

Artisanal Non-Timber Forest Products in Darién Province, Panamá: The Importance of Context

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*Non-timber forest products (NTFP) have been frequently studied as a means to conserve forests and provide income to user communities. Studies on NTFP have often been restricted to a single species, year and human user community. However, a number of recent studies are challenging these simplifications. Here, we examine a suite of artisanal NTFP that are of increasing economic importance to Wounaan and Emberá households in Panamá. Artisans make carvings from seeds of a tagua palm (*Phytelephas seemannii*) and the wood of cocobolo (*Dalbergia retusa*), and weave baskets from the fibres of the chungu palm (*Astrocaryum standleyanum*). We studied the ecology and socio-economics of these resources between 1997*

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*and 2001, and here consider ecological, spatio-temporal, and socio-political variables in the use of these artisanal NTFP. Our methods included the establishment of long-term demographic plots of *P. seemannii*, natural history observations, participant observation of harvest and semi-structured interviews of artisans and vendors. Our results indicate that the ecological effects of harvesting are vastly different for each species, but so too are spatial, temporal, social and political variables. We conclude by illustrating how contextualising the differences among these three NTFPs leads to answers of questions we did not ask, but also is more relevant to resource users, managers and policy makers.*

INTRODUCTION

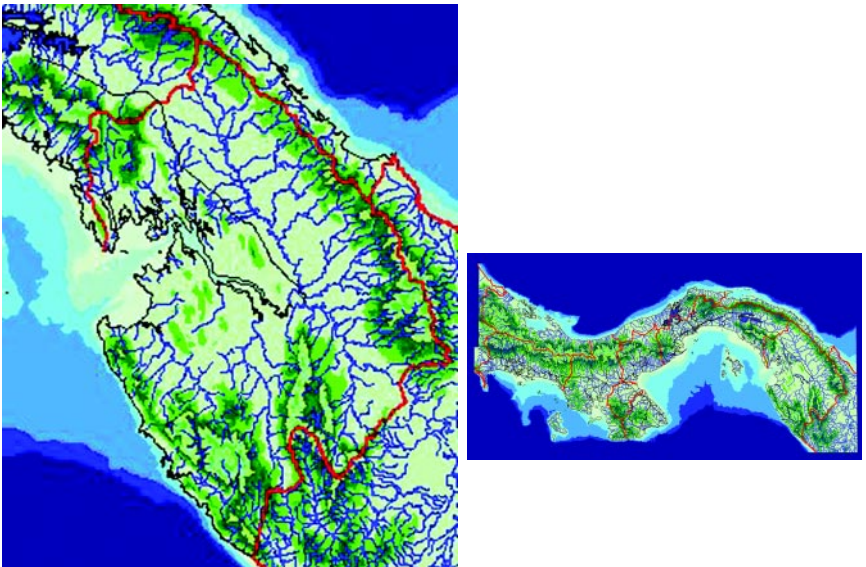
PEOPLE HAVE LONG harvested non-timber forest products (NTFP) in order to obtain useful materials, such as resins, fruits, fibres, latexes and nuts. In the last several decades, NTFP have been popularised by the idea that local human populations can harvest certain NTFP with relatively little ecological impact (Arnold and Townson 1998; Freese 1998; Godoy and Bawa 1993; Nepstad and Schwartzman 1992; Peters 1996; Schroder 1998) although a growing number of studies have challenged that assertion (Arnold et al. 2001; Crook and Clapp 1998; Peres et al. 2003; Peters et al. 1987; Peters et al. 2003; Shankar et al. 1996; Velásquez Runk 1998, 2001b; Walter 1998). Mirroring overall trends in ecology (Botkin 1990; Thompson et al. 2001), recent NTFP research has moved beyond a tendency to focus on a single species, a single population, a single year of research or even a single human user community by also considering spatial, temporal and socio-political variables of NTFP harvest, use and management. Recent ecological NTFP work has considered spatial variables such as distribution of multiple NTFP (Gould et al. 1998; Marshall and Newton 2003; Murrall et al. 1996; Salafsky et al. 1993; Straede et al. 2002), differential NTFP distribution across land cover and/or management types (Dalle et al. 2002; Miller 2002; Svenning and Marcía 2002; Ticktin and Johns 2002; Velásquez Runk 1998) and varying NTFP use and management by spatially distinct resource users (Evans and Sengdala 2002; Peres et al. 2003; Vasquez and Gentry 1989) as well as temporal variables such as intra- and/or inter-annual NTFP growth and yield (Anderson and Putz 2002; Bhat et al. 2003; Sinha and Bawa 2002; Ticktin et al. 2003), histories of NTFP use (Cunningham 2001; Dovie 2003; Peters et al. 2003), and changing resource management and/or policies (Dugelby 1998; Stewart 2003). This literature is accompanied by growing recognition of social and political variables in NTFP use and management (Dovie 2003; Marshall and Newton 2003; Stewart 2003). The incorporation of spatio-temporal and socio-political considerations in NTFP studies, in addition to ecological considerations, allows communities, researchers and managers a more complete view of NTFP and how they fit into complex biophysical, historical and cultural landscapes that are relevant for sustainability and management. Here, we add to these literatures by examining a suite artisanal NTFP, tagua (*Phytelphas*

seemannii) seeds used for carvings, cocobolo (*Dalbergia retusa*) wood used for carvings and chungá (*Astrocaryum standleyanum*) fibres used for basket making by Wounaan and Emberá communities to craft art marketed in eastern Panamá. We use our experiences to illustrate how expanding our research to incorporate spatio-temporal and socio-political considerations with ecological ones allowed us to more fully understand these resources and how they might be better managed.

METHODS

From January 1997 to December 2001 we studied the ecology and socio-economics of three artisanal non-timber forest products of eastern Panamá, primarily in Darién province (Figure 1). The Darién province of Panamá is considered part of the Darién/Chocó biogeographic region, which extends from eastern Panamá into northern Ecuador, and is characterised by floral and faunal assemblages of North and South American origin (Dinerstein et al. 1995; Gentry 1986; Stattersfield et al. 1998). The area is characterised by lowland tropical moist forest, and is the most extensively forested province of Panamá. Lowland eastern Panamá has a distinct dry season from December to April with annual rainfall of 2,000–2,500 mm and temperatures averaging 27°C (Instituto Geográfico Nacional Tommy Guardia 2003). In addition to sharing a similar biogeography, Panamá's Darién province and Colombia's Chocó department are also both home to Wounaan and Emberá communities.

Figure 1
Eastern Panamá with Darién Province Indicated by Red Boundary Lines
(Inset Map Indicates the Location of Darién within Panamá)



Wounaan and Emberá indigenous peoples were historically considered one group, the Chocó. In the late 1700s, Emberá (also known as Emperá, Eperá or Empeñá) and later Wounaan (also known as Waunana, Noanama or Nonamá) began moving from Colombia into Panamá (Herlihy 1986). The groups speak mutually unintelligible languages (Emberá *bedéa* and Wounmeu respectively), but they have historically intermarried to a limited degree. Anthropologists consider them to have very similar, yet distinct, cultures, cosmologies and material culture (Reichel-Dolmatoff 1960, 1962; Tayler 1996; Wassén 1935). Approximately 7,000 Wounaan and 22,000 Emberá live in Panamá, mostly in Darién (Dirección de Estadística y Censo 2001). Virtually all Wounaan and Emberá live off of agriculture, fishing, ecotourism and art from NTFP.

We initiated fieldwork by travelling throughout Darién province to assess resource distribution and use. As a result of this initial work, we signed formal agreements with Emberá and Wounaan indigenous leadership to carry out research on their land and in their communities, both inside and outside indigenous reservations (*comarcas*), and we also obtained village approval for all research. In 1997 we established three permanent demography and yield plots of 50×50 m at two sites, Antadocito and Cerro Sapo, with high densities of *P. seemannii*. We measured adult palms throughout the plots, and juveniles and seeds in nested sub-plots totalling 100 m² of each plot. Throughout 1997 and 1998 local assistants helped us to measure leaf, flower and fruit phenology of adult palms every three months in one site. These data were combined with annual measurements from 1997 to 2001 of adult and sub-adult palm stem height, leaf number, length of largest leaf, number of pinnae of largest leaf, inflorescence number, infructescence number, number of fruit per infructescence, foliar coverage, and light level in both sites. Juvenile recruitment was tallied annually and juvenile leaf number, length of largest leaf and number of pinnae, as well as seed number and viability (as assessed by seed weight) were recorded. Palms and seeds were marked with paint and we changed paint colours with each census to best track growth. These ecological data were complemented with GPS points on *P. seemannii* distribution throughout the province and differentially corrected with a base station. In 1998 we interplanted 125 seedlings of *P. seemannii* and 150 seedlings of *Dalbergia retusa* at approximately 3×3 m in community gardens with the villages of La Chunga and Arimae. In the village of Puerto Lara we also included 260 seedlings of *A. standleyanum*, and in the village of Mogue, seedlings were given to each household to plant within their landholdings. Tree height and leaf growth data were taken on these sites in 1999 and 2000, and fire prevented additional data collection in all but the Arimae site where data were last recorded in 2003. Additional ecological data on *D. retusa* and *A. standleyanum* were largely obtained by natural history observations, literature review and expert informant interviews as the sparse distribution of *D. retusa* and initial funding that excluded *A. standleyanum* limited field activities.

Information on harvest, processing and art elaboration was obtained via participant observation and semi-structured interviews. We selected villages based on

artisanal reputation (which we backed up with site visits) and safety, as some villages were in politically unstable areas. We worked in the villages of La Chunga (75 per cent of households interviewed), Puerto Lara (74 per cent of households interviewed) and Mogue (47 per cent of households interviewed), with additional observations from the village of Arimae (Figure 2). La Chunga and Mogue are largely composed of Emberá, and Puerto Lara and Arimae are largely Wounaan. In each village informal interviews were conducted in Spanish with translation into Wounmeu (by F. Peña or P. Mepaquito) or into Emberá *bedéa* as necessary. Additional information was obtained from the Dirección General de Artesanías Nacionales 1995 census of 1,510 Darién artisans. We also conducted semi-structured interviews on history of art production and art sales with artisans, vendors, scientists and other local experts in Panama City, and have made additional observations on artisanal NTFP resource use during 2002 and 2003.

Figure 2
*Marked Tagua Palm, *Phytelephas seemannii* (Left) and Carving Made of Several Tagua Seeds Glued Together and Painted (Right)*



Note: Carving by Saludo Membora from 1997 courtesy of Tropical Illusions.

RESULTS

Tagua

Tagua (*Phytelephas seemannii*) is a dioecious, decumbent, short, understory palm distributed throughout the lower slopes of eastern Panamá (Figure 2). Tagua occurs

in dense stands, known as *taguales*, with 270 to 400 adult palms per ha with a ratio of 1:1 male to female palms. Initial data analyses indicated significantly higher leaf and inflorescence production rates for male palms than female palms ($p < 0.05$). There was also inter-annual variation of leaf productivity in both male and female palms, and inter-annual variation of infructescence productivity in female palms, but these data require additional analyses with environmental data, particularly in light of the 1997–98 El Niño year. Female palms have an average of four infructescences with thirty seeds per infructescence. Tagua infructescences have a long maturation time, from three to five years, and seeds are collected when the infructescence breaks open and the seeds fall to the ground.

We found that the *taguales* of eastern Panamá are largely unharvested, with a superficial seedbank of 4,425 to 5,250 viable seeds per ha. These *taguales* are largely uncollected because the preferred tagua seeds come from what appears to be a different subspecies of tagua, with larger, rounder seeds (Figure 3), tall, erect stems with distinct nodes, and curled tepals on the pistillate inflorescence (Velásquez Runk 2001a). According to local residents and artisans these larger-seeded palms have a more restricted distribution near the continental divide of eastern Panamá. Due to political instability in that area, we were only able to visit one *tagual* of the larger-seeded palm where few seeds were found. Given that this larger-seeded palm is heavily favoured by artisans, but appears to have a restricted range, it is quite likely that harvest of seeds is unsustainable. However, political instability in the region prevented us from further examining the demography, growth, yield and harvest effects of this population. In the four communities, we planted tagua seedlings from the common, small-seeded palm and found that mortality across the four communities was quite high at 45 per cent (Table 1). Community members attributed this high mortality to a beetle consuming the palms' cotyledonary petiole.

Figure 3

Seed of Phytelephas seemannii (Left) and Larger Seeded Tagua (Right)



Note: Photo by J. Tuxill

Table 1
Two-year Survival of Tagua and Cocobolo Seedlings

Village	Tagua (%)			Cocobolo (%)		
	Survival	Mortality	No data*	Survival	Mortality	No data*
La Chunga	47	37	16	68	33	0
Puerto Lara	49	48	2	80	20	0
Mogue	21	53	26	42	32	26
Arimae	59	40	0	82	13	6
Mean	44	45	11	67	24	9

Note: * 'No data' reflects planting per household: a number of households were absent during data-taking periods.

Processing tagua seeds is straightforward, requiring only the removal of the shell-like endocarp and, frequently, softening the ivory-coloured endosperm by soaking in water. Carving differed markedly in the three villages, as did access to the resource (Table 2). For example, in Puerto Lara about half the households had at least one carver, yet travel time to collect the seeds averaged five hours; as a result, 75 per cent of carvers purchased seeds. These results reflect not only the lack of resource availability near Puerto Lara, as the community is in a heavily deforested area, but also the relevance of ethnicity. Puerto Lara is almost entirely Wounaan, and using tagua as a carving medium was suggested by a scientist at the Smithsonian Tropical Research Institute (Dalling et al. 1996; Velásquez Runk 2000) who worked with Wounaan carvers to foster the art in the 1980s. Indeed, Panamá City vendors note that approximately 90 per cent of commercial carvers are Wounaan. Our analysis of the 1995 artisanal census data indicated that Wounaan have significantly higher annual production of art than Emberá ($p = 0.001$) and specifically higher production of tagua carvings and basketry ($p = 0.001$). Carving can be quite lucrative, particularly to these city-based carvers who may earn up to US\$ 50 per day by using electric Dremmel tools™ (Figure 2). Carvers based in eastern Panamá, however, use only knives or small chisels in their work, earning them \$2 per day in an area where the daily wage is \$5. Although rural carvers earn much less than urban carvers, the former note that this income is quite important especially as it allows them to work comfortably out of their homes rather than in laborious agricultural activities. Carvers typically paint pieces with Indian inks, which they usually obtain by trading finished pieces with vendors.

Tagua seeds were exported from Panamá, mostly from the Caribbean slope (Howe 1998), in the late 1800s and 1900s for buttons and toys (Dalling et al. 1996; Howe 1998), and in 1920 raw tagua nut export from Panamá exceeded timber exports (Ewing and Murray 1922). The tagua carving market stems from the 1980s efforts described above, and the market expanded rapidly in the 1990s, but by 2000 there was a glut of carvings on the market and consumer interest began to return to cocobolo carvings.

Table 2
*Artisanal Households, Harvest Travel Time and Purchase of
 Eastern Panamá's Principal Artisanal NTFP*

	<i>La Chunga</i>	<i>Puerto Lara</i>	<i>Mogue</i>
Total artisanal households	24*	28**	15***
Proportion of households with tagua carvers (%)	20	54	7
Average travel time to harvest tagua (hours)	1.9	5.0	1.4
Proportion of tagua carvers who purchase tagua (%)	18	75	0
Proportion of households with cocobolo carvers (%)	60	18	53
Average travel time to harvest cocobolo (hours)	3.6	NA	2.8
Proportion of cocobolo carvers who purchase cocobolo (%)	0	100	40
Proportion of household with chungu weavers (%)	96	100	100
Average travel time to harvest chungu (hours)	1.9	5.0	1.4
Proportion of chungu weavers who purchase chungu (%)	18	75	0

Notes: * 75 per cent of households interviewed;
 ** 74 per cent of households interviewed;
 *** 47 per cent of households interviewed.

Cocobolo

Cocobolo (*Dalbergia retusa*) is a relatively slow-growing tropical rosewood, sparsely distributed throughout old-growth forests of Panamá's Pacific slope (Figure 4). In eastern Panamá there is little natural regeneration of cocobolo and local residents were largely unfamiliar with seedlings of the species, although we found it to germinate readily *ex situ*. We found few mature trees for study, yet did note that the species has inter-annual fruiting. The wood has been commercially harvested in the region for at least 100 years (Goldman 1920; Pittier 1922; Record and Garratt 1923), chiefly for use as knife handles, and in 1917 Panamá exported 2.6 million kg of cocobolo (Record and Garratt 1923). This history of harvest combined with artisanal harvest and cocobolo's distribution have made this a scarce resource. Cocobolo also is the most frequently used dye plant for chungu fibres, as the shavings and sawdust are used to create colours ranging from light brown to black (Velásquez Runk 2001b). Cocobolo fared well when planted, having an overall survivorship of 67 per cent (Table 1). Cocobolo trees produced multiple stems through basal branching, yet grew fairly quickly with average heights of over 2 m after two years.

Cocobolo is often harvested from downed trees, including roots, because the wood is extremely resistant to decay since it contains a natural fungicide (Bultman and Parrish 1979; Bultman and Southwell 1976). Nonetheless, standing trees are also felled for artisanal use and interviews revealed that at least 50 per cent of cocobolo extraction was via destructive harvest. Several carvers may share trees, aiding each other in the felling and dividing up the wood amongst themselves. Harvesters' preferences vary for locally recognised shades of yellowish, reddish and black wood, the latter from roots. Cocobolo is typically removed from harvest sites in pieces up to a metre in length, as larger pieces are too heavy to carry. Our

Figure 4

Leaves of Cocobolo, *Dalbergia retusa* (Left) and a Vase Carved of Cocobolo Wood (Right)



Note: Artisan unknown, 1997 carving courtesy of Tropical Illusions.

results (Table 2) indicated more cocobolo artisans in the towns of La Chunga and Mogue than in Puerto Lara, which may reflect a longer history of commercial carving among Emberá or an effect of resource scarcity in Puerto Lara, or both. Travel time to harvest cocobolo averaged five hours from Puerto Lara, and all carvers here purchased cocobolo.

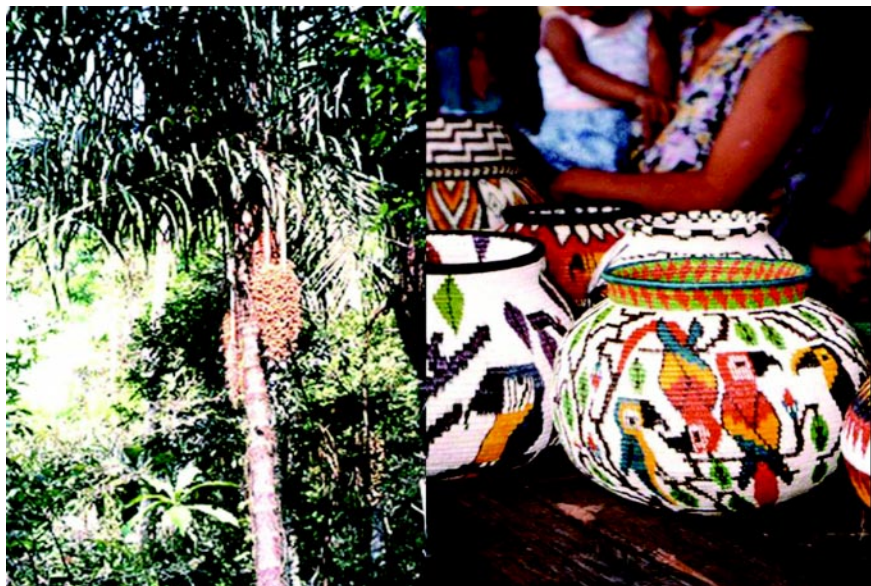
Carvers use chisels and knives to work the wood (Figure 4). There is no processing of the wood, with the exception of allergic carvers who keep the near-finished carvings in water prior to sanding in order to keep sawdust levels low. Cocobolo carvers are typically male and a master cocobolo carver can earn US\$ 5 to 30 per day using knives and chisels. The great majority of master cocobolo artisans live in the community of Majé, in Panamá province. Emberá and Wounaan have carved cocobolo commercially for about thirty years, although they have a long tradition of carving shamanic curing staffs and household implements from the wood. In the late 1990s cocobolo carvings lost market share to tagua carvings, attributed to the much smaller size and weight of tagua. Yet, in 2002, the cocobolo market began to increase again.

Chunga

Chunga (*Astrocaryum standleyanum*) is a solitary, sub-canopy palm reaching 15 m in height (Figure 5). The palm is heavily armed, most notably on the stem, which

has flattened spines that may reach 20 cm in length. Chunga is distributed throughout the lowland areas of eastern Panamá and its relative abundance in unexploited areas may be similar to that of central Panamá's Barro Colorado Island, where it was the most frequently occurring stem in the 50 ha plot (Condit, personal communication). We planted chungá only in the village of Puerto Lara and after two years there was a 67 per cent survival.

Figure 5
*Chunga Palm, *Astrocarym standleyanum* (Left) and*
Baskets of Chunga Fibers Circa 1998 (Right)



The palm is destructively harvested by felling, usually by men, although only the spear leaf and frequently the first expanded leaf are used. As with all harvests, Wounaan and Emberá only gather chungá with the waning moon as they believe this insures the strength of the fibres (Gallego Castillo 1995; Reichel-Dolmatoff 1960; Velásquez Runk 2001b). However, in the past several years the need for fibres has meant that Wounaan and Emberá purchase them, although do not gather them, from mestizo vendors during any phase of the moon. In our research villages chungá harvesters typically sought their own resources with the exception of Puerto Lara, where 75 per cent of weaving households purchase chungá (Table 2).

Although men frequently harvest chungá, women typically process and use the fibres, and fibre processing is markedly more labour intensive than processing tagua or cocobolo. Sitting down, a weaver folds a pinna at the midrib, wraps the distal end of the pinna around her toe, and fully extends the pinna towards her with one hand. Then, with her other hand, she makes a clean cut to the proximal end of one side of a pinna and carefully peels away the upper epidermis and

mesophyll along the entire length of the lamina. She repeats this for the second side of the pinna. Once the fibres are removed from all of the spear leaf pinnae, she soaks them overnight in soapy water to lighten the colour. Then she places them to dry and bleach further in the sun. The pinnae from the expanded leaf are not as flexible and they are more difficult to separate into fibre than the unopened spear leaf (Velásquez Runk 2001b). Also, because fibres from the expanded leaf are darker and do not whiten, they are dyed or, rarely, used as light green fibres. Weavers also harvest and prepare the foundation fibres from naguala (*Carludovica palmata*) and sew the chungá fibres around coils of naguala (ibid.).

After reviewing the number of baskets for sale in Panamá City stores and estimating basket turnover, we estimate that 16,000 palms are harvested per year for baskets (ibid.), and, clearly, this is an unsustainable trend. Harvest has caused the local extirpation of chungá near a number of communities of eastern Panamá. Chungá weavers earn US\$ 0.50 to US\$ 16 per day. This has become an important source of cash for women, and in our research villages 96 to 100 per cent of women wove chungá baskets for commercial sale (Table 2). Chungá fibres have long been used in shamanic ceremonies and to tie loincloths. Commercial weaving stems from a tradition of using the chungá fibres for household baskets. Fine chungá baskets have a strong market among international basket collectors and a large basket can cost several thousand US dollars. Vendors note that 90 per cent of fine weavers are Wounaan.

DISCUSSION

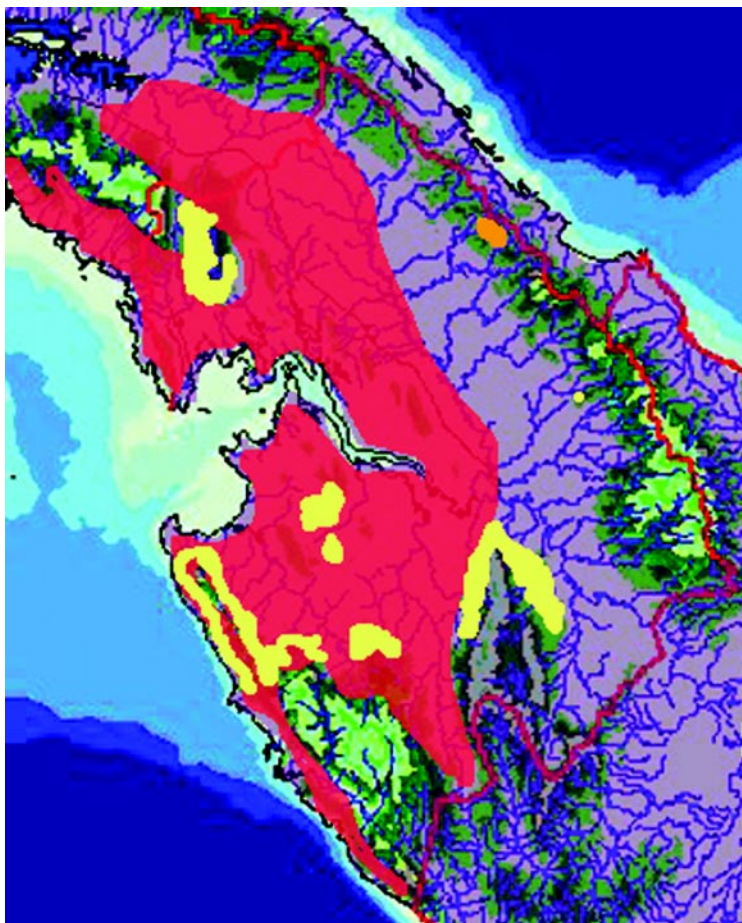
Emberá and Wounaan artisanal NTFP are an important suite of species for management. Our initial project plans, however, conceptually lumped these NTFP together without much consideration of variations among them. Our research illustrates the many differences among these artisanal NTFP and suggests that explicit incorporation of such variables will only improve their management.

A combination of differing plant parts used and harvesting regimes result in distinct ecological effects of NTFP use. In the case of tagua the propagule is harvested; in chungá the entire palm is destructively harvested for just one or two leaves; and in cocobolo the wood may be harvested from downed individuals or may be destructively harvested. As a result, the common tagua appears to be sustainably used (based on the larger number of seeds observed in the superficial soil seed bank), but the large-seeded palm appears to be unsustainably used. Cocobolo use may be sustainable, but will become more unsustainable as new trees are felled to meet demand. Chungá use is clearly unsustainable as thousands of palms are felled annually to meet local needs. From a management perspective, then, these three NTFP require vastly different management strategies based on differing harvest regimes.

In addition to these distinct harvest regimes, there are also spatial considerations of distribution, habitat type and spatially distinct resource users to take into account for management of these NTFP as a suite. Most notably, although these NTFP are

found within the landscape of eastern Panamá, they have different distributions and habitats. Tagua is found on low slopes, cocobolo only in the Pacific slope's remaining mature forests, and chungá throughout the lowlands (Figure 6). Management of tagua is more complex because the preferred tagua, which may be a distinct subspecies, appears restricted to a much more limited geographic area than the more commonly occurring tagua palm (Figure 6). In addition, it is not simply natural distribution that has an impact species use. As we found for scarce resources of tagua, cocobolo and chungá in Puerto Lara, artisanal communities near

Figure 6
Map of Eastern Panamá Province and Darién Province



Note: The map indicates the distribution of these three NTFPs: tagua distribution is in yellow; cocobolo distribution is in coral; and chungá distribution is in purple throughout the lowlands. The stand visited of larger-seeded tagua is indicated by the yellow in the north-central area of the map.

the Pan-American highway obtain their raw materials from outside their communities, indicating the degradation of the forests near the highway (Figure 7). An additional spatial consideration is that not all communities are equally reliant on art as a source of income. Most Wounaan communities and other communities on established ecotourism routes are more reliant on art income and, therefore, exert greater pressure on their artisanal resources. Nonetheless, other non-artisanal communities may supply artisanal materials, and in the case of chungu, for example, we have witnessed villages up to ten hours away by boat supplying fibre to artisanal villages.

Figure 7
Artisanal Communities in Darién with the Pan-American Highway



Note: It indicated by the black line running NW–SE through the province. Communities that obtain artisanal materials in their villages are indicated by yellow dots; communities that obtain artisanal materials outside their villages are indicated by black dots.

Temporal considerations, such as intra- or inter-annual NTFP growth and yield, histories of NTFP use, and changing resource management and/or use policies, also need to be taken into account when managing these three non-timber forest species. We found that individuals of both tagua and cocobolo exhibited inter-annual variation in fruiting. It is not known whether variation in fruiting is correlated with environmental variation, including El Niño Southern Oscillation (Condit et al. 2004; Wright et al. 1999). Moreover, the use of these resources has changed over time. For example, a century ago, cocobolo was harvested for timber rather than for artisanal purposes and current distributions of that tree may more accurately reflect patterns of historic use than natural distribution. Over the past two decades people living in Darién have changed their use of resources as a result of the increased access to markets from the extension of the Pan-American highway into the region in the 1980s.

Regardless of changing resource use, the current and historic importance of timber extraction in the region (ANAM et al. 2001; Romero et al. 1999; Torrealba 1996) has served to minimise government resource managers' knowledge of non-timber resources as well as the recognition of the important role they play in income generation for local communities. As a result, government resource managers frequently view forest resources as the domain of foresters and concessionaires—often from outside the region—rather than of local communities. Although interest in the region's timber resources has yet to wane, interest in establishing protected areas for the use and management of NTFP as well as the management of those areas by indigenous communities are subject to temporal changes in government. Given changes in resource availability and governmental perceptions of forest, indigenous leaders have elected to focus on ensuring tenure to their land before focusing on resource management efforts.

It is important to note that spatial and temporal variables might also be related to social and political variables important to NTFP management. Our research demonstrated ethnic differences in NTFP artisanal use and production. Although initial plans were to work with both Emberá and Wounaan, given greater artisanal production by the Wounaan, NTFP management activities might best be initiated with this ethnic group. Interestingly, however, because Emberá are 22,000 people to Wounaan's 7,000, the voice of the minority group is less likely to be heard when planning such management activities with joint indigenous leadership organisations.

As scientists, we often reduce our research to a discrete, manageable question. However, a research question that is feasible given our own time and financial constraints may not be the right question for the resources we seek to manage. Indeed, such questions may lead to wrong answers. For example, if we record data in a year of exceptionally high fruiting, but only for a year, our management prescription will be incorrect. If we study a single NTFP population rather than sampling across a meta-population, we risk making assumptions that may not hold true for other populations. If we work with a particular resource user group and gather data via interviews, we might miss important behavioural data that

contradicts self-reports. And if we fail to consider power relations that may be relevant to natural resource policies, our policy recommendations will never be brought to the table. By failing to contextualise our research, we may indeed jeopardise the novel knowledge our work advances.

CONCLUSIONS

The use of multiple artisanal non-timber forest products by Wounaan and Emberá communities provides a valuable case study of the importance of ecological, spatial, temporal, social and political variables in the management of non-timber resources. We believe that consciously broadening research efforts to assess these variables allows not only a more realistic and complex view of NTFP, but also a more accurate one that enables communities and environmental managers to better plan for sustainable resource use. Though difficult, failure to incorporate considerations of temporal changes, spatial variation, social difference and larger power relations into NTFP research may lead to inappropriate management recommendations and results that are of limited utility to users, and may call into question the idea of sustainability (Lélé and Norgaard 1996).

References

- ANAM, ANCON and Fundacion NATURA (2001), *Informe Final: Proyecto Evaluación y Fiscalización de Sitios de Aprovechamiento Forestal en la Provincia de Darién y la Región Este de Panamá*. Panamá City: ANAM, ANCON, NATURA.
- Anderson, Patti. J. and F.E. Putz (2002), 'Harvesting and Conservation: Are Both Possible for the Palm, *Iriartea deltoidea*?', *Forest Ecology and Management*, 170: 271–83.
- Arnold, J., E. Michael and M. Ruiz Pérez (2001), 'Can Non-Timber Forest Products Match Tropical Forest Conservation and Development Objectives?', *Ecological Economics*, 39: 437–47.
- Arnold, Michael and Ian Townson (1998), 'Assessing the Potential of Forest Product Activities to Contribute to Rural Incomes in Africa', *ODI Natural Resource Perspectives*, 37: 4.
- Bhat, P.R., K.S. Murali, G.T. Hegde, C.M. Shastri, D.M. Bhat, I.K. Murthy and N.H. Ravindranath (2003), 'Annual Variation in Non-Timber Forest Product Yield in the Western Ghats, Karnataka, India', *Current Science*, 85: 1350–55.
- Botkin, Daniel B. (1990), *Discordant Harmonies: A New Ecology for the Twenty-first Century*. New York: Oxford University Press.
- Bultman, J.D. and K.K. Parrish (1979), 'Evaluation of Some Wood-extractives and Related Compounds as Anti-borer, Anti-fungal, and Anti-termite Agents', *International Biodeterioration Bulletin*, 15: 19–27.
- Bultman, John D. and Charles R. Southwell (1976), 'Natural Resistance of Tropical American Woods to Terrestrial Wood-destroying Organisms', *Biotropica*, 8: 71–95.
- Condit, R., S. Aguilar, A. Hernandez, R. Perez, S. Lao, G. Angehr, S.P. Hubbell and R.B. Foster (2004), 'Tropical Forest Dynamics Across a Rainfall Gradient and the Impact of an El Niño Dry Season', *Journal of Tropical Ecology*, 20: 51–72.
- Crook, Carolyn and Roger Alex Clapp (1998), 'Is Market-oriented Forest Conservation a Contradiction in Terms?', *Environmental Conservation*, 25: 131–45.
- Cunningham, Anthony B. (2001), *Applied Ethnobotany: People, Wild Plant Use, and Conservation*. London: Earthscan Publications.

- Dalle, Sarah Paul, Heraclio López, Domingo Diaz, Pierre Legendre and Catherine Potvin (2002), 'Spatial Distribution and Habitats of Useful Plants: An Initial Assessment for Conservation on an Indigenous Territory, Panama', *Biodiversity and Conservation*, 11: 637–67.
- Dalling, J.W., K.E. Harms, J.R. Eberhard and I. Candanedo (1996), 'Natural History and Uses of Tagua (*Phytelephas seemanii*) in Panama', *Principes*, 40: 16–23.
- Dinerstein, Eric, David M. Olson, Douglas J. Graham, Avis L. Webster, A. Steven, Marnie P. Bookbinder and George Ledec (1995), *Conservation Assessment of the Terrestrial Ecoregions of Latin America and the Caribbean*. Washington, DC: The World Bank.
- Dirección de Estadística y Censo (2001), *Censos Nacionales de Población y Vivienda: Resultados Finales Total del País*. Panamá City: Contraloría General de la República.
- Dovie, Delali B.K. (2003), 'Rural Economy and Livelihoods from the Non-Timber Forest Products Trade: Compromising Sustainability in Southern Africa?', *International Journal of Sustainable Development and World Ecology*, 10: 247–62.
- Dugelby, B.L. (1998), 'Government and Customary Arrangements Guiding Chicle Latex Extraction in the Petén, Guatemala', in R.B. Primack, D. Bray, H. Gallerri and I. Ponciano (eds), *Timber, Tourists, and Temples: Conservation and Development in the Maya Forest of Belize, Guatemala, and Mexico*, pp. 155–77. Washington, DC: Island Press.
- Evans, Tom D. and Khamphone Sengdala (2002), 'The Adoption of Rattan Cultivation for Edible Shoot Production in Lao PDR and Thailand: From Non-Timber Forest Product to Cash Crop', *Economic Botany*, 56: 147–53.
- Ewing, William and Alexander Murray (1922), 'Report on the Economic and Financial Situation in the Republics of Panama and Costa Rica'. London: His Majesty's Stationery Office.
- Freese, Curtis H. (1998), *Wild Species as Commodities: Managing Markets and Ecosystems for Sustainability*. Washington, DC: Island Press.
- Gallego Castillo, B. (1995), 'Materias Primas Vegetables Utilizadas en la Elaboración de Artesanías por las Comunidades Indígenas Waunan del Bajo Río San Juan' (Primary Vegetative Materials Used in Crafting Art by the Waunan Indigenous Communities of the Lower San Juan River). Santiago de Cali, Colombia: Convenio FES–Artesanías de Colombia, Comunidades Indígenas del Bajo San Juan.
- Gentry, A.H. (1986), 'Contrasting Phytogeographic Patterns of Upland and Lowland Panamanian Plants', in W.G. D'arcy and M.D. Correa-A (eds), *The Botany and Natural History of Panama*, pp. 146–60. St Louis, Missouri: Missouri Botanical Garden.
- Godoy, Ricardo and K. Bawa (1993), 'The Economic Value and Sustainable Harvest of Plants and Animals from the Tropical Forest: Assumptions, Hypotheses, and Methods', *Economic Botany*, 47: 215–19.
- Goldman, Edward A. (1920), *Mammals of Panama*. Washington, DC: Smithsonian Institution.
- Gould, Kevin, Andrew F. Howard and Gustavo Rodríguez (1998), 'Sustainable Production of Non-Timber Forest Products: Natural Dye Extraction from El Cruce Dos Aguadas, Petén, Guatemala', *Forestry Ecology and Management*, 111: 69–82.
- Herlihy, P.H. (1986), 'A Cultural Geography of the Embera and Wounan (Choco) Indians of Darein, Panama, with Emphasis on Recent Village Formation and Economic Diversification', unpublished doctoral dissertation. Baton Rouge: Department of Geography and Anthropology, University of Louisiana.
- Howe, James (1998), *A People Who Would Not Kneel: Panama, the United States, and the San Blas Kuna*. Washington, DC: Smithsonian Institution.
- Instituto Geográfico Nacional Tommy Guardia (2003), *Síntesis Geográfica*. Panamá City: Instituto Geográfico Nacional Tommy Guardia.
- Lélé, Sharachchandra and Richard B. Norgaard (1996), 'Sustainability and the Scientist's Burden', *Conservation Biology*, 10: 354–65.
- Marshall, Elaine and Adrian Newton (2003), 'Non-Timber Forest Products in the Community of El Terrero, Sierra de Manantlán Biosphere Reserve, Mexico: Is Their Use Sustainable?', *Economic Botany*, 57: 262–78.

- Miller, Christopher (2002), 'Fruit Production of the Ungurahua Palm (*Oenocarpus bataua* subsp. *bataua*, Arecaceae) in an Indigenous Managed Reserve', *Economic Botany*, 56: 165–76.
- Murrall, K.S., U. Shankar, R.U. Shaankar, K.N. Ganeshaiah and K.S. Bawa (1996), 'Extraction of Non-Timber Forest Products in the Forests of Biligiri Rangan Hills, India. 2: Impact of NTFP Extraction on Regeneration, Population Structure, and Species Composition', *Economic Botany*, 50: 252–69.
- Nepstad, D.C. and S. Schwartzman (eds) (1992), *Non-Timber Forest Products from Tropical Forests: Evaluation of a Conservation and Development Strategy*. New York: The New York Botanical Garden.
- Peres, Carlos A., Claudia Baider, Pieter A. Zuidema, H.O. Lucia, Karen A. Kainer, A.P. Daisy, Gomes-Silva, Rafael P. Salomao, Luciana L. Simones, Eduardo R.N. Franciosi, Fernando Cornejo Valverde, Rogerio Gribel, Glen H. Shepard, Milton Kanashiro, Peter Coventry, Douglas W. Yu, Andrew R. Watkinson and Robert P.G. Freckleton, (2003), 'Demographic Threats to the Sustainability of Brazil Nut Exploitation', *Science*, 302: 2112–14.
- Peters, Charles M. (1996), *The Ecology and Management of Non-Timber Forest Resources*. Washington, DC: The World Bank.
- Peters, Charles M., Silvia E. Purata, Michael Chibnik, J. Berry, Ana M. Lopez and Myrna Ambrosio (2003), 'The Life and Times of *Bursera glabrifolia* (HBK) Engl. in Mexico: A Parable for Ethnobotany', *Economic Botany*, 57: 431–41.
- Peters, Charles M., J. Rosenthal and Teodile Urbina (1987), 'Otomi Bark Paper in Mexico: Commercialization of a Pre-hispanic Technology', *Economic Botany*, 41: 423–32.
- Pittier, H. (1922), 'Botany of the Species of Dalbergia of Mexico and Central America', *Journal of the Washington Academy of Sciences*, 12: 54–65.
- Record, Samuel J. and George A. Garratt (1923), 'Cocobolo', *Yale University School of Forestry Bulletin*, 8: 5–43.
- Reichel-Dolmatoff, G. (1960), 'Notas Etnograficas Sobre los Indios del Choco', *Revista Colombiana de Antropologia*, 9: 73–158.
- (1962), 'Contribuciones a la Etnografia de los Indios del Choco', *Revista Colombia de Antropologia*, 11: 169–85.
- Romero M., A. Mosquera and Dalia Vargas (1999), *La Industria Forestal en Panamá: Consideraciones Para su Reversión*. Panamá City: Autoridad Nacional del Ambiente (ANAM) Organización Internacional de las Maderas Tropicales (OIMT).
- Salafsky, Nick, Barbara L. Dugelby and John Terborgh (1993), 'Can Extractive Reserves Save the Rain Forest? An Ecological and Socioeconomic Comparison of Non-Timber Forest Product Extraction Systems in Petern, Guatemala, and West Kalimantan, Indonesia', *Conservation Biology*, 7: 39–52.
- Schroder, Jobst-Michael (1998), 'Non-Timber Forest Products and Their Potential for Preserving Tropical Humid Forests', *Plant Research and Development*, 47/48: 108–17.
- Shankar, U., K.S. Murali, R.U. Shaankar, K.N. Ganeshaiah and K. S. Bawa (1996), 'Extraction of Non-Timber Forest Products in the Forest of Biligiri Rangan Hills, India. 3: Productivity, Extraction, and Prospects of Sustainable Harvest of Amla, *Phyllanthus emblica* (Euphorbiaceae)', *Economic Botany*, 50: 270–79.
- Sinha, Aditi and Kamaljit Bawa (2002), 'Harvesting Techniques, Hemiparasites and Fruit Production in Two Non-Timber Forest Tree Species in South India', *Forest Ecology and Management*, 168: 289–300.
- Stattersfield, Alison J., Michael J. Crosby, Adrian J. Long and David C. Wege (1998), *Endemic Bird Areas of the World: Priorities for Biodiversity Conservation*. Cambridge, UK: Bird Life International.
- Stewart, Kristine M. (2003), 'The African Cherry (*Prunus africana*): From Hoe-handles to the International Herb Market', *Economic Botany*, 57: 559–69.
- Straede, Steffen, Gustav Nebel and Arun Rijal (2002), 'Structure and Floristic Composition of Community Forests and Their Compatibility with Villagers' Traditional Needs for Forest Products', *Biodiversity and Conservation*, 11: 487–508.

- Svenning, Jens-Christian and Manuel J. Marcía (2002), 'Harvesting of *Geonoma macrostachys* Mart. Leaves for Thatch: An Exploration of Sustainability', *Forest Ecology and Management*, 167: 251–62.
- Taylor, D. (1996), *Embarkations: Ethnography and Shamanism of the Chocó Indians of Colombia*. Oxford: Pitt Rivers Museum, University of Oxford.
- Thompson, John N., O.J. Reichman, Peter J. Morin, Gary A. Polis, Mary E. Power, Robert W. Sterner, Carol A. Couch, Laura Gough, Robert Holt, David U. Hooper, Felicia Keesing, Charles R. Lovell, Bruce T. Milne, Manuel C. Molles, David W. Roberts and Sharon Y. Strauss (2001), 'Frontiers of Ecology', *BioScience*, 51: 15–24.
- Ticktin, T. and T. Johns (2002), 'Chinanteco Management of *Aechmea magdalenae*: Implications for the Use of TEK and TRM in Management plans', *Economic Botany*, 56: 177–91.
- Ticktin, T., T. Johns and V. Chapol Xoca (2003), 'Patterns of Growth in *Aechmea magdalenae* (Bromeliaceae) and its Potential as a Forest Crop and Conservation Strategy', *Agriculture, Ecosystems and Environment*, 94: 123–39.
- Torrealba, Pablo (1996), *Las Políticas de Aprovechamiento Forestal en Darién, Panamá*. Panamá City: CCAB, CEASPA, GRET-FUNDESCA.
- Vasquez, Rodolf and Alwyn H. Gentry (1989), 'Use and Misuse of Forest-harvested Fruits in the Iquitos Area', *Conservation Biology*, 3: 350–61.
- Velásquez Runk, J. (1998), 'Productivity and Sustainability of a Vegetable Ivory Palm (*Phytelephas aequatorialis*, Arecaceae) under Three Management Regimes in Northwestern Ecuador', *Economic Botany*, 52: 168–82.
- (2000), 'Aprovechamiento de Artesanías: Socioeconomía de Artesanías Wounaan y Emberá de Productos Forestales No Maderables' (Taking Advantage of Art: Socioeconomics of Wounaan and Emberá Art from Non-Timber Forest Products). Panamá City, Panamá: Proyecto Manejo de Cativales y Productos No Maderables con Comunidades Campesinas e Indígenas en Darién: 57.
- (2001a), 'An Interesting Population of *Phytelephas* from Panamá', *Palms*, 45: 196–99.
- (2001b), 'Wounaan and Emberá Use of the Fiber Palm *Astrocaryum standleyanum* (Arecaceae) for Basketry in Eastern Panamá', *Economic Botany*, 55: 72–82.
- Walter, Sven (1998), 'The Utilisation of Non-Timber Forest Products in the Rainforests of Madagascar A Case Study', *Plant Research and Development*, 47/48: 121–44.
- Wassén, H. (1935), 'Notes of Southern Groups of Chocó Indians in Colombia', *Etnologiska Studier*, 1: 35–182.
- Wright, S. Joseph, Claudio Carrasco, Osvaldo Calderon and Steve Paton (1999), 'The El Niño Southern Oscillation, Variable Fruit Production, and Famine in a Tropical Forest', *Ecology*, 80: 1632–47.