class 1	Deciduous forest	66,400	√
Class la	Dry deciduous forest	300	
Class Ib	Sinkhole	—	√
Class lc	Deciduous western forest	5,700	√
Class 2	Seasonal forest	24,500	√
Class 2a	Seasonal high forest	27,800	
Class 3	Semi-evergreen forest (cohune ridge)	500	√
Class 4	Semi-evergreen forest (highland)	8,800	
Class 4a	Semi-evergreen forest (lowland)	44,300	√
Class 5	Transitional semi-evergreen forest	40,700	
Class 6	Evergreen southern forest	12,300	
Class 7	Semi-evergreen forest	34,200	
Class 8	Semi-evergreen forest (broken ridge)	5,400	√
Class 9	Low evergreen palm forest	4,700	
Class 10	Evergreen cohune forest	2,500	√
Class 11	Gallery forest	1,400	
Class 12	High evergreen forest	5,900	√
Class 13	Evergreen palm forest	1,100	
Class 14	Limestone hilltop forest	1,100	
Class 15	Alluvial forest	5,600	√
Class 16	Riverine	1,600	
Class 17	Pine Forest	10,300	
Class 18	Oak and pine	900	
Class 19	Transitional pine, grass and palmettos	10,900	
Class 20	Open grass	2,200	
Class 21	Open with *Pinus oocarpa*	800	
Class 22	Pine, oak and *Liquidamber*	3,400	
Class 23	Tigerbush	100	
Class 24	High altitude forest	100	
Class 25	Open pine scrub forest	1,200	
Class 26	Fern dominated	1,000	
Class 27	Milpa zone	3,300	
	Total area of classification	329,100	
	Total area with commercial xate	160,800	

palms per ha, and an average of 22.1 *C. oblongata* per 20 x 20 m plot, equivalent to 553 palms per ha (Table 2).

We have not attempted to estimate the value of leaf illegally extracted from the GMM as, in contrast to the CFR, it is not possible to ascertain what proportion of the unsampled area has been visited by xateros. However, we estimate the current value of the standing crop of commercially valuable xate leaves in the GMM for *C. ernesti-augustii* and *C. oblongtata* as U.S. $333,000. *Chamaedorea ernesti-augustii* would contribute U.S. $145,000 while *C. oblongata* would contribute ca. U.S. $188,000. Assuming all harvested leaves survived transportation, the standing export value of the fishtail resource alone across the GMM is estimated at U.S. $5 million (based on an export value of U.S. $4.00 per 15 leaves). However, the exploitation of NTFPs is not currently permitted within Belizean national parks and archaeological reserves.

DISCUSSION

RESOURCE ABUNDANCE

Chamaedorea is clearly widespread across the CFR and the GMM, and is an important component of the understorey vegetation. *Chamaedorea oblongata* is the most abundant of the five species; It IS more than twice as abundant as C. *ernesti-augustii,* the second-most common *Chamaedorea* species. These are the only two species growing in the region with both commercially valuable leaves and sufficiently high densities to be of economic value. Average density of *Chamaedorea* species in the GMM ranged from 20/ha for C. *schippii* to 553/ha for C. *oblongata.* *Chamaedorea schippii* was only recorded in one plot, situated on a hilltop, reflecting the predilection of this clumping species for limestone hill summits (Hodel 1992). Natural *Chamaedorea* abundances are known to vary greatly, depending on the species and the region. In the neighboring Peten region of Guatemala, for example, densities of between 771 and 1,951 individuals/ha have been recorded for C. *oblongata,* and between 565 and 1,017 individuals/ha for C. *elegans* (Reining et al. 1992; Radachowsky et al. 2004). These are higher than those reported here for the Chiquibul Forest of Belize. In contrast, densities of fishtail calculated from the few studies conducted in the Peten seem to be far lower than those in Belize. For example, Radchowsky et al. (2004) found less than 50 fishtail individuals in 364 plots, each 5 x 10 m. This is equivalent to 27 plants/ha, less than 10 percent of the abundance found in this study. In Veracruz (Mexico), populations of C. *tenella* range between 450 and 800 per ha, whereas populations of C. *metallica* O. E. Cook ex H. E. Moore exceed 2,400 per ha (Vovides and Garcia Bielma 1994).

EXTENT AND VALUE OF ILLEGAL HARVESTING

Although both C. *ernesti-augustii* and C. *oblongata* have significant economic value, only C. *ernesti-augustii* was recorded as having been harvested. Most likely, this is due to a dwindling resource base in Guatemala and the premium prices currently paid for fishtail leaves. However, should market forces change, the situation could be reversed. Although the floricultural industry has consistently demanded xate leaves for many decades, the market is whimsical, with the favored species constantly changing.

All economic benefits of xate collection in Belize have benefited Guatemala. No evidence of trade within Belize was found, although at the time of submission of this work, the authors had received anecdotal reports of harvesting within other forests reserves well inside Belize, such as the Manatee Forest Reserve. Given that these other reserve areas are located far from the border, it is most likely that if these reports are proven true, then such harvesting will have been conducted with Belizean involvement. The value of the illegal harvest from Belize has been estimated at D.S. $3.5 million per annum (Alianza para un Mundo Justo 2003). Our analyses suggest that this figure is too high. Although the CFR is not the only forest area in Belize harvested by xateros (another is the Colombia River Forest Reserve), it is the most significant in terms of area and the available xate resource. Although the value of the illegal harvest may have been inflated in some reports, it is still clearly significant. For comparison, forestry and logging over the whole of Belize contributed D.S. $5.4 million (0.5 percent) to Belizean gross domestic product (OOP) in 2003 (Central Statistics Office 2004).

ECONOMIC VALUE OF RESOURCE AND SUSTAINABILITY OF HARVESTING LEVELS

We estimate that the per-hectare standing xate leaf value for the GMM for forests known (or believed) to support commercial species of *Chamaedorea* is D.S. $2 per ha. This value is similar to those found by other authors for other palm leaf resources. For example, Flores and Ashton (2000) calculated the value of the leaf resource of *Geonoma deversa* (Poit.) Kunth (used for thatching) in the Peruvian Amazon to be between U.S. $2 and D.S. $26 per ha. Estimates of the economic value of NTFPs vary widely. A review of 24 studies making economic valuations of NTFPs from around the world ranged from U.S. $l/ha/year (/ha/year) to D.S. $420/ha/year, the average being D.S. $50/ha/year (Godoy et al. 1993). Much of this variation is explained by the biological and economic diversity of the different study sites. A recent study in the tropical rain forest of eastern Honduras (Godoy et al. 2000) calculated that the combined value of consumption and sale of forest goods ranged from D.S. $17.79 to D.S. $23.72/ha/year.

It is important to note that the estimated standing value figure calculated here for xate represents a snapshot in time. *Chamaedorea* palms are continuously producing new leaves, so there is the potential to harvest any area more than once, although of course, such a practice may not be sustainable. A prerequisite for determining the economic potential of *Chamaedorea*, and ensuring sustainability of the industry in Belize, is to identify how frequently new leaves are produced. This knowledge then should dictate how frequently leaves should be harvested if yields are to be sustained. Preliminary data from the Chiquibul Forest indicate that leaf turnover rates for fishtail are 1.56 ± 0.66 new leaves per year (Wicks 2004). A similar study conducted in Mexico on populations of *C. radicalis* also found annual leaf production to be around two leaves per year (Endress et al. 2004). Clearly, if only two leaves are being produced each year, removal rates cannot be both high and sustainable. This area still requires research in *Chamaedorea*, although studies have been conducted on other palm genera. For example, an investigation on the effects of varying leaf harvest intensities of *Hyphaene coriacea* Gaertn. in KwaZulu-Natal (South Africa) showed little difference in leaf production trends between harvested and unharvested palms over a four-year period (McKean 2003). However, preliminary data from another study in the Chiquibul Forest indicate that long periods of leaf harvesting increase mortality and decrease reproductive capacity in both *C. ernesti-augustii* and *C. oblongata* (Porter Morgan 2004). Short-term studies of *Chamaedorea* elsewhere have detected a significant effect of leaf removal on leaf growth and reproduction but not on palm survival (Endress et al. 2004; Oyama and Dirzo 1988). However, the long-term effects of frequent defoliation on leaf production and reproduction in *Chamaedorea* are unknown because these studies have been carried out over, at most, a two-year period, so plants were defoliated only once or twice during the study period. The effects of defoliation depend on the intensity of harvest. Some studies have found that moderate leaf removal frequencies result in a short-term increase in leaf and fruit production (Anten and Ackerly 2001; Oyama and Mendonza 1990), although yields later declined. Leaf removal can also result in palms producing shorter leaves (O'Brien and Kinnaird 1996), which, in the case of *Chamaedorea*, can mean that they are no longer suitable for sale. That populations of *Chamaedorea* palms have been depleted by over-harvesting in Mexico and Guatemala (Escalera Mas 1993; Radchowsky et al. 2004; Reining et al. 1992) strongly suggests that the long-term effects of frequent harvesting are more severe than has been estimated by these short-term studies. Although the extraction of NTFPs has been suggested as a potentially non-destructive means of using tropical forests (Peters et al. 1989), the harvest of many NTFPs has been identified as unsustainable (O'Brien and Kinnaird 1996; Siebert 2004; Soehartono and Newton 2002; Vasquez and Gentry 1989).

One factor that would improve the sustainability of the industry would be to pay xateros for the quality of the leaves collected, rather than for the number of leaves they harvest (Radachowsky et al. 2004; Reining et al. 1992). This would reduce the pressure on the palm resource and serve to raise the prices obtained by xateros. At present, prices are kept low because the buyers know that a high proportion of the leaves will not be of suitable quality to export. Attempts are now being made to introduce this means of payment in the community managed forests of Uaxacttin and Carmelita (Guatemala) using monitoring systems and the establishment of sorting houses where xateros are only paid by quality. The World Conservation Society, the Rainforest Alliance, and the Association of Forest Communities in the Peten (ACOFOP) have developed this initiative. Early results show that wastage is significantly reduced using this system, with the proportion of high-quality fronds delivered by xateros increasing from 50 percent to over 90 percent (Radachowsky et al. 2004). Terms of reference for recently approved Belizean licenses, of which only one in the south of the country is currently active, clearly state the need for harvesters to be paid by quality only, so the benefits of this system are recognized by the Belize Forestry Department.

In addition to the adverse effects of leaf harvesting on *Chamaedorea* populaUons, the xate industry has other ecologically detrimental effects. There have been numerous anecdotal reports of increased incidence of hunting within the CFR associated with the recent xatero activity. This is supported by the observations of the authors, who have frequently seen the presence of carcasses of protected animals such as tapir (*Tapirus bairdii* [Gill 1865]), paca (*Agouti paca* [Liimaeus 1766]), peccaries (*Tayassu tajacu* [Link 1795]), *T pecari* [Linnaeus 1758]), and eggshells of tinamu species (Family: Tinarnidae) in xatero camps. There also has been a marked decline in regional game (Bol 2004 pers. corum.), although it is impossible to determine with confidence whether this trend can be attributed to xatero activity alone. Research to provide a baseline of current game populations from which to gauge any future decline is a priority.

XATERO ECONOMICS

It is difficult to ascertain exactly how much a Guatemalan xatero may earn collecting in Belize, although it is clearly economically worthwhile for them to enter the country and risk the potential six-month imprisonment or a fine of D.S. $500 (Belize Times 2004). Although there are only sporadic patrols of the forest area by the Belizean Defense Force, arrests are made each year, with some involving the exchange of gunfire. Prison sentences have been passed, and these have been high profile, both in Belize and Guatemala, so xateros are aware of the potential risk of arrest. The amount earned depends on the amount of xate encountered per day, the price paid for the leaf, and the number of days worked per year. Informants in the CFR claim to harvest between 1,000 and 1,500 fishtail leaves on a good day. Dsing the average recent market rate of D.S. $0.77 per 100 leaves (Table 3), a collector gathering the higher quantity could earn approximately US. $11 per day. This is over twice the minimum legal (and *de facto)* wage in Guatemala, which is D.S. $5.00 a day (Grant 2004, pers. corum.), but only slightly higher than the statutory n linimum wage in Belize, which is D.S. $1/hour for agriculture and US. $1.25/hour in other sectors. Because not all days would be "good days," this value should be considered an upper limit. The daily amounts earned by xateros working in the Peten of Guatemala are similar to those estimated here for the Chiquibul, and range from D.S. $5 to US. $10 (Radachowsky et al. 2004; Trujillo 2004, pers. corum.). It should be remembered, however, that although leaves are available year round, collecting xate is generally a seasonal occupation. Finally, the consensus among those interviewed in Centrel America was that the current high price for fishtail is likely to prove a teJ;llporary phenomenon, driven by dwindling supplies and increased demand from new ED countries.

Factors that would decrease the wage of xateros working in Belize are poorly known. For example, Guatemalan xateros working in the Chiquibul often pay middlemen to hire horses to transport their bundles out of the forest. Furthermore, it can take several unpaid days for the harvesters to complete the round trip to the harvesting site. To reach undegraded populations of xate in Belize, xateros are penetrating increasingly deeper into the Chiquibul—and thus farther from the Guatemalan border—each year (Bol 2004, pers. comm.). The distance between the Guatemalan border and the easternmost xate harvesting sites is over 40 km, which typically is a two-day walk.

There has been much discussion in Belize about establishing a concession-based xate industry that would employ Belizeans in the Chiquibul Forest. Several factors have suggested that this would not be economically viable. First, the past high level of harvesting has already put the resource under severe pressure. Second, future legal harvesting would likely be conducted in competition with the continued illegal harvesting by xateros unless policing activities greatly increase. Third, Belizean salaries are higher than those in Guatemala. As illustrated above, the minimum agricultural wage in Belize is about D.S. $8/day, depending on the hours worked. The differences in socioeconomic status between Belize and Guatemala can explain why it is overwhelmingly Guatemalans and not Belizeans who are currently harvesting xate in Belize. Illustrating this point, in mid-2005 and after much consideration, the Belizean Forestry Department granted a xate-harvesting concession to a Belizean within the Chiquibul Forest. However, as of early 2006, this had still not yet been actively taken up, the concessionaire stating that under the present economic circumstances it would not be economical for him to do so. In addition, there is a significant difference between the Chiquibul forest area where no Belizean communities are present, and neighboring forest areas in the Peten. In the case of the Chiquibul, access to the forest is at least an hour's drive from the nearest settlement.

THE PROBLEM OF MONITORING FUTURE XATE CONCESSIONS

One of the main factors hindering the development of a sustainable Belizean xate industry within the CFR is the continued presence of

Guatemalan xateros. The data provided here show that incursions are commonplace and geographically widespread. If illegal harvesting cannot be controlled, it will prove impossible to establish a management regime that limits leaf extraction in over-harvested areas. Likewise, establishing and monitoring legal quotas would be problematic. For example, there would be no incentive for potential concessionaires to forego cutting all available leaves of commerCial quality to ensure that xate populations remain healthy. If this becomes common knowledge, others will come shortly afterwards imd cut any leaves that remain. In addition, it will be difficult to distinguish between cuts made by authorized harvesters and those made by illegal operators.

Resolving the illegal xatero issue is extremely problematic as constant policing of the remote forest border is impractically costly. In addition, the sensitive political issue of the long-standing border dispute between the two countries (Lauterpacht et al. 2002) makes any enforcement fraught with diplomatic difficulties. On the occasions when Guatemalan xateros have been apprehended inside the Belizean border, their incarceration has been accompanied by adverse international press reports about Belizean aggression, and the Organization of American States (OAS) is frequently called upon to arbitrate in such situations. One of the major reasons cited within Belize as to why a xate industry should be established within the CFR is that it would create a Belizean presence in an otherwise unpopulated part of their territory and hence would discourage illegal incursions.

PLANTATIONS: THE END OF WILD HARVESTING?

In response to the declining wild populations, there has been a move toward plantation-grown xate leaf, led by Mexico, which exports 80 percent of the world's leaf. *Chamaedorea* species are relatively easy to grow (Hodel 1992). The key requirement is shade. Xate species can be cultivated in tropical conditions either under a natural forest canopy, which means the rainforest understorey has to be cleared, or under shade-giving crops such as cacao (CEC 2002). There are now many plantations in Mexico and, to a lesser extent, in Guatemala, where it is estimated that 10 percent of xate exports already come from cultivated sources (Alianza para un Mundo Justo 2003). Although plantations of species such as C. *elegans* are well established, as yet there are no producing fishtail plantations. However, several have been established in the Peten, including at Suculte, Union Maya Itza, and Carmelita. Carmelita, which has been harvesting wild xate for generations, has recently begun cultivating *Chamaedorea* in response to declining local natural stocks (Trujillo 2004, pers. comm.). Should these relatively new enterprises prove successful and expand, it may prove difficult for wild-harvested leaf to compete with them. Revenue achieved (and in the case of fishtail, expected) from plantations varies between U.S. $294 to U.S. $9,375 per ha, depending on the species grown, the density of planting, the intensity of harvesting, and the price obtained (Table 5). The stated price, especially, varies depending on the source of information and the date on which it was obtained, so care should be taken when assessing this information. However, even the lowest rates quoted are ten times higher than the maximum levels that can be achieved in the wild, based on our estimates, though there are considerable establishment and maintenance costs. Harvesters in plantations are not paid by quantity collected, but are given a daily wage. In early 2006, the Suculte plantation, for example, was paying a daily salary of 40 quetzales, which is equivalent to a wage of just over U.S. $5 (Grant 2006, pers. comm.).

Although some plantations such as that at Union Maya Itza in Guatemala are community-run, they are unlikely to employ all those currently harvesting leaf in the wild. The establishment of plantations in Guatemala has been put forward as a means of creating economic opportunities and of reducing the need for Guatemalan xateros to enter Belize thereby serving to defuse the border conflict. In part, the project at Suculte was originally established and funded by donors as a "conflict resoluti~m" project. However, it remains to be seen whether such initiatives provide sufficient economic opportunities for local communities.

In Belize, several community initiatives are establishing plantations. Two examples are the Itzamna Society in Cayo District and the Ya'axche Conservation Trust (YCT) in the Toledo District. Both these organizations are assisting local farmers to grow xate organically under a shade crop of cacao, for which they already have a secure international organic market. It is hoped that this extra crop will supplement the

TABLE 5: *CHAMAEDOREA* PLANTATIONS: PLANTING DENSITY, HARVESTING INTENSITY AND INCOME GENERATION.

Species	Plants per ha	Leaves cut/plant/yr	Leaves cut/ha/yr	U.S. $/100 leaves	Gross Income (U.S. $)/ha/yr	Predicted Lifespan of plantings	Income Achieved or Predicted	Location	Reference
C. elegans	90,000	4	360,000	3.00	10,800	15	Predicted	Suculte, Guatemala	Grant (2004, pers. comm.)
	8,570	6	171,420	0.39	669	N.A.	Achieved	Veracruz, Mexico	Ramirez (2002)
	16,890	12	202,680	0.91	1,836	N.A.	Achieved	Veracruz, Mexico	CEC (2002)
C. ernesti-augustii	60,000	2.5	150,000	6.25	9,375	15	Predicted	Suculte, Guatemala	Grant (2004, pers comm.)
	20,000	3	60,000	0.49	294	N.A.	Achieved	Veracruz, Mexico	Ramirez (2002)
C. oblongata	20,000	3	60,000	0.42	252	N.A.	Achieved	Veracruz, Mexico	Ramirez (2002)

N.A.: Information not available

other various agricultural activities of the farmers. However, to succeed in this venture they must surmount considerable challenges. Unlike Guatemala, Belize has no experience of marketing or selling xate, and the structures for its sorting, storing, and shipping are not currently in place. In addition, xate buyers deal in large quantities of leaf, and it remains to be seen whether relatively small community initiatives can provide the crop regularly, with high quality, and in the large amounts of xate leaf demanded by the industry.

THE ROLE OF CERTIFICATION

Product certification is an increasingly popular market tool. It harnesses a consumer's desire to buy items that have come from an environmentally friendly source. The certification of NTFPs is in its infancy and well-documented case studies are few. A number of community-managed forests in Belize and Guatemala already produce timber carrying the Forest Stewardship Council (FSC) label. Unlike timber, however, recent research has shown that there is a low general market interest in "eco-labeled" xate, with consumer knowledge of its origins being meager (CREM 2002). For certification to have maximum effect, accreditation needs to be accompanied by a program improving market awareness. Current exporters, as well as those developing plantations, are not keen to highlight that the industry is unsustainable and, in some cases, is based on illegal harvesting. They worry that such information may depress the markets and precipitate a market switch to other products. However, once plantations have been established it is likely that there will be an increased international drive to flag these as being "environmentally friendly," with marketing information stressing how such plantations are reducing pressures on natural forests. There are concerns, however, that unless plantations are supplied from seed plantations, the need to constantly replace stock will drive a market for wild-collected seed, which also may be very damaging. Two community-based forest concessions in the Peten at Uaxactun and Carmelita have recently gained FSC certification for their xate, accredited by Smartwood. However, it is too early to know whether higher prices will be attained for such certified stock, or whether the management of the xate resource improves as a result. In the case of the Belizean cacao growers in Toledo, who are certified as organic, any xate grown under cacao shade will also necessarily have to be organic, and it is hoped that this may also provide a market edge. However, those seeking certification should be aware that even when a premium market price is gained, the time and financial costs associated with certification can often neutralize or outweigh the benefits of being certified (Cole 2003).

CONCLUSIONS

The data summarized here clearly show that xate leaf in the CFR is an economically significant NTFP. At present, however, it does not contribute to the Belizean economy, and it is doubtful whether the establishment of a legitimate Belizean-managed wild-harvesting industry within the Chiquibul region is a viable option due to past harvesting pressures, the absence of communities living within the region on the Belize side of the border with Guatemala, and the relatively high salaries in Belize when compared with Guatemala. Although its extraction is currently commercially viable for Guatemalans, who enter illegally across the border, harvesting leaf from natural forests may not be equally attractive for Belizeans. Indeed, there is also some doubt as to whether a legitimate Belizean industry based on non-enriched wild populations would be able to compete in the long-term with the increasing number and sizes of established plantations throughout Central America with their more favorable economies of scale. Although there has been a constant demand for xate leaf for many decades, market preferences of the floricultural industry have been known to change rapidly, and the local industry is very sensitive to small changes in demand. For this reason, it is advisable for plantations to grow a broad spectrum of species so they can respond to market demands.

Economics aside, for Belize to develop its own sustainable xate industry, there needs to be careful management of the resource based on sound ecological data. If this is not done, it is highly likely that any wild Belizean industry will follow the patterns of those in Mexico and Guatemala, which now suffer from an increasingly degraded natural resource base. One solution that might benefit Belize and Guatemala is for both countries to work together. The Belizean Government has recently issued licenses in southern Belize for Belizeans to harvest and sell xate leaf using Guatemala's existing export infrastructure, thereby legalizing the industry. However, harvesting has not yet started and it remains to be seen how successful this venture will be. In addition, the possibility of licensing individual Guatemalan harvesters to work in Belize is being examined. This may be economically favorable due to the lower salaries of Guatemalans. However, many within Belize perceive such a solution as being politically unacceptable. In addition, moves are being made by Guatemalan xate investors to establish processing sheds in Belize, which would provide Belize with the potential to develop its own export trade.

Perhaps of greatest important for the future of the Chiquibul Forest is a management presence within the forest currently, the already over-stretched Belize Forest Department does not have the resources to maintain a permanent presence within its confines, and members of the Belize Defense Force only conduct patrols sporadically. However, there is some cause for optimism. In October 2005, a workshop was held in San Ignacio (Belize) to investigate how the Chiquibul Forest, as well as other forest reserves within the Maya Mountain area, might be brought under a greater management presence in the future. This initiative was coordinated by the Belizean NGO Friends of Conservation and Development, supported by the Belize Forestry Department, and funded by Conservation International. As a result, a funding proposal is being developed, and it is hoped that, if successful, such funding will mean that the Chiquibul Forest will be regularly managed and patrolled, and that this will result in the necessary controlled environment for the establishment of a variety of sustainable forest industries.

ACKNOWLEDGMENTS

This work was funded by the U.K. Darwin Initiative project 162/12/012. The authors acknowledge the support of the Belize Forest Department, especially Osmany Salas, Marcelo Windsor, Lizandro Quiroz, Percival Cho, Hector Mai, Natalie Rosado, Carl Tillet, and Lewis Usher. In addition, thanks are due to the British High Commission, the British Army, Coos Minty (Maya Forest Enterprises), and Isidro Bol (Las Cuevas Research Station), the Belize Botanic Garden, the Ya'axche Conservation Trust (Toledo), the Toledo Cacao Growers Association, Teakettle Enterprises, the Itzarnna Society (San Antonio, Cayo District), the Belize Community Service Alliance, Alianza para urn Mundo Justo (Guatemala), the Asociaci6n Coordinadora Indigena y Campesina de Agroforesteria Comunitaria Centtoamericana (Guatemala), and the community of Carmelita (Guatemala). Thanks are due to the field assistants who spent many months with us conducting the surveys, notably Victor Quiroz, Matthew Bol, Luis Morey, Rudolfo Lobos, and Ricardo Cocom. Finally, we thank the many informants who took the time to discuss with us the mechanics of the xate industry, and Roan Balas McNab (Wildlife Conservation Society), as well as the anonymous reviewer, for their constructive comments on the manuscript.

Literature Cited

Alianza para un Mundo Justo. 2003. Growing together: Socioeconomic development of southern Peten and Belize communities through the sustainable management, controlled harvesting and commercialization of xate. First Quarter Project Report. Alianza para un Mundo Justo. Santa Elena, Guatemala.

Anten, N. P.R. and D. D. Ackerly. 2001. Canopy-level photosynthetic compensation after defoliation in a tropical understorey palm. Functional Ecology 15: 252-262.

Bateson, J. H. and LH. S. Hall. 1977. The geology of the Maya Mountains, Belize. Overseas Memoirs Institute of Geological Sciences 3: 1-43.

Belize Times. 2004. Guats caught red-handed stealing xate. Belize City, Belize. http://www.belize-times.bz/news/story/3376.shtml [accessed 20 July 2005].

Castillo Mont, J.J. 1999. The palms of Guatemala and their ornamental uses. Acta Horticulturae 486: 33-39.

---, N. R. Gallardo, and D. Y. Johnson. 1994. The Pacaya Palm *(Chamaedorea tepejilote;* Arecaceae) and its Food Use in Guatemala. Economic Botany 48(1): 68-75.

Central Statistics Office (Belize). 2004. Statistics for Gross Domestic Produce (1994-2003). Central Statistics Office (CSO), Belize. http://www.cso.gov.bz/statistics/gdp2004.pdf [accessed 07 July 2005].

Chemonics International. 2003. Community forest management in the Maya Biosphere Reserve: Close to financial self-sufficiency? Guatemala BIOFOR IQC Task Order 815. USAID. Guatemala.

Cole, D. 2003. The impact of certification on the sustainable use of Devil's Claw *(Harpagophytum procumbens)* in Namibia. FAO Non-Wood Forest Products Programme. FAO. Rome. http://www.fao.org/forestry/foris/pdf/NWFPIN amibia [accessed February 2006].

Commission for Environmental Cooperation ~CEC). 2002. In search of a sustainable palm market in North America. Commission for Environmental Cooperation (CEC). Montreal. http://www.cec.0rg/files/pdfIECONOMY /PALM"09-02-e.pdf [accessed 07 July 2005].

Consultancy and Research for Environmental Management (CREM). 2002. European market survey and analysis for sustainable xate, harvested in Guatemala. Consultancy and Research for Environmental Management (CREM). Amsterdam, Netherlands.

Endress, B. A., D. L. Gorchov, and M. B. Peterson. 2004. Harvest of the palm *Chamaedorea radica/is,* its effects on leaf production, and implications for sustainable management. Conservation Biology 18(3): 822-830.

Escalera Mas, C. E. 1993. Caracterizaci6n de los factores eco16gicos relevantes en las comunidades donde el shate *(Chamaedorea* spp.) es componente, en San Miguel la Palotada, Peten. Facultad de Agronomfa. Guatemala, Universidad de San Carlos de Guatemala.

Flores, C. F. and P. M. S. Ashton. 2000. Harvesting impact and economic value of *Geonoma deversa,* Arecaceae, an understory palm used for roof thatching in the Peruvian Amazon. Economic Botany 54: 267-277.

Forum Interparlementaire des Ameriques (FIPA) and United States Agency for International Development (USAID). 2002. Xate *(Chamaedorea* spp.): Situacion del sistema de recolecci6n y exportaci6n y recomendaciones para un plan de trabajo: insumo para una politica de recursos forestales no maderables en areas protegidas. Guatemala.

Godoy, R., R. Lubowski, and A. Markandya. 1993. A method for the economic valuation of non-timber tropical forest products. Economic Botany 47: 220-233.

---, D. Wilkie, A. Cubas, G. Cubas, J. Demmer, K. McSweeny, H. Overman, and N. Brokaw. 2000. Valuation of a Central American rainforest from consumption and sale of goods. Nature 406: 6791: 62-63.

Government of Belize. 2004. Office of the Prime Minister: cabinet meeting of 27 April 2004. Press Release (28 April 2004) Press Office, Belmopan. http://www.belize.gov.bz/pressoffice/pres s_releases/28-04-2004-3201.shtml [accessed 9 May 2004].

Heinzman, R. and C. Reining. 1988. Sustained rural development: extractive forest reserves in the Northern Peten of Guatemala. Report to USAID, WWF, and Yale School of Forestry and Environmental Studies. Yale University School of Forestry and Environmental Studies. New Haven, Connecticut.

Henderson, A., G. Galeano, and R. Bernal. 1995. Field guide to the palms of the Americas. Princeton University Press, Princeton, New Jersey.

Hodel, D.R. 1992. *Chamaedorea* palms: The species and their cultivation. AlIen Press, Lawrence, Kansas.

Iremonger, S. and N. Y.L. Brokaw. 1995. Vegetation classification for Belize. Appendix 1 in R. Wilson, ed. Towards a National Protected Area Systems Plan for Belize. Programme for Belize and Inter-American Development Bank, Belize.

Jimenez Perez, J. L., L. Trejo Hernandez, e.. E. Gonzalez Romo, E. Jurado Ybarra, H. Villalon Mendoza, and F. Perez Guerrero. 1999. Manejo de palmilla *(Chamaedorea radicalis)* en la Reserva de la Biosfera "El Cielo." Instituto de Ecologia y Alimentos. Ciudad Victoria, Tamaulipas, Mexico.

Johnson, D. V. 1997. Non-wood forest products: Tropical palms. Food & Agriculture Organization (FAO), Rome.

Johnson, M. S. and D. Chaffey. 1973. An inventory of the Chiquibul Forest Reserve, Belize. Land resource study No. 14. Land Resources Division, Overseas Development Administration, Surrey.

Lauterpacht, E., S. Schwebel, S. Rosenne and F. O. Vicuna. 2002. Legal opinion on Guatemala's territorial claim to Belize. Belize Chronicles Series. The Angelus Press Ltd., Belize.

McKean, S. G. 2003. Toward sustainable use of palm leaves by a rural community in Kwazulu-Natal, South Africa. Economic Botany 57(1): 65-72.

Meerrnan, J. and W. Sabido. 2001. Central American Ecosystems: Belize. Programme for Belize, Belize City. 2 volumes.

Mendoza, A. and K. ()yama. 1999. Ecology, management and conservation of potentially ornamental palms. Acta Horticulturae 86: 79-83.

Nations, J. D. 1992. Xateros, chicleros and pimenteros: Harvesting renewable tropical forest resources in the Guatemalan Peten. Pages 208-219 in Redford, K. H. and C. Padoch, eds. Conservation of neotropical forests. Columbia University Press, New York.

O'Brien, T. G. and M. F. Kinnaird. 1996. Impact of harvest on leaf development of the Asian palm *Livingstonia rotundifolia.* Conservation Biology 10: 53-58.

Oyama, K. 1990. Variation in growth and reproduction in the Neotropical dioecious palm, *Chamaedorea tepejilote.* Journal of Ecology 78: 648-663.

---. 1992. Conservation and exploitation of tropical resources-The case of *Chamaedorea* palms. Evolutionary Trends in Plants 6: 17-20.

--- and R. Dirzo. 1988. Biomass allocation in the dioecious tropical palm *Chamaedorea tepejilote* and its life history consequences. Plant Species Biology 3: 27-33.

--- and A. Mendoza. 1990. Effects of defoliation on growth, reproduction, and survival of a neotropicai dioecious palm, *Chamaedorea tepejilote.* Biotropica 22(2): 119-123.

Penn, M. G., D. Sutton, and A. MUllfO.2004. Vegetation of the Greater Maya Mountains, Belize. Systematics and Biodiversity 2: 21-44.

Peters, e.. M., A. H. Gentry, and R. O. Mendelsohn. 1989. Valuation of an Amazonian rainforest. Nature 339: 655-656.

Porter Morgan, H. 2004. Towards the sustainable use of xate palms in Belize *(Chamadorea* spp.): The effects of defoliation on leaf growth and reproduction. Report to the UK Darwin Initiative.

Radchowsky, J., V. H. Ramos, R. Garcia, J. L6pez, and A. Fajardo. 2004. Effects of managed extraction on populations of the understorey palm, xate *(Chamaedorea* sp.) in northern Guatemala: Monitoring ecological integrity of the Maya Biosphere Reserve, Peten, Guatemala. Report. Wildlife Conservation Society.

Rainforest Alliance. 2004. Reliable sources: Environmentally sound and socially just harvesting of non-timber forest products: certified chico initiative at the Rainforest Alliance. Profiles in Sustainable Forestry Rainforest Alliance, New York. http://www.rainforest-alliance.org/programs/profiles/forestry-chico-initiative.htrnl. [accessed 07 July 2005].

Ramirez, F. 2002. Manual para el cultivo de xate, CICAFOC, Veracruz, Mexico.

Reining, e., R. Heinzman, M. Cabrera Madrid, S. L6pez, and A. Sol6rzano. 1992. Non-timber forest products of the Maya Biosphere Reserve, Peten, Guatemala. Washington D.e., Conservation International.

Siebert, S. F. 2004. Demographic effects of collecting rattan cane and their implications for sustainable harvesting. Conservation Biology 18(2): 424-431.

Soehartono, T. and A. C. Newton. 2002. The Gaharu Trade in Indonesia: Is it sustainable? Economic Botany 56(3): 271-284.

Thomas, M.M., N.e.. Garwood, W.J. Baker, S. Henderson, S.J. Russell, D.R. Hodel, and R.M. Bateman. 2006. Molecular phylogeny of the palm genus *Chamaedorea,* based on the low-copy nuclear genes PPPRK and RPB2. Molecular Phylogenetics and Evolution 38: 398–415.

Vasquez, R. and A. H. Gentry. 1989. Use and misuse of forest harvested fruits in the Iquitos area. Conservation Biology 3: 330-349.

Vovides, A. P. and M. A. Garcia Bielma. 1994. A study of the in situ situation of four species of threatened understorey palms of the genus *Chamaedorea* in the wild in the state of Veracruz, Mexico. Principes 38: 109-113.

Waiter, K.S. and H.J. Gillett. 1998. 1997 mCN Red List of Threatened Plants, meN-The World Conservation Union, Gland, Switzerland and Cambridge, UK.

Wicks, N. 2004. Preliminary fishtail xate *(Chamaedorea .ernesti-augustii)* growth survey data in the Chiquibul National Forest, Belize. Report for the Darwin Initiative.

Wright, A. e.. S., D. H. Romney, R. H. Arbuckle, and

V. E. Via. 1959. Land in British Honduras. Colonial Research Publications No. 24. Her Majesty's Stationary Office, London.

LIST OF INFORMANTS

Oral or written information is cited as a personal communication (pers. comm.) in the text. Xatero informants have not been listed as their anonymity was assured.

Bol, I. 2004. Operations Manager, Las Cuevas Research Station.
Briggs, J. 2004. Administration Manager, Caribbean Farming Group.
Chillmaid, A. 2004. Sunflora Ltd.
Cotterill, S. 2004. Tregothnan Foliage.
du Plooy, J. 2004. Belize Botanic Garden.
Grant, R. 2004, 2006. Regional Director, Alianza para un Mundo Justo (AMJ).
Green, E. 2004. Belize Forestry Department.
Guzman, W. 2004. Forest Manager, Alianza para un Mundo Justo (AMJ).
Hadley, D. 2004. Commercial Assistant, Alianza para un Mundo Justo (AMJ).
Hargrove, G. 2004. Maya Gold Project Manager, Green & Black's.
Kenyon, K. 2004. Rower and Plants Association, UK.
Madrid, J. 2004. Vida Silvestre, CONAP.
Mesh, J. 2004. San Antonio farmer working for the Belize Botanic Garden.
Rosado, P. 2004. Xate plantation worker, Suculte Guatemala.
Sabido, W. 2004. Programme for Belize (PfB).
Sho, A. 2004. Organic Cacao Extension Worker, Ya'axche conservation Trust (YCT).
Steen, U. 2004. Florimex AB, Sweden.
Thomas, L. 2004. Manager, Teakettle Enterprises.
Trujillo, M. 2004. Carmelita Cooperative, Guate-mala.
Windsor, M. 2004. Wildlife Officer, Belize Forestry Department.