LTS INTERNATIONAL

Recommendations for the inclusion of nationally important NTFPs in standard forest inventories

SC/08/2002

Recommendations for the inclusion of nationally important NTFPs in standard forest inventories (EI & ISSMI)

Report to the EDF/Uganda Forest Department: Forest Resources Management and Conservation Programme

Consultancy SC/08/2002: Non-wood forest products, assessment methods and plan of action.

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Executive summary

This consultancy was undertaken at the request of the EDF/Uganda Forest Department: Forest Resources Management and Conservation Programme to support the development of sustainable and equitable management of Uganda's forest reserves.

Information gathered during field trips, meetings with key national stakeholders and literature searches was used to build up a list of nationally important NTFPs.

The key finding was that NTFPs are an important component of economic activity based on Uganda's forest reserves and that this included: collection of craft materials, medicinal plants and foods including bushmeat. Much of this activity is not accounted for in forest management and is undervalued by forestry staff. There is a need to be more pro-active in the provision of data and advice on inventory and sustainable management. In particular there is a need for FD and UWA to work together to tackle the issue of regulation of bushmeat hunting which is either completely illegal or a free for all on 'vermin' species.

The consultant was able to meet with a great many people several of whom provided invaluable data as well as visit six forests. Careful consideration of all of this information and data resulted in a suite of recommendations for inclusion of important NTFPs into EI. In passing ideas for the management of NTFP resources have been made and are offered to stimulate discussion of the future policy and management for NTFPs in Uganda.

The main points of the recommendations are listed in the summary table.

Summary table of recommendations for inventory

Issue	Observation	Recommendations	Pages
Identification of important NTFPs	A database of list important NTFPs taken from literature, meetings and field visits was prepared and used to identify priority species for inclusion in EI	products for inclusion in forest inventory should be prioritised according to (1) demand and (2) threat	12
		The database could be augmented as new information becomes available either from literature, reports or field work	12
Protocols for NTFPs in EI	Bamboo	*Oxytenanthera* and any exotic bamboos encountered during the inventory should be reported and measured	13
		bamboo inventory needs to be done in the shooting season which is reported by the Rangers as being September-November	17
		Therefore, age class as shoots, young, mature, old and dead should be used along with records of damage and borer attack.	18
	Rattan	there is a need to undertake more detailed work on rattan growth, maturation and regeneration rates	21
		agreed with the field team that it would be possible to tally rattan into 2 m length classes	22
	Palms	record the size of palms in terms of height rather than diameter	27
		Plants greater than 1 m tall should be recorded from the whole plot with those below 1 m tallied in the north-west quadrant of the plot. Notes should also be made of the extent and type of harvesting present on the plants	27
	Climbers	It is recommended that *Smilax* and *Loeseneriella* are included in EI	28
		a simple count of the number of stems present in the whole plot – either rooted or crossing the a plot is recorded for the climbers	32
	Trees and shrubs	for shrubs a count of the number of stems and the size of the largest stem per plant is recorded	32
		wild coffee and *Aframomum* should be included as they are marginally commercialised	40
		There are five species in Table 14 that do not appear in the EI species list. Most of these are shrubs and should be included in EI	41
		it is recommended that woody stems down to 5 cm are included in EI	41
		It is suggested that the project procure some callipers to measure small sized stems	41
	Bushmeat	New codes need to be included in EI to record pertinent features of pole harvesting	42
		The requisite skills can be acquired by either having a few UWA staff join the EI team or FD staff trained in these skills	37

Issue	Observation	Recommendations	Pages
General sampling inventory issues	The standard EI layout will not be sufficient to obtain reliable estimates for small reserves	Bushmeat - For small reserves (<10km²– cutting of a large number of transects may not be desirable because it would open up the forest. In this case data could be collected along existing trails and along the perimeter. Useful information could also be obtained from interviews with knowledgeable local residents – recording approximate time since last definite sighting of a species	39
		Plants - For reserves which are an awkward shape or are less than 5 km² in area it is suggested that the regular strata are abandoned in favour of a simple division of the reserve into roughly evenly sized units in an objective manner	54
	There is a need to clarify why EI is being done and how it contributes to management planning	It will be worthwhile re-considering how the EI NTFP data is going to be used and the scale at which it is most relevant	47
		It is important that the limitations of EI data are well understood, it will probably be unable to provide sufficiently detailed information for quota setting except at the crudest (national) level	47
		In order to generate the data quickly enough to proceed with management planning and also to put the reserves in a national context (or bigger picture) would require that the rate of field work is dramatically increased	56
Data analysis and presentation	Present EISys/EIPac systems cannot accommodate the inclusion of NTFPs into EI	It is suggested that EISys is modified to accommodate the 25 m² sub-plot and the smaller sized trees	50
		The bushmeat data needs to be analysed using the DISTANCE software and the results integrated into the EI database at the block or reserve level	50
		The calculation of errors for other NTFPs can be set up as queries incorporated into the EI database	50
	There is almost no use of existing EI data in management plans	suggested that EI data could be used to stimulate management planning	56
		The data should be analysed and presented to the FD District staff and partner communities in CFM in a form accessible to them	56
NTFPs in ISSMI		suggestion would be to adopt the EI protocols including NTFPs for assessment of the four temporary sample plots located in the corners of the ISSMI block	57
		more appropriate to construe the CFM inventories as the equivalent of ISSMI for NTFPs	57

Summary table of other recommendations

Issue	Observation	Recommendations	Pages
Bamboo management	Changes in bamboo extent over the last 50 years may be because of changes in disturbance regimes	this should be confirmed from further study as it may be possible to prevent the loss of bamboo, as a socio-economically important productive resource, through more intensive management	19
	A management system to intensify bamboo production in Echuya should be implemented in zoned bamboo production zones	recommended that ethno-ecological surveys should be undertaken in both of these communities to gather information on bamboo management, life history and ecology	20
		priority access for the Batwa should be considered	20
	Many bamboo species have mass flowering followed by die off – if this is the case for Arundinaria many people are going to be impoverished	observations of a 'greying' of the bamboo, a 'sickness' and 'drying off' should be investigated as a matter of urgency	20
		Contingency plans should be prepared in the event of a mass flowering and die off both in terms of seed collection and protection of the cleared sites for bamboo re-establishment	20
		Forest rangers and UWA staff should be briefed on the signs of imminent flowering	20
		cultivating alternative species in bamboo villages should be investigated	20
Rattan sustainability	Rattan resources are very depleted and are nearing econoic extinction in many reserves	Communities should be encouraged to enrichment plant suitable, degraded sites within the reserves with *Calamus*	23
		exotic species could be introduced into plantations and grown under eucalyptus in suitable sites	23
		monitoring to determine growth rates and harvesting impacts	28
		assess population densities and to determine growth and replacement rates	29
Medicinal plants	Once medicinal plant collection is commercialised resources can quickly become depleted – the extent of commercialisation in Uganda is not known	Greater attention should be given to the collection and naming of forest herbs used as medicines	30
		more work is required to determine the level of threat posed to the populations of the preferred species	30
		there is a need for some evaluation of the extent of cross-border collection of medicinal plants	31
		There is a need to describe the status of the herb markets and trade linkages in Uganda	31
		It is necessary to formulate a policy to balance exploitation for timber and medicinal use	32
		Further work is required to determine the quantities in which different species are required and to formulate management plans to supply these amounts on a sustainable basis	32
Wildlife conservation	Since hunting is underground there is no co-operation between FD and hunters	a more sympathetic approach that accepts regulated hunting of less vulnerable species may help to encourage co-operation between hunters and the FD	36
Poles	It may be possible to manage some understorey species through coppicing	confirm this with observations or experimental cutting in other areas	43

Issue	Observation	Recommendations	Pages
New resources	There may be species presently underexploited in Uganda which could be developed to provide new income opportunties	Identifying possible income generating products which are not presently exploited would require screening of wild plants and animals in Uganda and market research to identify which would find a market either within the country or for export	44
		To secure the incomes and markets for these species requires sustainable management of existing resources and conservation both *in situ* and *ex situ*	45
	Subsistution of over-exploited resource with those more capable of withstanding exploitation is required	Substitution presents opportunities for commercialisation of new resources but needs to be done on a sustainable basis	45
		urgent need to determine the identity of this climber and any other substitutes for rattan	45
		Marantochloa is one possible substitute for rattan at least for tourist or export orientated craft items	45

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List of acronyms

CFM	Collaborative forest management
CID	Centre for Integrated Development
EI	Exploratory inventory
FD	Forestry Department
FR	Forest Reserve
FORRI	Forest Resources Research Institute
ISSMI	Integrated stock survey and management inventory
LVEMP	Lake Victoria Environment Management Programme
NACOTHA	National Assembly of the Council of Traditional Healers Associations
NCRL	Natural Chemotherapeutic Research Laboratory
NP	National Park
NTFP	non-timber forest product
PSP	Permanent sample plot
RSA	Republic of South Africa
SE20	20% sampling error
UWA	Uganda Wildlife Authority
WCS	Wildlife Conservation Society

Disclaimer

The spelling of the species names in this report are taken from the list included in the EI database. It appears that many of the spellings are incorrect and some genera names have not been updated (e.g. *Fagara* is now *Zanthoxylum*). This database list needs to be updated and corrected.

Acknowledgements

Many people assisted the consultant during this assignment (see Annex 2 for the full list) and their contribuition to this report are gratefully acknowledged. Several people deserve special mention because of their willingness to divulge information and to make available data from their own studies. Robert Bitahiro is thanked for provision of his unpublished 5x5 m plot bamboo data for Bwindi. Dezidérius Irumba provided participatory inventory data for raphia from Tero West and his draft report of CFM inventory in Sango Bay. Dezi also tracked down the data from the CFM inventory of Budongo when we thought it was lost. Andy Plumptre provided plant data from the WCS survey of Echuya as well as reports of the mammal survey of Kalinzu. James Acworth was always helpful and facilitated access to numerous people, sources of information and arranged the field trips. TSS staff in particular Jimton Acobo and Fred Ahibisibwe.

I would also like to thank my fellow consultants David Hafashimana and Jackson Mutebi for their insights and company in the field.

Bryan Dickinson assisted with the recommendations for the bushmeat surveys.

1. Introduction

This report was prepared in partial fulfilment of the consultant's terms of reference (see Annex 1). It focuses on the identification of nationally important non-timber forest products[1] (NTFPs) and makes recommendations for inclusion of priority species in the standard Exploratory Inventory (EI) used in the natural high forests of Uganda. Suggestions for the incorporation of NTFPs into the developing collaborative forest management (CFM) programme is contained in a separate report.

The work was undertaken as a desk study based in Kampala supplemented with meetings with important national stakeholders (see Annex 2) and field visits to six Forest Reserves (Mabira, Budongo, Mpanga, Sango Bay, Kalinzu and Echuya) and Bwindi Impenetrable National Park. All of these people contributed to the development of the ideas contained within this report and are thanked for their time and willingness to share knowledge, unfinished reports and data with the consultant. However, the consultant takes full responsibility for the recommendations presented in this report.

The requirement for integration of NTFPs into EI meant that the recommendations for NTFPs had to utilise the same sampling design. This constraint meant that recommendations focussed on determining the optimal size of sub-plot for various NTFPs and the features of the resources that should be measured and recorded. Annex 3 gives details of the statistics used to analyse the data from inventories of specific NTFPs with particular reference to the number of plots required to achieve a target sampling error which is a measure of the precision of the inventory. A target sampling error for forest inventory of 20% was adopted for this report as this is commonly used in other countries (e.g. Ghana). However, the final choice of target error should be made with regard to what figures e.g. national standing volume or stocking of a particular species and the level of certainly required for the decisions to be made from the data.

[1] The term non-timber forest product (NTFP) is used in preference to non-wood forest product (NWFP) as many of the products are made from wood (i.e. building poles and drums). Timber is taken as including all processing of wood for use in construction or furniture. Charcoal and firewood are also excluded as these are bulk uses of wood and can be accomodated by the standard tree inventory data. Services such as eco-tourism and water sources have also been excluded as they are difficult to assess in standard forest inventory.

2. Background

There are a number of publications which list the important NTFP species for Uganda (Naluswa 1993, Emerton and Muramira 1999, Hafashimana et al. 2000, EAGO 2002, Walter 2002). The consensus of these is that there are a great many wild, forest products that are used by rural Ugandans. It has been estimated (NEMA 1996, reported and updated to 1998 prices by Emerton and Muramira 1999) that the consumption of non-wood forest products (excluding poles from trees) has a value of some USh 66 billion per year; in comparison, wood products from natural forest representing some USh 138 million. However, the full list of plants, fungi, animals, insects, fish etc. that are in use in Uganda would be impractical to inventory. For example, Okello (1999) identified 140 plant and 14 animal species collected from Semuliki NP had local use and cultural significance.

NTFP demand and supply is highly dependant on the vegetation type, vegetation structure (i.e. its integrity), proximity to urban areas and culture (especially of people living closest to the forest). Consequently what is important to one cultural group may not be of interest to another and what is threatened in one forest may be plentiful in elsewhere. Increasing affluence has two effects: to decimate populations of commercialised species even far from urban centres (e.g. rattan) and the cessation of interest in subsistence products (e.g. leaves for wrapping food are replaced by newspaper and plastic bags). It is difficult to ascertain the current status of many NTFPs in Uganda though it is clear that there is a much lower level of commercialisation than observed in west Africa. From field observations and literature it would appear that only craft materials, poles and medicines from high forest have commercialised at the regional or national levels. Demand is locally high for products such as bushmeat, climbers for tea baskets and Raphia palm for tobacco but are not traded beyond a few Districts.

Management of different types of products should, ideally, be based on sound data on locations, densities, growth and reproduction rates, harvesting techniques and ecosystem impacts. How this information is collected and used varies for local use and nationally commercialised products. At the local level PRA style techniques are most appropriate and are incorporated into the CFM procedures and are not dealt with here (see separate CFM inventory report). Nationally important NTFPs require a different approach that integrates the demand for products across the country. Some work on the identification of national priorities for inventory has already been done (Hafashimana et al. 2000).

Hafashimana et al. 2000 identified the following as priorities for data collection both in terms of socio-economics and ecological aspects[2]:

Wild food plants

Honey and by-products

Gum arabic/resins

Commercial products (e.g. coffee)

Edible oils (shea butter and palm oil)

Fibres and climbers (for crafts)

[2] Eco-tourism and rubber were also on the list but have been omitted. Eco-tourism because it is a ‘service’ rather than a tangible ‘product’ and rubber because it is no longer collected from wild (*Funtumia elastica*) trees.

Bushmeat

Bark cloth

Bamboo

Rattan

The obvious omission from this list are medicinal plants which are used a significant source of health care for 80% of Ugandans. Although such lists are useful it is necessary to identify priorities at the species level.

3. Identification of nationally important NTFPs

It was agreed at the consultancy orientation meeting held in Kampala on the 13th May that **products for inclusion in forest inventory should be prioritised according to (1) demand and (2) threat**. Such a process will tend to focus attention on species which are already in decline which are an immediate management concern. A preliminary list of important NTFPs was drawn up by the meeting (see Annex 4) and prioritised according to the need for inventory. The ranks are presented in the tables below were appropriate.

Lists of species which are in high demand with dwindling supplies were accumulated from field trips, meetings and the available literature (see references) and entered into an ACCESS database. This contains information from 28 sources covering 17 locations (reserves, districts and for the whole country). In all 139 species of plant, animal, bird etc. were mentioned as being 'important' in terms of demand or resource scarcity. In all 301 records were entered into the database, this is called 'Important NTFPs.mdb'[3] and is with the EC Forestry Project in Kampala. **The database could be augmented as new information becomes available either from literature, reports or field work**. With additional inputs the database could be used to (a) identify important NTFPs for strategic planning and (b) indicate where they are collected from.

Although mushrooms were mentioned everywhere as being seasonally collected from all forests it was evident that it would not be possible to identify species and are only commercialised in a few localities e.g. Mount Elgon (Scott 1997) and at roadside selling points such as that close to Mpanga along the road to Masaka. Mushrooms were therefore not included in the database.

Simple counts of the number of times a product was mentioned as being important was used to rank the species (see Annex 3 for full list). The relatively small number of reserves visited, scarcity and bias (towards well documented sites e.g. Bwindi) of published accounts means that the list produced is incomplete and can hardly be considered representative. However, there is general agreement on the most important species regardless of how the data is manipulated so it can serve as a starting point for assessment of important NTFPs in Uganda. Inventory recommendations are discussed under five headings: craft materials, medicinal plants, wild foods and poles as these are the main categories of non-timber products widely used and traded in Uganda.

[3] ACCESS 2000

4. Craft materials

Crafts are an important source of income for rural Ugandans. The most commonly traded craft items are baskets and mats woven from a variety of raw materials harvested from a range of ecosystems. Table 1 lists the raw materials used in crafts including the preferred species for drum making. Although the manufacture of drums is a non-timber use of a tree it does not require any special consideration in EI as all the drum species are already included in the EI tree list.

Table 1: Raw materials used to make commonly traded craft items

Species	Life form	Product	Rank	Inventory issues
Arundinaria alpina	Bamboo	Baskets, building poles	1	Measure in 25 m² sub-plot
Calamus deeratus	Rattan	Baskets, furniture	1	Tally by height class
Loeseneriella apocynoides	Climber	Baskets		Tally useable plants
Maesopsis eminii	Tree	Drums	3	None
Marantachloa spp.	Herb	Baskets	3	% cover
Phoenix reclinata	Palm	Mats, baskets	2	Tally by height class
Polyscia fulva	Tree	Drums	2	
Raphia farinifera	Palm	Fibre, brooms	2	Tally by height class
Smilax anceps	Climber	Baskets		Tally useable plants

4.1 Bamboo

There are two bamboos indigenous to Uganda: *Arundinaria alpina* the montane bamboo and *Oxytenanthera abyssinica* the lowland bamboo. Of these *Arundinaria* is by far the most numerous and is traditionally heavily exploited where it occurs in pure stands. Little is known about *Oxytenanthera* and it is not possible to indicate whether the protocols developed for *Arundinaria* are appropriate for this species. ***Oxytenanthera* and any exotic bamboos encountered during the inventory should be reported and measured**. Modifications to the protocol may be required if the species turns out to have a different mode of growth to *Arundinaria* e.g. be present in very dense, isolated clumps – in which case the shrub protocol may be more appropriate.

The National Biomass Study (as reported by Walugembe undated) indicates that *Arundinaria alpina* is present in substantial pure stands on Mount Elgon, Rwenzori, Bwindi and Mgahinga NPs and in Echuya FR. Collection is permitted on a personal use basis in some of the NPs and commercially under licence in Echuya. It is the stands in Echuya were commercial collection is permitted and could potentially be developed which is the concern of the Forestry Department. Within Echuya both dry and green culms[4] are harvested for use as building poles and for basket weaving respectively. Demand is high for bamboo and there are many communities who are dependant on it for their livelihoods (in the case of the Batwa it is their main source of income for the

[4] A culm is a single stem of bamboo.

purchase of food and clothing). Dry culms are used locally for building while bamboo baskets are traded over much of Uganda. Bamboo is also cut by Rwandans as part of the Echuya Forest Reserve borders Rwanda (see

Map 1) where there are no natural stands. Echuya is one of only three forests in this area that contains bamboo. The other two, Bwindi and Mgahinga NPs are closed for bamboo harvesting which means the pressure on Echuya for bamboo is intense. This is a unique situation where UWA and FD could work together as recommended by Jackson Mutebi (Mutebi 2003).

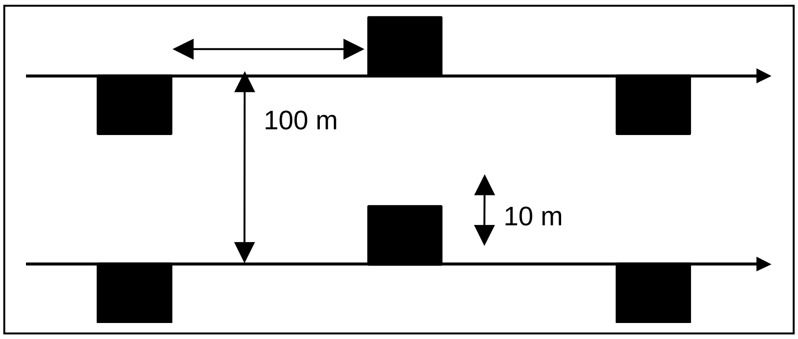
4.1.1 Inventory

Bitariho (1999) undertook inventories of bamboo stands in Bwindi and Mgahinga. The sampling design used was a stratified systematic - stratified according to density of bamboo (from aerial photos and field surveys) into homogeneous, mixed bamboo dominant and mixed bamboo trees dominant stands. Within each stand sample transects spaced at 100 m intervals were laid out E-W from available trail and centre of patch with the starting point being randomly selected. The plots were 10x10 m in size and spaced 100 m apart on the transects. The plots were alternately laid on the left to right side of transect line as in Figure 1.

In each plot the following records were made for each culm:

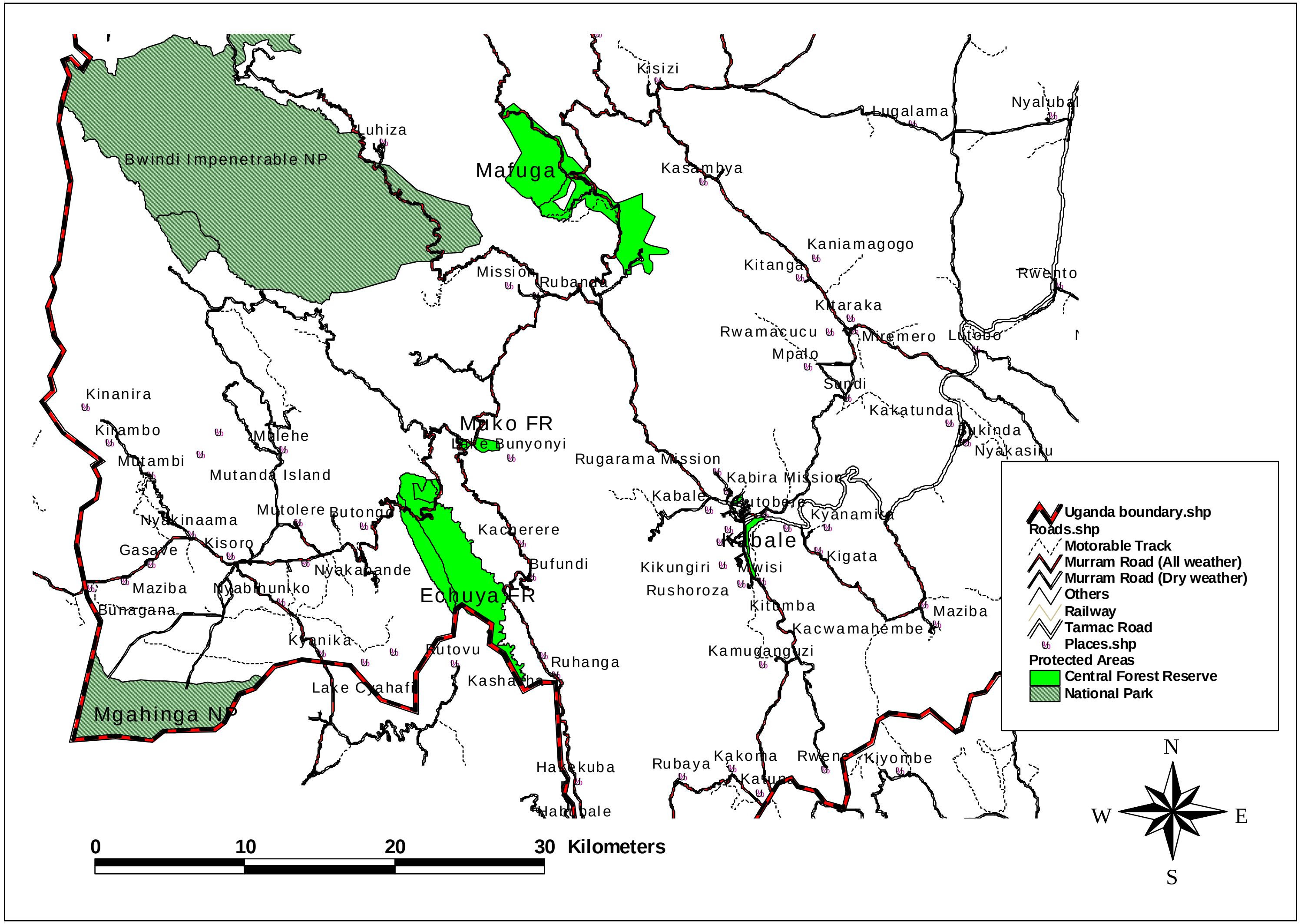
Stem diam (mm)
Stem height
Internode length
Age class (shoot, young, mature, old, dead)
Gorilla / Monkey / Elephant damage (~15% of stems)
Borer infestation (moth larvae)
Quality (as assessed by users)

Figure 1: Layout of bamboo sample plots (Bitariho 1999)



The results give culm densities ranging from 5,000 to 41,000 culm per ha across the stand types with highest densities in pure stands. Culms in Echuya are larger than those for Bwindi and Mgahinga and since size is inversely related to density it is likely that densities in Echuya will be lower but still extremely high.

Map 1 Location of Echuya Forest Reserve



The optimum design for an inventory is a compromise between the size and number of plots. Table 2 gives some sample data for different sized plots which indicates the number of plots required to achieve the target sampling error of 15%. It is clear from these data that fewer, larger plots give roughly the same sampling error as a greater number of smaller plots. These data suggest that as few as five 10x10 m plots could estimate culm density in a pure stand. However, there are other considerations such as the representaiveness of the sample. It is obvious that spreading a greater number of plots across the forest will better represent the whole area and permit mapping of stand characteristics albeit at crude resolution. In this case it may be desirable to use the same sampling design as the standard EI for comparison with other reserves and for logistical ease. However, this is not strictly necessary as there is little timber in Echuya so the need for comparison is lessened. If we assume that there are advantages to using the same design this decision would determine the sampling design and hence the number of plots which makes the decision to be made the size of the plot to be used.

Table 2: Sample data for Mgahinga and Bwindi

Statistic	Mgahinga	Bwindi
Data source	Bitariho 1999	Cunningham 1992
Stand type	Homogeneous	Homogeneous
Plot area	25 m²	100 m²
Plot dimensions (m)	5 x 5	10 x 10
Number of plots	20	4
Average culms per plot	69	177
Variance	978.93	796.67
Standard error	7.17	16.29
SE%	20.59	18.41
CV%	44.88	15.94
N for target 20% SE	20	2.5

Field experience suggests that it would be easier for the field crews to measure 70 rather than 180 culms per plot so a plot size of 25 m² which equates to a quadrant of a circle of 5.6 m radius. In 2002 the FD district staff undertook small scale participatory inventories as a preliminary to CFM in several villages around Echuya. The sample plots were restricted to the bamboo areas adjacent to the village and were rather few in number. A sample of these data has been analysed and is presented in Table 3. These data indicate considerably higher variances as indicated by the CV% than the data for pure stands given in Table 2 which is to be expected as these stands were mixed. The estimated area of bamboo in Echuya in 1990 (Banana & Tweheyo 2001) was 474 and 976 ha for pure and mixed stands respectively. If the whole area is subjected to EI more than 1000 plots would be enumerated which is more than sufficient to obtain precise results for all age classes of bamboo in all types of stand. Note that in

Table 3 that the estimates for shoots is both low and has very high variance meaning a large number of plots are required to obtain precise estimates. Bitahiro (1999) gives much higher numbers of shoots and these low figures are probably a consequence of the inventory having been done at a time when shooting was not happening in some parts of the forest. This is a good reminder that if estimates of the number of shoots is required that the **bamboo inventory needs to be done in the shooting season which is reported by the Rangers as being September-November**.

In a standard forest inventory it is difficult to measure height accurately especially from within stands where it is difficult to see the top of the plant as is the case with bamboo. Since harvesters seldom take the whole culm (most were cut at least a metre from the ground) a count of culms will probably give a good enough indication of resource amounts. However, age class and damage are important features which determine the utility of the culm. The former because young, greeen stems are used for baskets while odler, brown stems are used for building and the latter because borer damage severly impairs strength and hence building use. Both age and damage. Therefore, **age class as shoots, young, mature, old and dead should be used along with records of damage and borer attack**. A record of recently cut stems should also be recorded as this will give an indication of current harvesting levels and permit a re-contruction of the age-structure of the population.

Table 3: Inventory data for bamboo plots in Echuya (DFO 2002)

Statistic	Culms per 100 m² plot						
	Shoots	Young	Mature	Old	Dead	Diseased	Total
Average	32.43	75.71	63.14	100.57	13.86	1.86	287.54
Var	696.95	2048.90	1491.14	4234.28	61.14	1.81	26848.69
N	7	7	7	7	7	7	7
Std Error	10.78	18.48	15.76	26.56	3.19	0.55	66.89
SE%	66.47	48.81	49.93	52.83	46.07	59.14	46.52
CV%	81.41	59.78	61.15	64.70	56.43	72.43	56.98
N for 20%	66	36	37	42	32	52	31

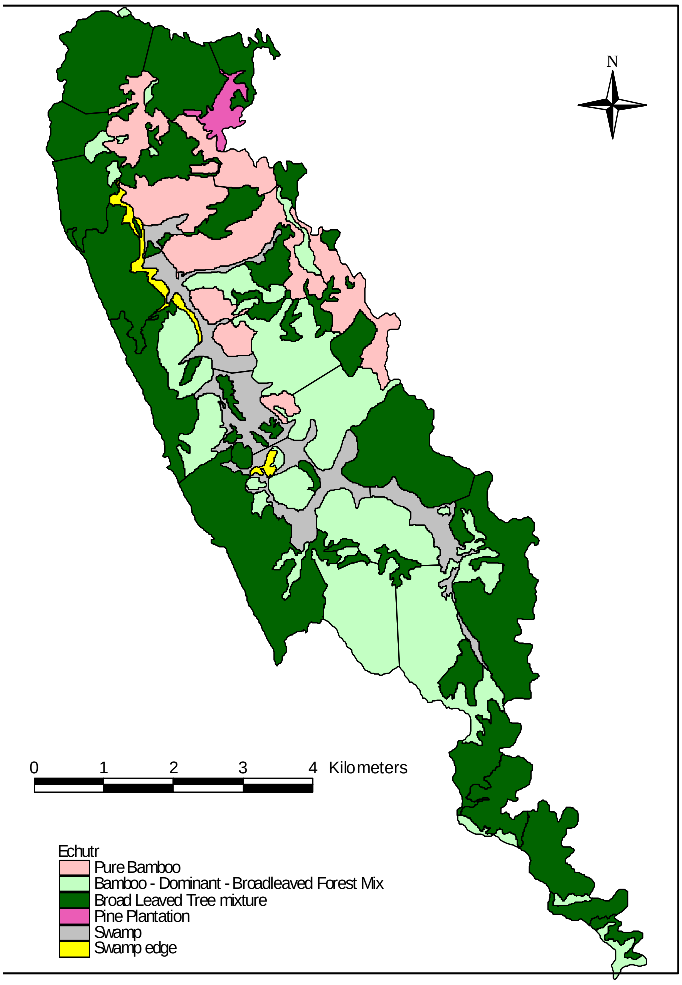
If we assume that roughly four times as many 25 m² as 100 m² plots are required[5] then the figures in Table 3 suggest that at least 280 plots might be required to attain a 20% sampling error. It is now necessary to determine whether the EI inventory would provide sufficient plots. Banana and Tweheyo (2001) give the results of interpretation of air photos taken in 1990 for Echuya as representing 474 ha of pure bamboo and 976 ha of mixed bamboo and trees. The sampling intensity for EI is 1% and this is made up of 20 x 500 m² plots per 1 km² block. This means that following standard EI procedure that approximately 95 and 195 plots would be placed in pure and mixed bamboo respectively. This should be sufficient[6] to obtain precise estimates of stocking density for any age class of bamboo culm in pure or mixed stands.

Map 2 shows the distribution of pure and mixed bamboo within Echuya in 1990 (from Banana and Tweheyo 2001). It is clear that there are discrete blocks of bamboo that should be amenable to EI inventory although the extreme topography of the reserve may mean some areas are not easily accessible. It is the practice with EI to exclude areas zoned as nature reserves. In this case it will be important to overlay the vegetation map with the zonation to see how many plots are likely to fall in bamboo. If there are not enough then there may be a need to augment the number perhaps by reducing the size of the blocks, keeping the 20 plots within a block.

[5] These relationships are rarely linear but this is a reasonable assumption in the absence of smaller test plots.

[6] Note that the two stage design of EI means that sampling errors will be lower than those calculated for a one stage design as in the table. The correct calculations to estimate the required number of units for the EI design is co\mplex and cannot be done for bamboo as there is no data available for this design.

Map 2: Bamboo zones within Echuya FR



In the event that an area of bamboo is zoned for intensive management it would be necessary to implement an intensive inventory of the resources. Such a management inventory would have the same function as ISSMI but could not be done in the same manner because of the enormous number of culms that would be encountered. It is suggested that a bamboo management inventory should have a relatively high number of plots and be either pre-stratified or laid out systematically so it can be post stratified.

4.1.2 Ecology and management

Over the past 50 years about half the pure stands have been replaced by trees with bamboo becoming a minor component of the understorey (Banana & Tweheyo 2001). It is presumed that this is a successional process which may previously been arrested by elephant and buffalo browsing/disturbance and perhaps fire. However, **this should be confirmed from further study as it may be possible to prevent the loss of bamboo, as a socio-economically important productive resource, through more intensive management**.

There are two groups of people who are highly dependant on bamboo and have a long association with its management and use. The Batwa are an indigenous forestdwelling people who are acknowledged as experts in harvesting wild bamboo. The bamboo cultivators on the Ugandan side of Mgahinga have extensive knowledge of the growth and harvesting of planted bamboo. It is **recommended that ethno-ecological surveys should be undertaken in both of these communities to gather information on bamboo management, life history and ecology**. Intensively managed bamboo can be up to ten times more productive than natural stands (Andrew Benton, INBAR *pers comm*). Given the high demand for bamboo it is recommended that some of the bamboo be zoned for intensive management to maximise the production of both green (young) and brown (mature) culms. The Batwa are experienced in bamboo management and having been evicted from the reserve are now effectively landless and use bamboo as their principle source of subsistence income. When designing bamboo management for Echuya **priority access for the Batwa should be considered**. Indeed permitting them to return to the forest (perhaps under condition that there is no forest clearance) would be a good option for policing the reserve.

Bitariho (1999) reports that around 15% of shoots are browsed by monkeys, these continue to extend but are prone to borer (moth larvae) attack which makes the culms useless. Simple studies should be devised to investigate the timing of borer attack on the damaged culms to determine whether judicious cutting would facilitate the 'salvage' of damaged shoots at a useable length (or as firewood or other uses).

It is presumed that *Arundinaria* has a life cycle similar to that of most other bamboos and will experience periodic mass flowering followed by the die-off of the entire population. Bitariho (1999) discovered cultivated bamboo around Mgahinga that was 48 years old. This suggests that the present stands must now be at least 53 years old. Little is known of the flowering period for *Arundinaria* though there are reports of intermittent flowering (Rangers reports) which may be an early indicator. The recent reports and **observations of a 'greying' of the bamboo, a 'sickness' and 'drying off' should be investigated as a matter of urgency** as this may be an early warning of mass flowering or indeed a disease of the plants.

Contingency plans should be prepared in the event of a mass flowering and die off both in terms of seed collection and protection of the cleared sites for bamboo re-establishment this may mean protection from encroachment by trees and farmers. **Forest rangers and UWA staff should be briefed on the signs of imminent flowering** which are likely to be a marked reduction in leaf size especially at the ends of branches and the production of a short terminal spike signalling flowering within the next few months.

In order to reduce dependency on *Arunindaria* the possibility of **cultivating alternative species in bamboo villages should be investigated**.

4.2 Rattan

Calamus deeratus is the most widespread rattan in Uganda and has been traditionally used for baskets and binding poles in construction. Over the past ten years or so demand has steadily increased for furniture and other household items made from rattan following fashions borrowed from south east Asia where rattan is both common and popular. There has also been a trend for rattan craft items to be promoted as a an income generating opportunity for disadvantaged groups with some items being exported. Unfortunately this has lead to demand outstripping supply in many places with rattan now being traded from Budongo to Kampala.

Calamus deeratus is a rhizomatous species which is found at high densities in swampy sites within high forest in western Uganda. Stem densities are highest in permanently water-logged sites (Okia 2001). Though it can also be found in well drained sites as long as rainfall is relatively high. Individual plants are long lived and produce new canes from the axils of the first leaf node on the stems. Only 25% of immature canes in Budongo were found to arise from seed. The canes scramble up into the canopy, typically reaching lengths of 10-16 m before flowering and dying. Stem diameters are reported to be between 1.0-2.8 cm (Sunderland 2003) though all stems observed during field work were less than 1 cm in diameter. It is the dry, dead stems which are harvested as rattan. Harvesting of dead stems of a vegetatively propagating species is inherently sustainable as long as demand is in step with the production of mature stems and harvesting does not damage the immature stems.

In a survey of rattan in three sites in Budongo Okia (2001) discovered that only 5.3% of the 4,210 stems encountered were mature and therefore harvestable. Around 10% of the juvenile plants are damaged either by insects or from harvesting. There was a significant link between intensity of harvesting and the amount of damage to immature stems and it was concluded that improper harvesting methods or techniques were being used. Okia (2001) also tagged and measured growth of 20 stems in each of his three sites. Measurements were taken at two monthly intervals for six months. Using these data to estimate annual growth gave stem extension rates of between 1.3 and 2.5 m per year. The length of mature cane varied from 9.4 to 11.4 m with a mean of 10.2 m. Dividing cane length by extension rates gives rough estimates of the minimum age of a mature cane of between 4 .5 to 8 years. Dividing the number of undamaged immature canes by the time to reach mature length gives an annual production of 150 to 430 canes ha^{-1} yr^{-1} from rattan rich areas (swamps). These figures are preliminary and **there is a need to undertake more detailed work on rattan growth, maturation and regeneration rates**.

The only other rattan species known to occur in Uganda is *Eremospatha haullevilleana* which has been reported from Semuliki NP (Sunderland 2003, Sheil 1997). This is a species of terra firme forest (i.e. not swamps) and occurs in closed-canopy and open areas. Like Calamus deeratus it is a thin cane with average diameters of 7-15 mm. It is not known if this species is harvested though it seems likely that this would have occurred before the NP was created.

4.2.1 Inventory

Compared to other NTFP species there have been a lot of developments in rattan inventory (e.g. Williams et al 1995, Nur Supardi et al 1999). Recommendations centre around stratification of rattan rich areas and the use of relatively small (0.0025 to 0.025) square or rectangular plots. Optimal sampling intensities of around 10% are advocated but in areas were rattan is ubiquitous. In order to examine optimal configurations for use in Ugandan high forest, the data generated by Okia (2001) for Budongo was analysed for sampling efficiency.

Okia (2001) used systematic strip sampling with 10 x 100 m strips laid at 20 m intervals across rattan patches giving a 3% sampling intensity. Each strip was divided into 10 x 10 m 'plots' (though strictly speaking these are sub-plots). In each plot the following was recorded:

Age classes: Seedlings, juveniles, mature

Damage

Ocular estimate of length

Canopy openess (spherical densiometer)

Sucker vs seedling regeneration

Unfortunately, the data are only presented in the thesis as plot frequencies so it was not possible to analyse the data as transects. Assuming that the 'plots' are independent and pooling data from all three sites yielded the statistics presented in Table 4.

These data suggest that 17 x 100 m² plots containing rattan are required to achieve an acceptable degree of precision in density estimates. However, rattan is relatively rare in most Ugandan forests and it is unlikely that many EI plots will contain rattan. Length and maturity are the most important features in determining the utility of rattan stems.

Table 4: Sampling statistics for rattan in Budongo (Okia 2001)

Number of plots	243
Mean stems per plot	42.34
Variance	307.05
Standard error	0.51
SE%	2.42
CV%	41.39
N to achieve 20% SE	17

During a trial of NTFP data collection in Mabira FR it was **agreed with the field team that it would be possible to tally rattan into 2 m length classes** as presented in Table 5 and **to record whether the stem was green or brown to indicate maturity and evidence of damage or harvesting of the stem**. As demonstrated in Table 2 that precise data can be obtained from a smaller number of large plots. Since we expect the number of EI plots that contain rattan to be small it is best to **enumerate them over the whole plot of 500 m²**. Although the amount of data in Table 5 is rather restricted it does serve to indicate that within a rattan patch that the numbers of smaller sized stems are too great to enumerate over the whole plot. **It is therefore recommended that stems less than 1 m tall** (class SD and 1 in Table 5) **are recorded only from the NW quadrant of the EI plot**. The shaded cells in Table 5 indicates the numbers of canes that would have been enumerated in Mabira using this recommendation.

Table 5: Test data for one rattan plot in Mabira

Size class	Nominal cane lengths	Sub-plots		Total (500 m²)
		125 m²	375 m²	
SD+	~ 0	13	6	19
1	< 1 m tall	26	67	93
2	1-2 m tall	8	4	12
3	2-4 m tall	1	8	9
4	4-6 m tall	3	1	4
5	> 6 m tall	4	1	5

+SD – seedling / sucker

4.2.2 Cultivation

Rattan is an important economic resource in much of South East Asia and several species are successfully cultivated. Afrirattan based in Cameroon is presently developing cultivation and utilisation techniques for African rattans (see Sunderland and Nkefor 2003). With assistance from the LVEMP, CID a local NGO is experimenting with *Calamus* cultivation in Mabira FR. They have a couple of nurseries were plants are raised from seed and then planted out in the forest. There are a few problems with the suitability of the planting sites but generally this sort of initiative should be encouraged and extended perhaps to Budongo. **Communities should be encouraged to enrichment plant suitable, degraded sites within the reserves with *Calamus*** as a source of future revenue and income opportunities.

Calamus is the main rattan in Uganda but where there are alternatives it is generally considered inferior in quality to other African species (Sunderland 2003). Only *Eremospatha haullevilleana* occurs in Uganda and even this is not the best quality cane. It would be worth considering cultivation of some of the larger, stronger African rattans e.g. *Laccosperma acutiflorum* and *L. robustum*. These are both low altitude species and may not be suitable for Uganda but *L. opacum* grows in Congo and may succeed in Uganda. Some of the Asian rattans grow at altitude and may do well in Uganda (INBAR may be able to advise on suitable species to try). It is generally not a good idea to introduce exotics into a natural forest and it should be discouraged. However, **exotic species could be introduced into plantations and grown under eucalyptus in suitable sites**.

4.3 Palms

There are two indigenous palms that are heavily used by local people as raw materials for craft items such as baskets and mats. Both occur in swamps and are used mainly as a source of craft materials. In the last year the enumeration of palms was added to the EI protocol as if they were trees.

4.3.1 Raphia

Raphia (*Raphia farinifera*) is used as a source of fibre, building materials and for palm wine. The raphia string is the peeled upper surface of unfurled fronds. The individual leaflet midribs are used to make brooms while the main frond midrib can be used for building. The sap can be tapped to make palm wine though this is not a common practice in Uganda evidence of tapping can be seen in areas with Congolese immigrants.

The string can be harvested sustainably or destructively. Sustainable harvesting removes just the extended but unopened frond from mature plants and can be repeated at approximately monthly intervals. Repeated harvesting probably reduces the size of the subsequent leaf and eventually the palm flowers and dies. It is not clear whether frond harvesting hastens the death of the plant but this seems likely. However, since the plant fruit before dying even this should not compromise the resources as long as the time intervals involved are sufficient for new plants to mature.

Evidence of destructive harvesting by tobacco farmers was reported (and observed) in Budongo. The leaflet midribs are used to ‘stitch’ tobacco leaves the bundles being hung for drying in covered barns. The tobacco farmers had removed the top of the plants by cutting across the stem which effectively kills them. It was suggested that one tobacco farm would require 2000 mid-ribs per year of either Raphia or Phoenix.

There are only 10 records of Raphia in the EI database. Two of these are from Mabira with the rest from Sango Bay. The data from Sango Bay was used to calculate errors[7] for Raphia in EI as shown in Table 6. The diameters of the plants recorded in existing EI vary from 14.2 to 47 cm with occasional notes of the height of the plants. Diameter is not a useful measure of the size of palms with height being better related to age, maturity and usefulness.

Table 6: Statistics for Raphia in Tero East and Tero West FRs

Statistic	Tero East	Tero West
Number of plants	3	5
Number of plots	69	68
Mean	0.0434	0.0735
Variance	0.0422	0.0691
SE	0.0249	0.0321
SE%	114.6	87.4
CV%	472.5	357.6
N for 20%	2232	1279

It is clear that the low numbers of Raphia encountered in normal EI gives rise to extremely high errors (> 80%). This is because it is just one species – the same would be true for all but the commonest tree species. Indications are more than 1000 EI plots would be required to estimate Raphia stocking at a 20% sampling error. This obviously means that the sampling intensity would need to be increased i.e. make plots bigger, have more of them in a block or make blocks smaller. However, since Raphia occurs in clumps confined to swamps a more effective mechanism would be to stratify the reserves. Swamps can easily be stratified from remote sensing (air photos and satellite images) and perhaps from topographic features (river confluences, flat and depressed land surface etc.). It is not likely that individual swamp stratum would be large enough to accommodate standard EI blocks and a different layout would be required. Perhaps selecting two 1 km transects in each stratum and laying out EI plots along them would be an effective compromise. However, the fact that both Tero East and West did not contain even one complete EI block points to the fact that EI is not well suited to irregular or small reserves. These issues are examined in more detail in Section 0.

A short field trip was made to Mabira with the EI field team to investigate inventory for Raphia. Three EI plots (12.4 m radius) were established in a swamp which contained Raphia to mimic swamp stratification. The plants were tallied into height classes starting from seedlings without an obvious stem up to 6 m plus trees. The data for the three plots along with standard inventory statistics are given in Table 7.

Table 7: Test data for Raphia in Mabira

Class		SD	1	2	3	4	5	
Height		Seedling	< 1 m	1-2 m	2-4 m	4-6 m	> 6 m	All - not SD
Plots	1	49	59	3	1	2	1	66
	2	2	41	0	0	0	0	41

[7] Without taking into account the two stage design of EI – this makes the calculations simpler especially as no complete blocks where enumerated in either reserve. Although these figues but will give an overestimate of the errors they should provide a reasonable indication of what can be expected.

3	0	55	1	0	0	2	58
Mean	17	51.667	1.333	0.333	0.667	1.000	55
Variance	769	89.333	2.333	0.333	1.333	1.000	163
SE	19.608	6.683	1.080	0.408	0.816	0.707	9.028
SE%	230.7	18.3	162.0	244.9	244.9	141.421	32.828
CV%	163.1	18.3	114.5	173.2	173.2	100.0	23.2
N for 20%	266	3	131	300	300	100	5

Table 7 indicates that many Raphia plants can be located within an EI plot within a swamp. This suggests that the very low numbers recorded in Tero East and West (see Table 6) only recorded those plants which presented a diameter of greater than 10 or 20 cm at 1.3 m height.

Table 7 suggests that only 3% of the palms greater than 1 m tall would be recorded assuming that only plants more than 4 m tall would satisfy these criteria. If all plants are counted in the plots then it appears that as few as five plots falling into swamps may be sufficient, though around 100 would be needed to estimate the number of plants more than 2 m tall. Normal EI in Tero East and Tero West located 3 and 5 plots respectively. If all Raphia in these had been recorded and assuming that there would have been, say, twice as many plots containing smaller sized plants then there would perhaps have been just enough plots to get a reliable estimate of the total number of Raphia in the reserves. In larger reserves, that contain significant areas of swamp it seems likely that normal EI would provide adequate data on Raphia.

4.3.2 Phoenix

Phoenix (*Phoenix reclinata*) grows in swamps and alongside rivers at reasonably high densities in suitable sites. It appears to favour open sites and does not occur at high densities under a forest canopy. It is used as medicine, building and fencing poles and as a raw material for making crafts e.g. mats (Irumba 2002). In areas where it is plentiful Phoenix makes a big contribution to local life. For example, the CFM profile for Nkalwe village in the Sango Bay area indicates that about 90% of the women and girls are involved in mat making both for domestic and commercial purposes.

The material for making mats is derived from extended but unfurled fronds. The fronds are cut without damaging the apical meristem, opened up, dried and the leaflets split for weaving or sale. A collector questioned during the field trip to Sango Bay reported that fronds can be harvested from a plant at approximately two month intervals depending on water levels (i.e. not during the rains). Frond harvesting concentrates on low growing (immature) plants within easy reach. Although the collector reported that the fronds get smaller with repeated cutting this is not a problem and does not kill the plants.

The stems of tall Phoenix are cut down and used as building poles as they are resistant to termite attack in contact with the soil. There is trade in Phoenix poles at least as far as Kampala where it is used to support roadside fences.

There are only three records of Phoenix in the EI data. Two specimens in one plot in Tero East and one plant in one plot in Tero West. It is obvious that this is insufficient to estimate the stocking of Phoenix nor indeed to estimate how many plots would be required. However, it seems likely that these low numbers are a consequence of the small sizes of Phoenix as it hardly ever reaches the 10 cm threshold for EI rather than it not being present in these reserves.

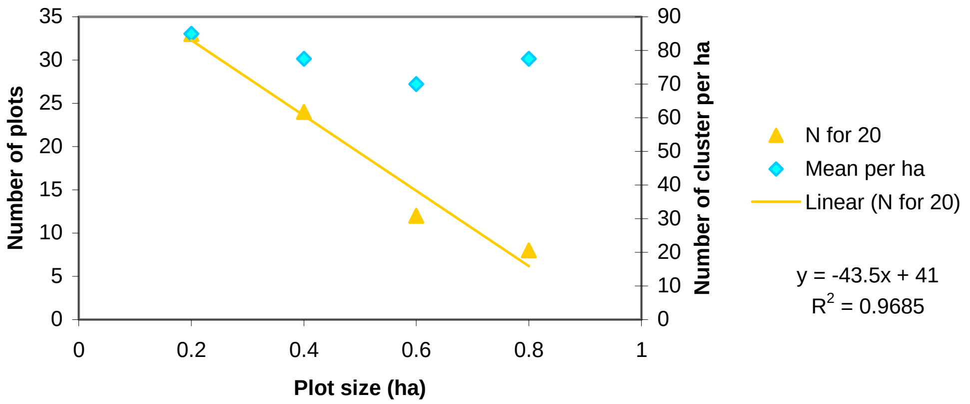
However, under the CFM initiative in Sango Bay participatory inventories of Phoenix were undertaken. Irumba (2002) reports that the significance of Phoenix to local livelihoods was such that a special inventory was devised for it in Tero East and West. The design of the CFM inventory of Sango Bay is described in detail in the report of NTFPs in CFM inventory. The basic design was systematic strip transects placed across the area of interest. The strips were 20 m wide with the centre lines spaced 200 m apart and of fixed length within a block – usually at least 1 km long. Phoenix tends to occur in small, dense clumps with the tallest individuals in the centre of the cluster. This makes it difficult to count the number of stems so the clusters were tallied into density classes:

Individual plants
1 = 2-5 stems
2 = 6-8 stems
3 = 9-10 stems
4 = 11-13 stems
5 = 13+ stems

Additional notes were made of harvesting for either stems or leaves. The clusters were recorded in 100 m sections of transect.

In the participatory inventory for Tero West, nine transects varying from 200 to 450 m long were established. These data permit an analysis of the relationship between plot size and the numbers required to achieve SE20 as shown in Figure 2. The mean per ha stays more or less constant with plot size and this is because the transects were restricted to Phoenix areas within the forest, nevertheless this indicates that Phoenix is fairly evenly spread throughout the area. For Phoenix in Tero West there appears to be a linear relationship between the size of a plot and the number required for SE20. The data suggests that as few as eight plots 400 x 20 (0.8 ha) would suffice.

Figure 2: Plot size and number of plots required for Phoenix in Tero West



The relationship between plot size and number required is linear and is fitted with the regression line: y = 43.5 size(ha) + 41. Using this to estimate the number of EI plots (0.05 ha) suggests that 38 plots would be required. The mean density of Phoenix from the CFM data is 77.5 clusters per ha which suggests that there should be about 3.5 clusters per EI plot. Some Phoenix was found in the three test EI plots enumerated in Mabira; two seedlings in plot 1 and two large plants in each of the other two plots but this was not a site rich in Phoenix.

The available data suggests that relatively few plots are required to estimate the density of Phoenix clusters in an area and this is probably roughly compatible with the results in Figure 2 . However, the clusters themselves contain many plants and it is desirable to get a more accurate assessment of the quantity of different types of resources present. To do requires a better assessment of the height of the palm. **Some work is required with harvesters to determine the sizes of palm harvested for each product**. Wherever possible the quantities of other products should also be estimated i.e. counting leaves when stems are the focus of harvesting. Such information should be used to encourage maximising the products from harvested stems. Suitable size classes should be worked up for the recording of plant utility. The number of stems should also be counted rather than estimated into density classes. However, it does appear that Phoenix forms dense clumps and this should also be noted.

4.3.3 Recommendations

Palms cannot be treated as trees and there is a need to **record the size of palms in terms of height rather than diameter**. This should be done by tallying plants into height classes large enough to minimise mis-classification errors. Two meter height classes are suggested for Raphia and may work equally well for Phoenix. **Plants greater than 1 m tall should be recorded from the whole plot with those below 1 m tallied in the north-west quadrant of the plot**. **Notes should also be made of the extent and type of harvesting present on the plants** as this will give an indication of demand and harvesting impacts. This should be done by assigning codes to the plants. Suggested codes are:

HL – leaf harvested

HS – stem harvested

HT – stem tapped

It is recommended that only recently cut stems are recorded to give an indication of current harvesting levels and to permit the interpolation of the current age structure of the population.

It seems that is it going to be easier to obtain reliable estimates of Phoenix densities than Raphia. In forests with large areas of swamp, standard EI should provide sufficient plots to generate a reliable estimate. However, in smaller forests or those with only small areas of swamp the number of plots containing palms is likely to be very low. If reliable estimates are required in these circumstances then it would be best to stratify the swamps and place more plots in them. The easiest way to increase the number of plots would be to reducing the distance between block lines or between plots on a line while in a swamp.

Obtaining estimates of stocking is only the first step in determining sustainable yields. There is a need to establish some experimental and observational work to determine plant response to frond harvesting. Cunningham (1998) presents the results of work to determining leaf production in *Hyphaene coriacea* in the palm veld of RSA. This was done by monitoring tagged plants on two selectively chosen sites. Leaf production was determined by measuring the total length of leaves on stem (partially opened leaves counted as fraction of open leaf) at monthly intervals. The data was used to estimate annual commercial leaf production from plants of varying size. Generic advice on palm productivity assessment derived from this, and other, experience can be found in Cunningham (2001).

Since palm leaf harvesting is usually undertaken by experienced harvesters (except the tobacco farmers who kill the plant) they should be involved as much as possible in the determination of productivity rates. Within the context of CFM, an adaptive management approach to palm leaf harvesting should be implemented. This should include **monitoring to determine growth rates and harvesting impacts**. Ideally the protocols to be used should be developed in collaboration with the harvesters who would undertake the periodic measurements. The simplest protocol to suggest as a starting point would be to objectively select[8] 30 plants in a range of size classes. The highest total unfurled frond should be tagged with a permanent marker and the number of open and emergent fronds counted and frond length measured. At regular intervals[9] the plants should be re-visited and the number of open and unfurled frond above the tagged frond should be counted and the length measured. To assess the impact of frond harvesting experimental cutting of at least 30 plants per size class should be tagged and subjected to cutting treatments which should include harvesting as normal by a experienced harvester. Other treatments should be cutting at longer intervals and a control which is not cut at all.

4.4 Climbers

There are two climbers which are traditionally made into baskets. These have been adopted by the large tea estates who generate considerable demand for the baskets. They are used by tea pickers and also on conveyor belts to move tea around the factories. Two climbers are used in this way: the stems of *Loeseneriella apocynoides* and runners of *Smilax anceps*. There are reports of the resource in forests close to large tea estates becoming scarce and it seems that over-harvesting is taking place though this is localised as there appear to be many climbers in forests further from the estates and there is little trade in the climbers. Baskets are bought by the Rwenzori tea estate for 1,000 Ush each, last about 4 months in the factory and are required in large numbers. This probably represents a significant income for harvesters and weavers. Unfortunately this is being threatened by resource depletion and at least one estate is experimenting with plastic baskets though these are brittle and don't last as long as the climber baskets. Since there are forests with these climbers it may be possible to harvest on a sustainable basis and thereby secure the livelihoods of the harvesters and basket weavers.

Smilax is a widespread species of disturbed areas across East, Central and southern Africa although it is reportedly scarce in areas where it is heavily used (Cunningham 1996). It can grow in fallow if they are long enough which is not the case around Bwindi at least. Regeneration is from the root-stock and birds disperse seed into forest margins and disturbed sites. Regeneration time was considered to be 6-12 months by users. This is therefore a species which has a good potential for sustainable management. It may even be a useful substitute for rattan in locations where it is present in large numbers. It may also be possible to cultivate the species under plantations.

Cunningham (1996) also makes some observations on *Loeseneriella apocynoides.* From his report this species is scarce, grows in older secondary and mature forests, present in low densities between 1500-1750 m. It is also slow growing with harvesters estimating it takes 10-20 years to reach a high quality useable diameter of 3-4 cm and can sprout from the base after cutting. *Loeseneriella* would therefore require more complex management systems and some patience. *Loeseneriella* has been the subject of a MSc project in the Botany Department of Makerere and

[8] The easiest method is to systematically select plants – say the 5th plant within 2 m of a randomly orientated transect line.

[9] Maybe start with quarterly visits and modify if this seems too long or short.

sponsored by the People and Plants Initiative. Unfortunately the consultant was not able to see the thesis nor obtain any of the data.

It is recommended that *Smilax* and *Loeseneriella* are included in EI. Simple **counts of harvestable stems rooted in the whole EI plot** would suffice until some data can be obtained on average stocking densities and distribution within the forest. Once more information of this type is available the recommendations can be revised. For these species the priority is to **assess population densities and to determine growth and replacement rates** which together would provide a basis for sustainable management planning.

5. Medicinal plants

The great majority of people in Africa depend on traditional medicine and it remains an important form of healthcare especially for the poorest members of society (Cunningham 1993). The traditional pharmacopoeia is extremely diverse and includes animals though plants tend to dominate. As populations grow and the area of natural vegetation diminishes the populations of plants used as herbal medicine come under increasing pressure. Almost all African plant medicines are collected from the wild with only limited supply of easily cultivatable plants coming from the gardens of herbalists. There is certainly little large scale commercial cultivation of medicinal plants in Uganda. Although collection for personal or village use is usually considered to be at low levels and sustainable, commercial collection can be devastating. It has been estimated that over-exploitation threatens 150 species of medicinal plants in at least one European country (Lange 1998 quoted in Hamilton 2003). Although the most intense commercial demand comes for plants collected for international export (e.g. *Prunus africana*) it is also possible for domestic commercial collection to threatened the continued existence of medicinal plants. There are reports of extinction in the wild of a medicinal herb in South Africa (Mitchell *pers comm*) and in Uganda, there is at least one plant threatened by medicinal collection (Hafashimana *pers comm*). Although many medicinal plants are widely dispersed and relatively common[10] the seriousness of local extirpation or even commercial extinction on livelihoods, health security and genetic erosion of the species should not be underestimated. As Hamilton (2003) confirms the main task in medicinal plant conservation is the development and implementation of robust *in situ* management systems to conserve or ensure sustainable production of heavily demanded plants.

Although all types of plants are used as medicine, in Uganda, most work has focussed on woody plants, especially trees (e.g. Cunningham 1993, Weisheit 2001, Boffa *et al* 2002). The database prepared for this study also only contains woody plants. This may mean that woody plants really are the most significant or threatened herbal medicines or that herbs and other plants are not being mentioned. Herbalists questioned in Kabale suggested that most medicines collected from Bwindi were herbs. Slow-growing forest herbs can be threatened as much as more obvious woody plants (e.g. American ginseng in the USA) and it can be difficult to determine that harvesting is increasing if the whole plant is removed. **Greater attention should be given to the collection and naming of forest herbs used as medicines**.

The survey also revealed that many of the favoured plant medicines come from dry woodlands rather than high forest. Even within species which occur in both woodland and forest, the woodlands are the preferred sources. This preference is largely cultural but also a reflection of the greater concentration of phytochemicals in dryland plants. This raises concerns for the status of medicinal plants in accessible woodland areas which where beyond the scope of the current contract and **more work is required to determine the level of threat posed to the populations of the preferred species**.

For the woody species, bark seems to be the part most often collected though roots, root bark and leaves are also used. This means that assessments of the recovery rates and impact on plant physiology is required as well as the population estimates (from inventory) and population dynamics (for PSP).

[10] Plants need to be relatively common before they can become widely known and used. Many are also used across their range e.g. many members of the *Ocotea* genera are used medicially from Uganda to the Southern Cape.

5.1 Commercial collection

During the consultancy it was determined that commercial collection is taking place from at least Bwindi (this was noted as incipient by Cunningham in 1996), Kalinzu and Budongo. It seems that ordered are placed by traders or manufacturers with local herbalists. In Bwindi, some of the registered collectors under the Multiple use agreements collect on order to a few herbalists who sell herbal preparations on a commercial basis. A local herbalist near Kalinzu who prepares medicines for sale to a herbal hospital said she and others send people into the forest to collect plants on a biweekly basis. She also reported that licenses could be obtained through a complex, and to her, unfair and opaque procedures for prices that mean only a few could afford them. However, the DFO says that he has never been approached for a license to harvest medicinal plants. There is obviously a need to encourage the institution of transparent access to medicinal plants within the FRs. This could perhaps be done by advertising a day when rights could be auctioned for commercial collection. However, this would only be effective if policing was effect in curtailing illegal collection. There is obviously no incentive to pay or even abide by a free license if there are no penalties for illegal collection.

In Budongo, there were reports of collection by Congolese and Tanzanian herbalists. The common understanding for this is that medicines are often marketed as being more potent if they come from a far away place I.e. another country and that Uganda herbalists are equally likely to be found in Congo and Tanzania. However, this suggests that **there is a need for some evaluation of the extent of cross-border collection of medicinal plants**.

On the market end of the potential trade network are the markets in urban areas and particularly those in Kampala. It is obvious that wholesaling of herbs is nowhere near the scale of the Durban Herb Market in RSA. However, Nalumansi (1998) did find 59 herb sellers plying their trade in 7 Kampala markets and that 60% of herb traders obtained their living solely from this activity. Staff at the National Chemotherpeutic Research Laboratory (NCRL) also mentioned that they had several contacts who collected herbs in large quantities for them and other buyers in Kampala. NCRL hires out their pickup to traders to move large quantities of herbs but were unaware of where the herbs came from. The Jubilee Park referral clinics organised by the National Assembly of the Council of Traditional Healers Association (NACOTHA) must also be a significant market for wholesale herbs.

There is a need to describe the status of the herb markets and trade linkages in Uganda as despite assurances to the contrary there appears to be at least incipient large scale commercialisation of medicinal plant collection. Managed in the right way this may present significant income opportunities for local collectors but done in an ad hoc manner runs the risk of threatening the resource and providing incomes only for the traders. Involving urban traders and herbalists in sustainable management schemes may help to avert some of the risks involved with commercialisation. Emerging experience with urban traders in Durban suggests that traders are sometimes willing to engage in forest management and are concerned about diminishing resources and the future of their own livelihoods.

5.2 Inventory of commercial medicinal plants

The database of important NTFPs developed for this consultancy was used to make a first pass at the list of commercial medicinal plants. This list is given in Table 8 along with the number of times the species was mentioned and the rank given for inclusion in any forest inventory by the consultancy orientation meeting. Most of the species in the list are trees and therefore are already included in EI but a few should be considered for inclusion in the list of species recorded in EI. Most of the additions to the EI species list are climbers or shrubs. Enumeration techniques for both of these are rather poorly developed as there are difficulties with the quantification of climbers and shrubs are often not the equivalent of small trees. However, since the part of the plant which is collected is not known for all of these species it is suggested that **a simple count of the number of stems present in the whole plot – either rooted or crossing the a plot is recorded for the climbers**. Several of the shrubs have many small diameter stems, for these a simple count of plants may suffice but it is suggested that **for shrubs a count of the number of stems and the size of the largest stem per plant is recorded**. Details of the suggested protocols to achieve this are given below.

Species from several of these genera are heavily harvested and becoming rare across Africa. The bark of Khaya species is heavily used and traded in bulk across west Africa (pers obs). Cunningham (1993) lists species of Ocotea, Warburgia as being threatened by medicinal bark collection in southern Africa.

Although many of the medicinal trees are already recorded in EI, Table 9 indicates the number of individuals of each species encountered in the EI for Budongo, Kalinzu, Mabira and Sango Bay. The table first gives the total number of trees greater than 20 cm d and the errors associated with them for all the enumerated reserves. There are large numbers of plots and trees in the EI assessments and correspondingly low errors, all of which fall well below SE20. However, for most of the medicinal species the numbers of tree recorded in each reserve are very low. Even if all 21 medicinal species on this list the numbers of trees is a very low percentage of the total and the same problem holds. The only places where there is a high percentage of medicinal trees are Tero East and West which are swamp forest with few trees and species and of which several are medicinal. The main observation from Table 9 is that the distribution of the species is very uneven for example *Zanthoxylum macrophylla* is found in higher numbers in Budongo and Kalinzu, very rarely in Mabira and not at all in Sango Bay reserves. This is a consequence of the ecological preferences of the species and also perhaps also an indication of harvesting as several of these species are also cut as timber (e.g. *Khaya* and *Entandophragma*). For such species it is **necessary to formulate a policy to balance exploitation for timber and medicinal use**. A ban on felling of medicinal species, especially those in short supply should be considered. If licenses are given for medicinal species there should at least be some mechanism in place to ensure that the bark is removed and made available to herbalists.

The status of many of the medicinal trees is a cause for concern. In particular the numbers of *Entandrophragma* are very low and the three trees recorded are 15, 20 and 21 cm in diameter, even these are probably too small to have useful bark. Some species were always rare (e.g. *Ocotea*) and some evaluation of past records is required to determine the extent of population degradation.

Further work is required to determine the quantities in which different species are required and to formulate management plans to supply these amounts on a sustainable basis. For some species this may well mean domesticating or at least planting them in farms, plantations or degraded forest. Work on the cultivation of some medicinal trees has been started by Anke Weisheit for her PhD in association with ICRAF. However, management plans for ensuring the genetic conservation and supply of the species until planted trees mature are also required.

Table 8: Medicines mentioned as being in heavy demand from the high forest

Life form	Latin name	Total mentions	Orientation meeting rank	Comments
Tree	*Prunus africana*	11	1	
Tree	*Zanthoxylum spp*.	8		
Tree	*Warburgia ugandensis*	7	1	
Tree	*Albizia coriaria*	4		
Tree	*Ocotea usambarensis*	4		
Tree	*Rauvolfia vomitoria*	4	1	
Tree	*Combretum molle*	3		
Tree	*Kigelia africana*	3		
Tree	*Sapium ellipticum*	3		
Tree	*Syzgium cordatum*	3		
?	*Carissa edulis*	2		Add to species list
Climber	*Entanda abyssinica*	2		Add to species list
Climber	*Mondea whytei*	2	1	Add to species list
Tall herb	*Vernonia amygdaline*	2		Common outside forest
Herb	*Dracaena steudneri*	2		Add to species list
Tree	*Desplatsia dewevrei*	2	1	
Tree	*Entandrophragma excelsum*	2		
Tree	*Hallea spp*	2		
Tree	*Acacia sieberiana*	1		
Tree	*Albizia zygia*	1		
Tree	*Bridelia micrantha*	1		Common outside forest
	Hoslundia opposita	1		
Tree	*Newtonia buchananii*	1		
	Puncia granatum	1		
	Rhus vulgaris	1		
Climber	*Piper guineense*	1		Add to species list
Parasite	*Thonningia sanguinea*	1		Very common
Shrub	*Euphorbia ticucalli*	1		Add to species list
Shrub	*Rytigynia kigeziensis*	1		Add to species list
Tree	*Balsamocitrus dawei*	1		
Tree	*Khaya anthotheca*	1		
Tree	*Parinari excelsa*	1		
Tree	*Podocarpus latifolis*	1		
Tree	*Spondianthus preussii*	1		

In order to prepare management plans it is necessary to have reliable estimates of the quantities available. The figures in Table 9 are generally very low and many of the considerable number of plots in each reserve are empty. This type of sparse population distribution is inherently difficult to quantify. In particular, the derivation of errors is problematic with large numbers of empty plots. It is obvious that a different type of sampling scheme is going to be required to achieve SE20 for any single medicinal plant species. However, this is going to be very expensive and time consuming. What is recommended is to use the EI data to formulate national, strategic plans for key species. The EI data would help to identify those reserves containing the species which could then be targeted for more detailed assessment. The design of such assessment would vary depending on whether it is a tree or climber, its population distribution and ecology and the extent of local knowledge of the resource. It is difficult to advise on particulars of any assessment method until the species have been selected and the form of management which the data is intended to inform has been decided.

A few modifications to the EI protocol to address medicinal plant use would be useful. These would include the addition of new codes to record evidence of medicinal harvesting (bark, roots etc.).

Beyond the need for accurate inventory there is also a need to establish optimal harvesting practices through experimentation. This should be undertaken in collaboration with herbalists as traditional practices may provide useful pointers to sustainable harvesting methods.

Table 9: Number of medicinal trees > 20 cm d recorded in existing EI data

				Sango Bay				
	Budongo	Kalinzu	Mabira	Kaiso	Malabig-ambo	Tero East	Tero West	Totals
Number of plots	1414	1187	2499	94	981	70	68	6313
Number of trees > 20 cm d	10244	10020	23433	769	7889	488	469	53312
Mean trees > 20 cm d	7.44	8.78	9.80	8.27	9.22	9.38	9.20	8.94
Overall SE%	0.26	0.29	0.14	4.95	0.42	3.04	2.85	0.07
Prunus africana	2	94	22		2			120
Zanthoxylum macrophylla	17	35	2					54
Warburgia ugandensis		23	4	1	2			30
Albizia coriaria	2		2					4
Ocotea usambarensis		2						2
Rauvolfia vomitoria	1	6	2					9
Combretum spp.			1					1
Kigelia africana	2		1		1			4
Sapium ellipticum	9	522	40	6	14	2	3	596
Syzgium cordatum	1	163	15	1	572	62	37	851
Desplatsia dewevrei	17		3					20
Entandrophragma excelsum		2						2
Hallea stipulosa		21						21
Acacia sieberiana	12		7					19
Albizia zygia	120	5	279					404
Bridelia micrantha	4	26	4	5	45	13	2	99
Newtonia buchananii		50	7					57
Balsamocitrus dawei								0
Khaya anthotheca	136		1					137
Parinari excelsa	2	224	2	1	1			230
Spondianthus preusii	4		5		85	95	64	253
Number of medicinal trees	329	1173	397	14	722	172	106	
Percent medicinal trees	3.21	11.71	1.69	1.82	9.15	35.25	22.60	

6. Wild foods

There are a number of wild foods which are collected from the forests. Many of these are used within the household and are not widely traded. Exceptions are a few woodland species and bushmeat. A few are important as 'famine foods' and used as a source of food during times of crisis.

6.1 Bushmeat

Throughout Africa there is a high level of use of wild meat. In Uganda this is not as prominent as in Central or West Africa. Presumably the high level of pastoralism together with traditional taboos against primate hunting in particular are responsible for the relatively abundant wildlife in Ugandan forests. Animals are the statutory responsibility of UWA who have a strong conservation bias and show little interest in animals outside their protected areas (NPs etc.). Relatively recently UWA effectively banned all hunting in Uganda and this has forced hunters and the bushmeat trade underground. However, hunting continues and was mentioned as being among the most important NTFP coming from all forests. Table 10 lists the bushmeat species mentioned most often in the NTFP importance database.

Table 10: Bushmeat species commonly hunted from forests

Common name	Species	Number of mentions in database	Orientation meeting rank
Bushpig	*Potamochoeros porcus*	7	2
Duiker	*Cephalophus spp*.	5	2
Grasscutter / Edible rat	*Thryonomys swinderianus*	5	2
Bushbuck	*Tragelaphus scriptus*	4	2
Francolin	*Francolinus spp.*	2	
Guinea fowl	*Numida meleagris* *Guttera pucherani*	2	
Porcupine	*Hystrix cristata*	2	
Buffalo	*Syncerus caffer*	2	
Fish		1	
Giant rat	*Aethomys kaiseri*	1	
Baboon	*Papio anubis*	1	
Colobus	*Colobus guereza occidentalis*	1	
Chimpanzee	*Pan troglodytes*	1	
Giant forest hog	*Hylochoerus meinertzhageni*	1	
Hyrax	*Dendrohyrax dorsalis?*	1	
Monitor lizard	*Varanus niloticus*	1	
Partridge	*Ptilopachus petrosus?*	1	
Squirrel	*Xerus erythropus*	1	
Red tailed monkey	*Cercopithecus l'hoestii*	1	

The preferred species of bushmeat are bushpig, duiker, edible rat and game birds (Francolin and Guinea fowl). None of these species are probably seriously endangered in Uganda even though there is obviously commercial trade in bushmeat (albeit perhaps at a rather low level compared to other countries). However, the presence on the list of species of conservation concern, notably primates is a concern. These record derive from a student project (Okello 1999) for Semuliki and are probably atypical as primates are not actively hunted in much of Uganda. In

Semuliki it is contended that hunting of primates is being undertaken by Congolese who have no taboos and indeed prefer monkey meat. Nevertheless the ban on hunting is obviously not effective in preventing hunting as bushmeat (albeit not primates) still appears towards the top of lists of important forest products. It is suggested that **a more sympathetic approach that accepts regulated hunting of less vulnerable species may help to encourage co-operation between hunters and the FD** (or UWA). Engagement with hunters may help to curb hunting of endangered animals by outside groups by strengthening the local hunters access and control of the resource. Regulated and legal hunting as a conservation tool has been used with some success in Cameroon and elsewhere. Lessons should be learnt from this and other legalised hunting initiatives.

6.1.1 Previous animal surveys

There have been several animal surveys in Ugandan FRs but there has been no comprehensive assessment of the distribution or abundance of larger mammals.

In the 1980's Peter Howard made a survey of 12 of the large FRs in Uganda. During these the presence/absence and approximate location of large mammals and signs of human use along paths walked within the forest. This gave some measure of variation within the reserves but were not sufficient to permit spatial mapping or abundance.

The FD biodiversity survey undertaken in the 1990's of 65 FRs included trees/shrubs, birds, small mammals, butterflies and large moths. This survey covered many of the larger and more significant FRs. Unfortunately, only a few of the birds recorded in this survey is hunted as bushmeat.

At the present time WCS are completing a survey of the FRs known to contain chimpanzees (Plumptre *et al* 2001) which includes most of the natural FRs in western Uganda. This survey aims to provide comparative data on the distribution and relative abundance of larger mammals which is intended to complement the existing FD data. Two methodologies were used (at least for the Kalinzu survey); reconnaissance counts based on existing paths and more formal transect counts. GPS readings are taken at the start of the line be it a path or cut transect. At 250 m intervals another GPS reading was taken and the forest type recorded. All animal and human impact signs were recorded along with a GPS location whenever they where encountered. The animal signs recorded are: monkeys identified to species, chimpanzee nests by age class, ungulates to species and dung of elephant, giant forest hog and bushpig. The perpendicular distance from the line to the animal location or sign was recorded. The DISTANCE method was used to calculate animal densities from both sets of data which were then compared. The comparisons showed that for some species there was a strong correlation between the path and transect densities and that for elephants and chimpanzees and to a lesser extent *Colobus guereza*, *Cercopithecus mitis, Cercopithecus ascanius*, bushpigs and red duikers the results from both methods are similar. This suggests that reconnaissance walks can provide reliable animal abundance data as well as distribution patterns.

6.1.2 Recommended animal survey methodology

Although the WCS study indicates that surveys along paths would provide results comparable to formal transects since EI already cuts transects they may as well be used. The easiest solution is to use the EI block lines for animal survey work. A minimum of 10 of these (10 km of survey line) would be required to obtain reliable estimates of animal densities. If normal EI does not provide sufficient transects then it may be necessary to either group reserves together or increase the sampling intensity.

In order to observe the animals objectively (i.e. before they start to use the transect line as a path) the animal surveyors should record along the transect within three days (and preferably the day after) the line is cut. Care should be taken to either record or preserve any dung and animal sign on the transect line itself. For the animal survey itself, approximately 5-10 km can be covered in one day depending on terrain. The survey walks should ideally take place in the early morning. Since dung decay rates and the visibility of footprints is different in the dry and wet seasons it is preferable to have all surveys taking place in the same season. This is unlikely to be possible as the animal surveys will need to take place at the same time as EI. A compromise would be to estimate decay rates for each season.

The DISTANCE methodology (Buckland *et al* 1993) is recommended to record selected signs of large mammals and signs of human disturbance. This is the methodology used in the WCS surveys and suggested for use by FD by Andy Plumptre (*pers comm*). DISTANCE is a method for determining the probability of encountering animal signs on a transect line using all signs visible from the line to increase the number of observations made. Since the probability of detecting signs decreases with distance from the line this needs to be taken into account. The density on the line is determined by fitting a model (often a Fourier transform) to the frequency of observations with distance from the transect. The calculations are complex but are easily done with the DISTANCE software that can be downloaded free from http://www.ruwpa.st-and.ac.uk/distance/.

The field measurements required for DISTANCE are straightforward. What is needed is:

- location along transect. Estimation by pacing from the nearest survey stick is probably sufficient. A pedometer (on level terrain) or hip-chain (but large quantities of biodegradable line needed) could be used for greater accuracy.
- perpendicular distance to object – by tape for stationary signs (dung) for short distances (say 5 m) from the transect centreline, and by binocular rangefinder for fleeing or more distant objects (sightings of animals/ chimp nests). When sighting distant objects with a rangefinder it is easiest to record sighting distance (distance from observer to object) if this is done then the angle between the transect line and the sighting line is also required so that perpendicular distance can be calculated trigonometrically.

The animal signs that should be recorded are given in Table 11 and the human impact signs in Table 12. For species which form groups (e.g. primates), the number in each group should also be recorded.

Although some signs may be confused (e.g. signs of giant forest hog & bushpig, or non-visual signs of antelope/duikers), providing size classes of footprints/droppings are recorded, they can still be analysed later.

The densities of signs are then turned into densities of animals by applying correction factors such as the decay rate of dung and chimpanzee nests and their rate of production. This means that the stage of decay of the dung and nests needs to be recorded (usually as age/decay classes). Ideally the decay rates should be determined by monitoring a set number of dung piles in each season (as the rates are heavily influenced by moisture content) as recommended by Barnes and Barnes (1992) for elephants. However, this is probably not possible in each reserve.

At present FD has no staff who are specifically trained in animal recognition and survey techniques. **The requisite skills can be acquired by either having a few**

UWA staff join the EI team or FD staff trained in these skills. This is an issue that needs to be resolved at an institutional level with UWA[11]. Training in DISTANCE techniques will probably be required in either case and can probably be provided by WCS (Andy Plumptre).

Table 11: Animal signs to record

Species	Sign	Notes
Elephant	Visual, dung, footprints?	Dung needs to be given age class (A-E) cf Barnes
Buffalo	Visual, dung, footprints?	Age class of dung needed
Giant Forest Hog	Visual, dung, scrapes, footprints?	Size and age class of dung needed
Bushpig	Visual, dung, scrapes, footprints?	Size & age class of dung needed
Large Antelope (Waterbuck, Bushbuck)	Visual, Call, droppings, footprints	Need to be able to recognise warning calls and footprints. Droppings needs size & age class
Small & medium duikers (Blue, Red Duikers)	Visual, Call, droppings	Need to be able to recognise warning call and footprints. Droppings needs size & age class
Monkeys (incl. Baboon)	Visual, Call	Need to be able to recognise visually & calls
Chimpanzee	Visual, Call, Nests	Need to be able to recognise call. Nests need to be given age class.
Other large vertebrates	Visual, Miscellaneous signs	Can include visual signs of Mongoose, Civet, porcupine, large reptiles (Monitor lizards, identifiable snakes) etc – depends on experience of surveyor. Also possibly large Hornbills?

Table 12: Signs of human disturbance to be recorded

Sign	Notes
People (Poachers/porters)	Must be sure that sounds come from within forest
Huts (Hunters/pitsawyers)	Whether in use or old
Shambas	Record what grown and whether / in use or fallow
Pitsaw sites	In use or not
Footpaths/roads	Can be classed depending on size of trail and also whether currently in use (age) bearing from transect may assist mapping
Fire-sites	Fresh / recent /old
Hunting signs	Pitfalls / nets etc.& whether in use or not. Carbide/batteries
Cut timber	Timber / Poles / firewood
Beehives	
NTFP collection	Bamboo, Cane/rattan cutting, bark collection, charcoal making etc. approx quantities?
Litter	Any items discarded by humans
Mining	Digging for sand/clay/minerals

[11] In the 2001 Ghana national forest inventory wildlife survey was included with the wildlife teams being led by a Wildlife Services Division officer seconded for the duration of the inventory. He then trained a couple of wildlife graduates with the intention that they would stay on to form the core of a wildlife team within the Forest Services Division.

If use of DISTANCE is considered too complex to be included in EI then it should be possible to obtain comparative data on encounter rates (per km of transect). For groups of objects, an estimation of the scale of activity useful (numbers of objects in groups)

For small reserves (<10km²– cutting of a large number of transects may not be desirable because it would open up the forest. In this case data could be collected along existing trails and along the perimeter. Useful information could also be obtained from interviews with knowledgeable local residents – recording approximate time since last definite sighting of a species. To do this the recorders would need to be experienced in interviewing and able to judge the reliability of interviewees. Several interviews from each sites needed. Interviews could also be extended to larger reserves.

6.2 Food plants

There are a number of important wild foods; commercial collection for livelihood support; casually collected snack foods and those used as a fall-back in times of food shortages. A deliberate attempt was made to exclude casually collected snack foods from the database of important NTFPs. This is not to undervalue the contribution that these make to food security especially for children but rather to focus attention on incipient commercialisation or bigger food security issues. The species that ended up in the database are listed in Table 13 along with the number of mentions in the database and the assessment of the orientation meeting of the importance of including the species in national forest inventory.

Interestingly the species which were most often mentioned were not those chosen by the orientation meeting. The highest priority species indicated by the meeting are those which have large export markets but which until recently have not been heavily harvested in Uganda. These two products, Gum arabic and Shea butter grow in the north of Uganda. *Borassus* is also a savannah species though this is a famine food rather than a commercial product.

Of the non-savannah plants listed in Table 13 the ones for which inventory is most relevant are the commercial species. These are *Vitellaria* from which fruits are harvested for extraction of Shea butter and *Acacia* from which resin is tapped and marketed as Gum arabic which is used as an additive in processed foods.

In the current EI it is suggested that *Vitellaria* is included in the EI species list while Acacia needs to be identified to species level (it is presently down as *Acacia* spp.). Both of these species occur in dry woodlands rather than high forest so will only feature when EI is done in these areas.

Harvesting fruit and resin are quite different processes, though both can be sustainable there is a need to ensure that the harvested populations remain healthy. Research on this would be ideal but both species are well known elsewhere (*Vitellaria* in northern Ghana and *Acacia* for gum arabic in Sudan). If it hasn't already been done by NARO a literature search should be done to determine the best harvesting methods for each species.

During the consultancy no visits were made to northern Uganda and so it is not possible to give detailed recommendations for the assessment of these two tree species. It is not even clear whether it is the intention to extend EI to the northern woodlands many of which are in customary hands rather than the FD.

Table 13: Important food plants

Common name	Species	Number of mentions	Orientation meeting rank	Comments
	Annona senegalensis	9		Fruit
Borassus	*Borassus aethiopum*	7		Fruit used as famine food
Wild coffee	*Coffea spp.*	4		Wildlings have been taken for planting coffee farms
	Garcinia escuensis	3		Fruit
Wild yam	D*ioscorea spp*.	2		Tuber used as famine food
	Aframomum spp.	1	3	Abundant, casually collected and traded fruit
Gum arabic	*Acacia spp*.	1	1	Recent large scale commercial collection of gum from tapped trees
Wild banana	*Ensete ventricosum* (syn*. E. edulis*)	1		Heart used as famine food
	Rubus guajava	1		Fruit
	Physalis cortifolia	1		Fruit
Shea butter	*Vitellaria paradoxa*	1	2	Recent commercial harvesting of fruit for export
Oil palm	*Elaeis guineensis*	1		Not a widespread species in Uganda

None of the other species on the list are really commercial and therefore are not high priorities for inclusion in EI. However, both **wild coffee and *Aframomum* should be included as they are marginally commercialised** and have potential for higher exploitation. It is obviously not appropriate to consider counting Aframomum stems or measuring diameters as it is a herbaceous plant. It tends to grow in dense clumps and the best way of obtaining some indication of availability would be to estimate the percentage of the plot occupied by the plant (i.e. leaf extent not stems). Wild coffee is a shrub and should be enumerated in the same manner as the medicinal shrubs – count stems on plant and measure largest diameter.

7. Poles

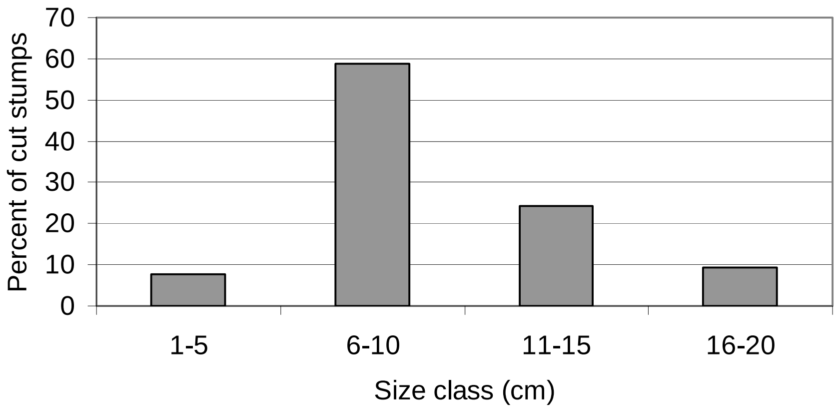
Perhaps the highest volume NTFP collected from the FRs are poles. They are required for building constructions such as houses and tobacco drying barns. It is estimated that up to 900 poles are needed for one tobacco barn and that they need to be replaced every three years. Most poles are young trees and as such they are already included in EI. Some are small trees which don't grow large enough to be counted in EI. Table 14 gives a list of species listed as poles in the NTFP importance database. This list is drawn mainly from Okello (1999) for the area around Semuliki NP and probably contains a bias towards species occurring there. **There are five species in Table 14 that do not appear in the EI species list. Most of these are shrubs and should be included in EI**.

Table 14: List of species preferred for use as building poles

Species	Life form	Recommendation
Acalypha spp.	Shrub	Add to inventory species list
Agave sisilana	Shrub	Exotic – exclude from inventory
Celtis spp.	Tree	
Chaetacme aristata	Tree	
Cynometra alexandrii	Tree	
Disopyros abyssinica	Tree	
Zanthoxylum macrophylla	Tree	
Holoptelea grandis	Tree	
Lasiodiscus mildbreadii	Shrub	
Markhamia platycalyx	Tree	Add to inventory species list
Melia azederach	Shrub	Add to inventory species list
Melletia spp.	Tree	
Rinorea beniensis	Tree	
Senna siamea	Shrub	Exotic – exclude from inventory
Tapura fischeri	Tree	
Teclea spp.	Tree	
Thecocaris lucida	Tree	

There is little data available on the preferred sizes of poles. The only study that looked at poles was done as part of a MSc project on Semuliki NP (Okello 1999). Okello measured 657 cut stumps in the National Park. All of the stumps were below 20 cm in diameter (measured on the stump) with a frequency distribution as indicated in Figure 3. These data seem to suggest that the preferred size for poles is between 5 and 15 cm diameter which is the same as the size preferences for Bwindi (Cunningham 1996). Since the EI protocols only measure stems down to 10 cm most potential poles would be left out. Therefore, **it is recommended that woody stems down to 5 cm are included in EI**. It would be too time consuming to measure down to 5 cm on the whole plot or indeed the 125 m² N-W quadrant. It is therefore suggested that stems between 5 and 10 cm diameter are enumerated in a 25 m² subplot formed within the N-W quadrant at a radius of 5.6 m. Measurements below 10 cm diameter are not easily made with a conventional diameter tape. **It is suggested that the project procure some callipers to measure small sized stems**. Ideally two orthogonal measurements should be made on each stem and averaged.

Figure 3: Sizes of trees cut as poles in Semuliki NP (Okello 1999)

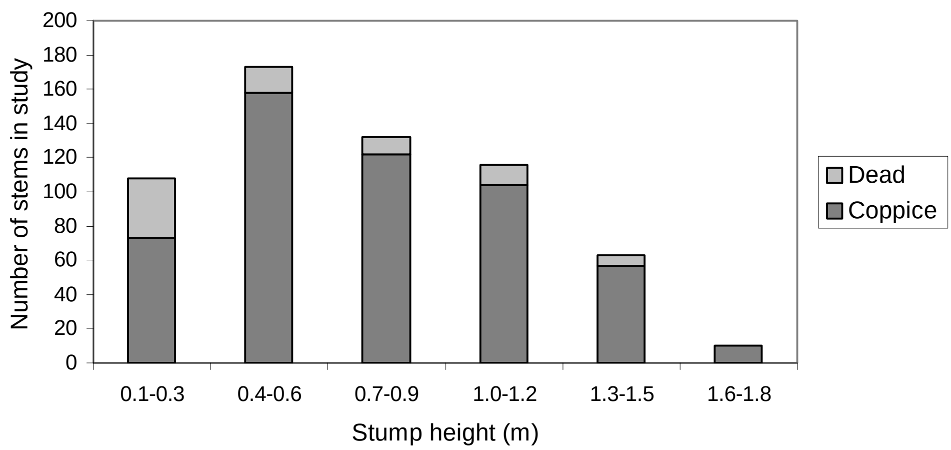


New codes need to be included in EI to record pertinent features of pole harvesting. The following are suggested :

CO	Coppicing
EC	Epicormics ('agony' shoots produced in response to wounding but unlikely to make a useable stem)
CU	Cut stem
C2	Coppice stem cut
C+	Coppice stems cut more than once

Okello (1999) discovered that nearly 90% of the 608 cut stumps he measured had coppiced. Data on the stump height suggests that there is an optimal height for coppice development of around 0.4 to 0.9 m (Figure 4).

Figure 4: Pole stump height and coppicing behaviour (Okello 1999)



Conventional wisdom on coppicing holds that stumps should be cut as close to the ground as possible. Besides this being difficult using a panga on a hard stem it also seems that it would compromise survival of the stem. It may be that cutting higher keeps the young growth out of reach of herbivores and therefore more likely to survive. Cutting a tree high for regrowth is termed pollarding and it would seem that this is preferable for at least the species and environment of Semuliki. However, it would be advisable to **confirm this with observations or experimental cutting in other areas**.

Poles are an important part of subsistence and local economies and are often traded between towns. There is a lot of different production systems that can be used for poles. They can be grown in plantation or on farms and coppiced (coppice of eucalyptus seems popular and successful at least around Kabale). However, many people still rely on poles cut from the forest and there is a need to consider the impact of this on preferred species and also on forest structure. It seems that many species and stumps will coppice but do these form harvestable stems? How long does it take? Can they grow into a timber tree? Can any of the preferred species be grown and coppiced for poles?

8. Potential commercial products

Besides highlighting species of conservation concern, there is also a need to identify resources with development potential. Such species would need to have defined markets and be present in quantities suitable for sustainable exploitation. Baldascini (2002) identified a set of forest products with the highest income generating potential and lowest environmental impacts. The screening process identified 55 potential products. Of these, 10 species from the natural high forest and 15 from savannah are not intended for timber use. It seems that the criteria for identifying potential products was closely related to its potential for domestication and there is little mention of the utilisation of resources which could be supplied from sustainable management of natural forest which is the focus of the present report. The characteristics of species which can be easily domesticated are also those that often facilitate sustainable management from the wild and this option at least until cultivation can supply demand needs to be examined.

8.1 New products

Identifying possible income generating products which are not presently exploited would require screening of wild plants and animals in Uganda and market research to identify which would find a market either within the country or for export. Examples of products which are commercialised elsewhere in Africa but not used in Uganda are:

Dracaena fragrans – Corn plant – This is well known houseplant in temperate countries which is native to tropical and sub-tropical Africa. It is scented and is purported to purify air in confined spaces such as offices. At one time this was being collected for export from Mabira and Mpanga by a horticulturalist who grew them on in a nursery in Entebbe for export as pot plants. This activity has ceased for unknown reasons (there are verbal reports this may have been at request of Forestry officers). Dracaena is plentiful and can be easily propagated and could perhaps be developed for export from Uganda. It seems that the Mabira plants have white and sometimes blue flowers rather than the pink/red more common in the cultivated houseplant. This should offer a marketing advantage.

Coffea spp. especially *canephora* – Wild coffee – two of the five Ugandan species can be used in the same way as commercial coffee. Wildlings were formerly taken for stocking coffee farms but this seems to be in decline. Wild coffee is exported from Ethiopia as a speciality and this is being done on a small scale from Kibale and could perhaps be further developed in Uganda, this is perhaps a better option that commercial coffee which is over-supplied on the world market. These wild species may also have more resistance to common coffee diseases.

Allanblackia kinbillensis – Seeds of a related species are harvested and sold for extraction of an edible fat in the Usambara Mountains in Kenya (Naluswa 1993)

Piper guineense – African pepper – fruit widely used as a condiment/spice in west Africa and collected commercially in Cameroon. Only the leaves, stem (‘bark’) and roots are harvested in Uganda for medicinal use though it is common in many forests.

Tetrapleura tetraptera – African marmite – a sweet mollasses-like extract from the pod is used as a flavouring in west Africa and commercially processed into stock cubes in Ghana.

Ricinodendron heudelotii – The nuts are widely used in central Africa for flavouring and thickening soup.

Although these, and many other species, have potential there is little sense in including them specifically into the inventories until some market research to identify those with the greatest market potential has been done. However, *Coffea spp*. have been included in the inventory as they can be done at little extra cost.

8.2 Substitution

There are many species which are demonstrably commercial but where the wild populations are under threat from over-exploitation. **To secure the incomes and markets for these species requires sustainable management of existing resources and conservation both *in situ* and *ex situ*.** These are species for which domestication is perhaps the only option for continued supply of products. Sustainable management is probably only an option for the best populations and substitution should be encouraged. **Substitution presents opportunities for commercialisation of new resources but needs to be done on a sustainable basis**. Unfortunately, for many of the medicinal plants substitution is not possible and there is an urgent need to initiate some pro-active conservation of these species.

It would appear that there is a particular problem with scarcity of good quality materials for craft work such as baskets and mats. The loss of rattan from many forests is having knock-on impacts on other species. The field trip to Mabira revealed that the tops of the round stools for sale are no longer made from rattan but from the stem of an unknown angiosperm climber found in similar, swampy sites as rattan. The stripped core of this climber is about 2 cm in diameter, is flexible when fresh but dries hard. The locals apparently have little knowledge of the climber and it properties are a recent discovery. There is an **urgent need to determine the identity of this climber and any other substitutes for rattan** before this too disappears. This could be done by taking a climber specialist (at Makerere) to see the climber in Mabira. Once this has been done, and something of its ecology, growth rates etc determine, the plant will have to be taken into the same management systems as envisaged for rattan.

There is an urgent need to commence cultivation of rattan and in the meantime to identify substitutes for rattan which can be used to reduce the demand for rattan at least until cultivated plants begin producing canes (about 7 years). ***Marantochloa* is one possible substitute for rattan at least for tourist or export orientated craft items**. *Marantochloa* is a large group of herbaceous plants that have tall stiff stems supporting single leaves. The stems are split and dried and used to weave baskets and mats. Most species are pioneers and occur at high densities in disturbed forest and swamps. These qualities mean that it is very abundant and can withstand repeated harvesting. Demand for *Marantochloa* is low and the populations could easily be more heavily exploited.

8.3 Domestication

As identified by Baldascini (2002), the easiest way of promoting returns on NTFP enterprises and sustainable production is to cultivate the species. To be worth cultivating a species has to be either very valuable with an assured, long term market or very easy to do. Table 15 gives a few suggestions of species which could be investigated with a view to domestication. The first three trees are all used for poles, timber and medicinal bark and would form valuable resources if successfully cultivated. Unfortunately, these are not species which can be successfully grown in plantation though they will do well in isolated plantings. These species would need to be grown in mixed plantations or as enrichment in degraded forest. The other species have either already been domesticated or have ecological characteristics which should facilitate it.

Table 15: Selected species with potential for domestication

Species	Domestication
Zanthoxylum spp. *Khaya anthotheca* *Entandrophragma excelsum*	Used as pole, timber and for medicinal bark. Could possibly be enrichment planted or grown in gardens/plantations. Mixed plantations and enrichment planting could be successful.
Calamus deeratus	Possible and trails started in Mabira, cultivation advice available from Afrirattan in Limbe, Cameroon Enrichment planting in degraded forest and in plantation both possible
Smilax anceps	Pioneer species that does well in disturbed land – propagates from runners
Prunus africana	Grown successfully in plantation in Kenya
Lasiodiscus mildbraeadii	Termite resistant, matures at small sizes in understorey, coppices well and could perhaps be used as an understorey in plantations
Thryonomys swinderianus	Housing and feeding system for successful rearing in captivity established in Togo some years ago. Could be used to supply legal bushmeat outlets.
Coffea spp.	Wild coffee used to establish coffee farms in the past – could wild coffee species be niche marketed internationally
Ficus natalensis	Specimens of this species have been requested for farm planting in Buganda for bark cloth.

9. NTFPs in EI

The recommendations made in relation to each product type are summarised in this section. A number of issues with EI sampling design for smaller reserves and for rarer species are also discussed for consideration by the TSS team. This is followed by a work programme for EI in the larger forest reserves.

9.1 EI objectives for NTFPs

According to James Acworth, EI is applied at the reserve level to obtain preliminary estimates of stocks on which to base FR level management plans.

Alder (2002) points out that “The Exploratory Inventory (EI) procedure has been used since 1990 . It is a low-intensity sampling intended to provide initial information about the species and stocking on natural forest areas for preliminary planning purposes.”

For NTFPs it is hoped that reliable estimates of stocking by reserve can be obtained. It was agreed that SE20 would be a reasonable target sampling error for these preliminary figures.

In order to simplify the protocols and maximise the integration of NTFPs into EI it was decided that the modifications to the timber EI would be kept to a minimum. The consequence of this is that the design will not be optimised for the different types of plants being inventoried but the analyses above indicate that in large reserves that sufficient data will be collected to generate reliable stocking estimates for most species. This is particularly the case for bamboo.

Unfortunately, it is likely in smaller reserves and those in which species are rare that the data generated by standard EI will have large errors. Table 4 for rattan and Table 6 for Raphia indicate that between 17 and 300 plots respectively containing these species would be required to achieve SE20. This is not likely for smaller reserves or those with small areas of swamps which both of these species require. Table 9 even more dramatically indicates that standard EI is not likely to produce reliable estimates of individual medicinal plant species.

The variable precision of estimates for different products is a natural consequence of compromise on design to accommodate a multi-resource inventory. More focussed inventories will probably be necessary if reliable estimates of specific NTFPs or species are required. **It is important that the limitations of EI data are well understood, it will probably be unable to provide sufficiently detailed information for quota setting except at the crudest (national) level**. It can however, provide an overview of the distribution and relative abundance of NTFPs across the country.

It will be worthwhile re-considering how the EI NTFP data is going to be used and the scale at which it is most relevant. The consultant’s hunch is that it would be best to consider the EI data as giving a strategic overview at the national as well as reserve level. (It can make a big difference knowing a particular resource is plentiful in a reserve if you also know it is not present in neighbouring reserves.)

9.2 Participation in EI

Several times in this report it has been suggested that harvesters are included in the EI team. This is because it is important to consider the perspectives and knowledge of harvesters when attempting to undertake inventory ostensibly on their behalf. At the very least harvesters should be asked to detail the size and quality classes of product of most interest and this information used to define the size/quality classes used in EI.

As detailed in the CFM report there are a number of issues that need to be resolved concerning the possible integration of EI and CFM inventories. Whatever the outcome of this it remains important to include representatives of harvesters in the inventory whenever possible for two reasons:

- They have expert knowledge of the resource and forest;
- To generate support or at least understanding of management prescriptions amoung those who will be affected,

9.3 Protocols for NTFPs

For logistical simplicity it is proposed that modifications to the EI plots are minimised. The main additions are the inclusion of a number of additional species (see Table 16) and a 25 m² sub-plot to the standard EI plot (see Figure 5). Table 17 gives the records to be made for each lifeform and Table 18 the codes to be used to record NTFPs. Annex 5 gives draft field sheets to be used with the suggested protocols.

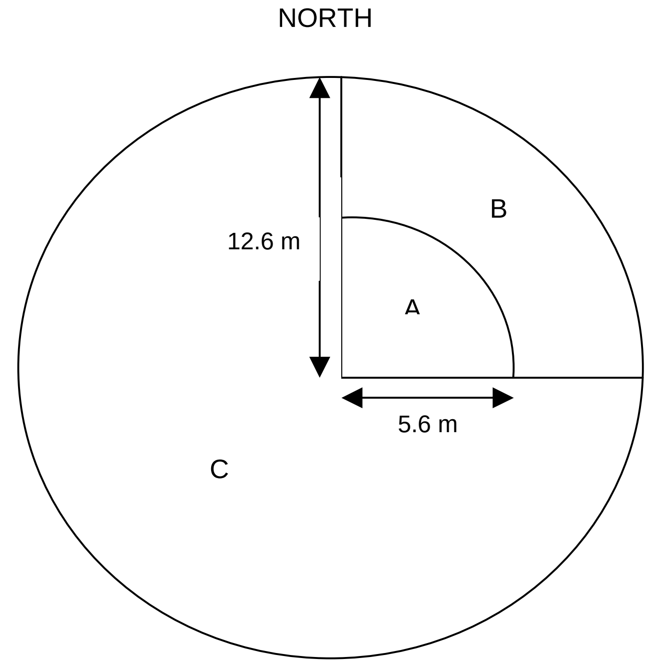
Table 16: Species to be included in EI

Life form	Species
Rattan	*Calamus deeratus*
Palms	*Raphia farinifera* *Phoenix reclinata* *Elaeis guineense*
Herbs	*Aframomum spp.* *Marantachloa spp.*
Climbers	*Smilax anceps* *Loeseneriella apocynoides*
Shrubs	*Acalypha spp.* *Coffea spp.* *Mondea whytei* *Markhamia platycalyx* *Melia azederach* *Rytigynia kigeziensis* *Lasiodiscus mildbraedii*
Trees	*Vitellaria paradoxa*
Bushmeat	See section 6.1.2

Table 17: NTFP enumeration within sub-plots

Life form	Sub-plot		
	A	B	C
Rattan	< 1 m tall	-	> = 1 m tall
Palms	< 1 m tall	-	> = 1 m tall
Herbs	-	-	Presence/absence
Climbers	-	-	Tally harvestable plants
Shrubs	-	-	Tally stems per plant Measure largest stem
Trees	Measure 5-9 cm (with callipers)	Measure 10-19 cm (with tape)	Measure >=20 cm (with tape)

Figure 5: Layout of sub-plots within standard EI plot



Sub-plot	Radius (m)	Extent	Area (m^2)
A	5.6	Quadrant	25
B	12.6	Quadrant	125
C	12.6	Whole	500

Table 18: EI codes to cover NTFP harvesting

Product	Code	Description
Poles	C1	Cut stem
	Co	Coppice shoots
	EC	Epicormics (profuse growth of shoots on stem/base of injured/dieing tree)
	C2	Coppice shoot cut
	C+	Coppice stems cut more than once
Phenology	FL	Flowered (for palms)
Harvesting	HB	Bark
	HR	Roots
	HL	Leaves
	HT	Tapped
Bamboo	SH	Shoot (not fully emerged)
	YG	Young: Fresh green stem (1-4 yr old)
	MG	Mature: Dark green stem (5-7 yrs old)
	OB	Old: Brown stem (> 8 yrs old)
	BA	Borer attack
	BT	Broken top
All	DE	Dead stems

9.4 Analysis of EI data

The calculation of errors for the NTFP portion of EI needs to be done in several stages. **The bushmeat data needs to be analysed using the DISTANCE software and the results integrated into the EI database at the block or reserve level**.

Data for trees 5-9 cm in diameter is basically the same as the normal EI tree data though it is collected from a smaller sub-plot. **It is suggested that EISys is modified to accommodate the 25 m² sub-plot and the smaller sized trees**. It should also be possible to include these data into the EIPac routines for determination of sampling errors.

The calculation of errors for other NTFPs can be set up as queries incorporated into the EI database. It is recommened that the error calculations are prepared as ACCESS queries (rather than incorporated into EIPac) on the basis that the sampling design can be treated as stratified random sampling as provided for in EIPac. The design is actually more akin to a systematic multi-stage sampling design with the 1 km blocks being the primary units, the transects the secondary and the plots themselves as tertiary units. However, using calculations for this design would be problematic for the EI data as many of the sample units are incomplete (i.e. plots were not enumerated if they fell outside the forest or in a nature reserve). Using the random formula is acceptable for systematic designs if we can consider the forest itself as effectively being random – a model based approach. This is generally considered to be acceptable in mixed forest.

Analysing the data is only the first step in its use. It is essential to ensure that the data are presented in an appropriate manner for understanding by different user groups particularly for villagers engaged in CFM. Interpretation of the data is also essential as it is this which bring about the understanding which leads to management decisions. Interpretation will be aided by careful use of existing work such as that contained within the student projects referred to in this report and also to the accumulated knowledge of the research projects established in Uganda such as Budongo Forest Research Centre and the Institute for Tropical Forest Conservation. Other work that is important is that done in Kabale as represented by Struhsaker (1997). There is a good opportunity for the FD to work together with these research centres and UWA to develop the understanding necessary to put forest management in Uganda onto a scientific, and hopefully sustainable footing.

9.5 Determing the number of plots/blocks required

There are a number of different methods for determining how many sample plots are required to achieve a target sampling error, in this case SE20. One of the simplest methods is that given in Annex 3 taken from Shiver and Borders (1996) and used extensively in this report. However, in the more complex situation were it is important to know how many plots are required to achieve SE20 for rarer species another method based on Taylor's power law (see Krebs 1999) can be used. Taylor's law is based on the observation that high-density populations tend to have high variances and low-density populations have low variance. The most common relationship between variance and population density is a power curve of the form:

$$s^2 = a\bar{x}^b$$

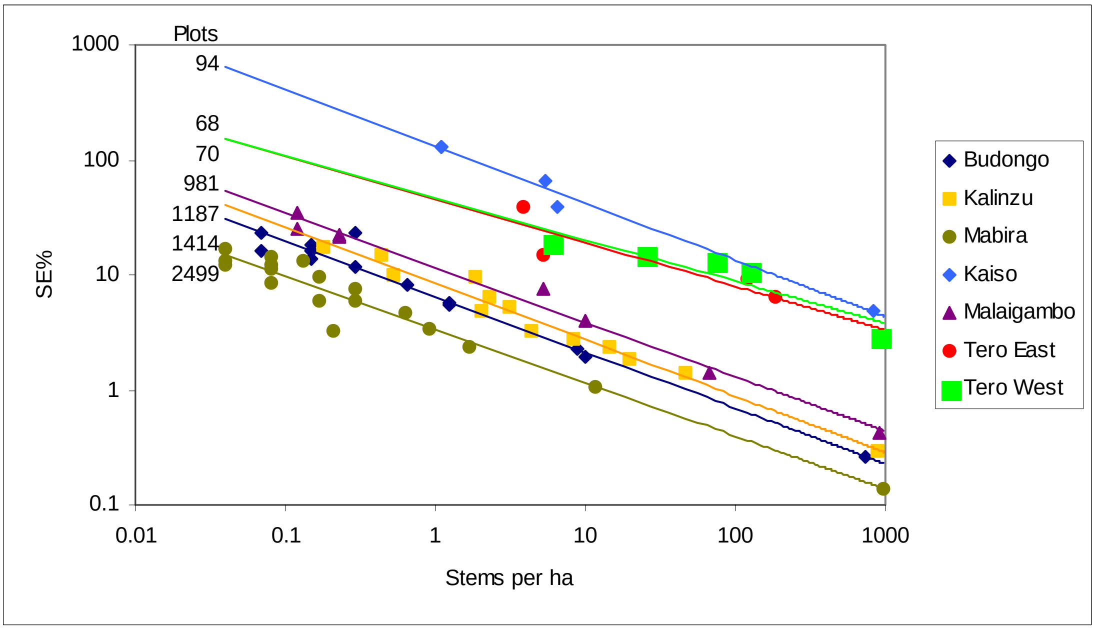
where s^2 = observed variance of a series of population counts

$\bar{x}$ = observed mean of a series of population counts

a & b = constants

This can be fitted either directly using a non-linear fit or by taking loarithims of both density and variance and fitting a straight line using linear regression. The samping error is directly related to the variance so it is possible to fit SE% against population density. However, since in calculating the SE% the variance is divided by the mean (see Annex 3) this eliminates the increase in variance with density and instead it becomes apparent that SE% will decrease with increasing density as there will be more observations of the plant in question. In order to examine these relationships the SE% for the medicinal species listed in Table 9 were plotted against mean density or all trees greater than 20 cm d on logged axes for the seven forests for which there is EI data (Figure 6). As expected points fall along straight lines for each reserve which indicates a power relationship and a variant of Taylor's power law. Furthermore five of the reserves have parallel lines and the seperation between them suggests that the number of plots determines the position of the lines (the intercept). Two of the lines have different slopes and are out of the plot sequence of the others. These reserves are Tero East and Tero West which are both swamps and quite different from the others which are mainly terra firme forest. These observations suggest that it may be possible to generate a model that could indicate the number of plots required to achieve a required SE% for rarer species, or to indicate the SE% that can be achieved with a certain number of plots.

Figure 6: SE% against stem density for medicinal trees in seven FRs



The model that gave the best fit was:

$$SE\% = (149.8587N^{-1.1270})(150,1720D^{-0.5005})$$

where: $SE\%$ = sampling error (95% confidence interval as % of the mean)

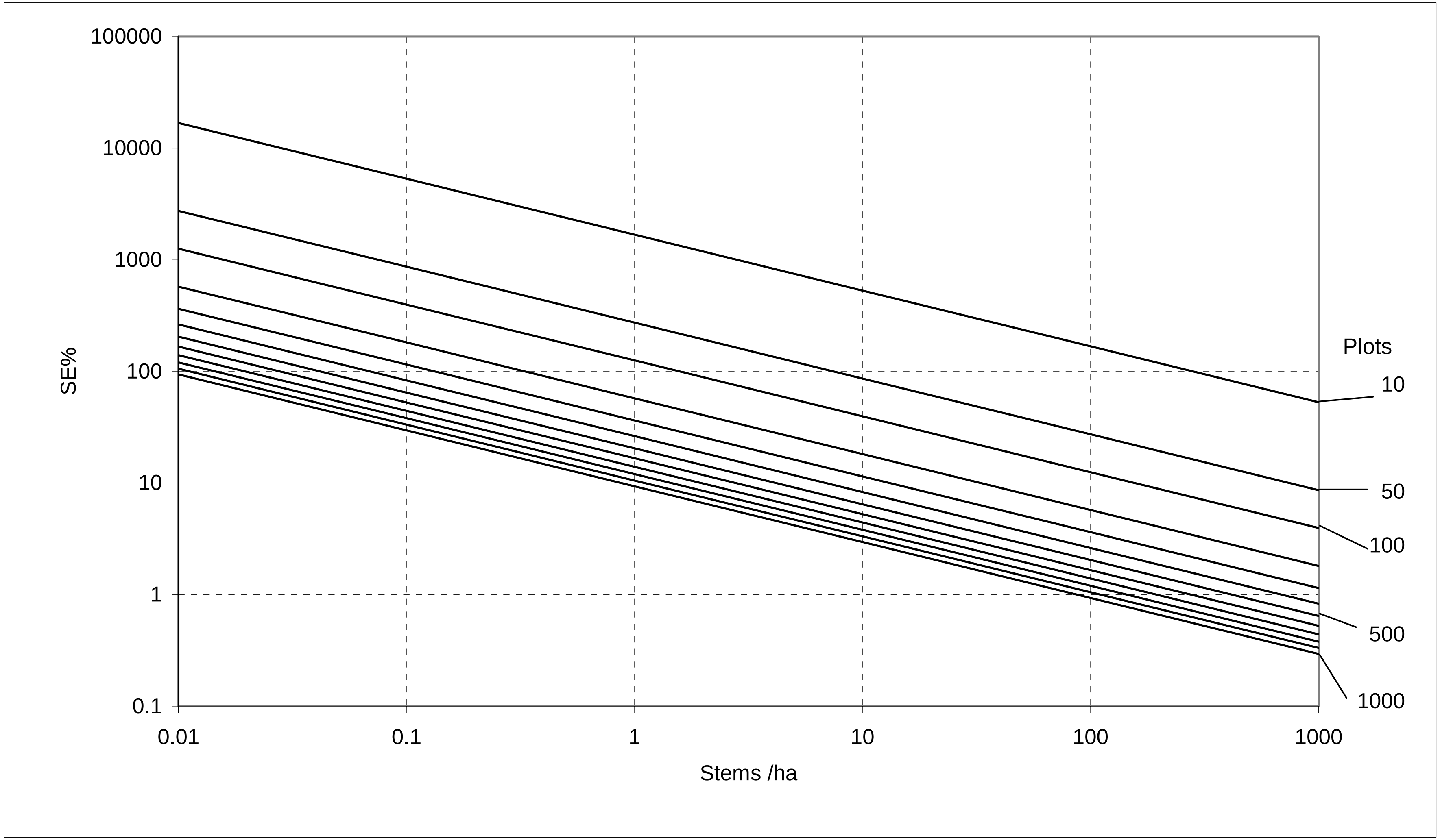
N = number of plots

D = stem density (> 20 cm d)

Although it is not strictly relevant for non-linear regressions the r² for this model was 0.9861 which indicates an extremely good fit. The model is shown graphically in Figure 7 below.

Besides illustrating the nature of the relationships exhibited in Figure 6, the graph in Figure 7 can be used to select an appropriate number of plots to achieve a specified sampling error for rarer species. If we have an idea that a species occurs at 1 per km² (0.1 per ha) would require around 1400 plots. Although this number was done for Kalinzu and Mabira it will not be possible to put so many plots in other reserves and keep the SI fixed at 1% - indeed it is even difficult to justify putting this many plots into large reserves. It is perhaps more appropriate to consider having reliable estimates for less rare species. SE20 for 1 tree per ha could be achived with 500 plots while SE20 for 10 trees per ha would need 200. In terms of standard EI this means 25 and 10 blocks repectively. Taking criteria of this type suggests that standard EI has over achieved in Kalinzu and Mabira and that far fewer plots would have sufficed to obtain estimates comparable to those from other reserves. Indeed these data suggest that in order to obtain comparable estimates across a range of reserve sizes that the same number of plots is required in each. In effect this means a higher sampling intensity in small reserves and lower in larger – a reversal of the normal mode of sampling proportional to size. It is suggested that the use of models

Figure 7: Model – SE%, stem density and number of plots



such as that in Figure 7 could be used to optimise the distribution of plots and effort in future EI exercises.

The development of an equivalent model for swamp forests as represented by Tero East and Tero West would require further data for other swamp forests. However, the results from these two reserves indicates that far fewer plots are required for swamp forest, presumably a consequence of their simpler structure and lower overall tree species diversity.

The message of Figure 6 and Figure 7 is that it is going to be difficult to obtain good density estimates for most NTFPs and certainly rare medicinal trees. At the level of EI it has to be accepted that it will not be possible to achive SE20 for many species as they have densities of less than 0.1 per ha. When better data is needed for the generation of management prescriptions it would be advisable to collect this in the context of ISSMI i.e. a management level census of populations within management blocks rather than by sampling.

However, to generate useful data at all it is recommended that a minimum of 200 plots be used in a reserve/management block. For standard EI this means a minimum of 5 blocks. In reserves of less than 5 km² it is suggested that the EI design is changed to increase the sampling intensity to maintain a minimum of 200 plots as outlined below.

9.6 Fitting EI into smaller reserves

The design of EI as well as the fixed % sampling intensity means that it does not fit comfortably within irregular, small reserves. There are many small reserves in Uganda which may not be well served by the standard EI design. However, there is little reason to change the design unnecessarily so the plots and spacing along transects should remain the same. In small reserves the issue is not the sampling intensity but rather the number of plots recorded. It appears that around 300 plots would suffice to give reliable results for most NTFPs but cramming this many into a small reserve would be wasteful of resources and would probably result in excessive damage the forest. **For reserves which are an awkward shape or are less than 5 km² in area it is suggested that the regular strata are abandoned in favour of a simple division of the reserve into roughly evenly sized units in an objective manner** (dividing a 3 km² reserve into thirds would suffice). In each strata notional transect lines 200 m apart would be prepared and selected randomly as in the standard protocols. In order to keep the number of plots, transects should be selected until 20 plots have been located within the forest.

For very small reserves (below 2 km²), even this accommodation will not work and the reserve would have to be treated as a single strata. If reliable data is required for such reserves the sampling intensity would have to be increased to generate more than 30 plots.

The details of these accommodations could be worked up in more detail and reliably once some data from small reserves is available.

9.7 Work plan for implementation of EI including NTFPs

Table 19 lists the largest FR in Uganda and gives an indication of progress with inventory in these reserves. EI has been completed in four reserves but in only two of these have palm data and even this is insufficient. Given that there is no NTFP data for the these four reserves, the question is going to be whether it is possible to re-visit the plots to enumerate NTFPs or whether doing this would not be worth effectively repeating EI for these reserves. Repeating the inventories would be time consuming and costly and would only add data on NTFPs. It may be that the extra data is not worth the cost and NTFP data will have to be collected during participatory assessments under CFM.

The WCS Albertine Rift project has completed large mammal surveys for six reserves and these data are reliable and recent. This data should be obtained from WCS (Andy Plumtre) and their advice sought on how their findings should contribute to and influence the management plans. If costs are high then a saving could be made by omitting bushmeat surveys in reserves visited by WCS in the immediate future though repeats in reserves visited more than five years ago would be informative.

Table 19: EI progress for largest Forest Reserves

Reserve	Animal survey	Area km²	EI	Palms
Budongo	Yes	822	Production area	
Bugoma	Yes	402		
Echuya	Yes	35		
Itwara		87		
Jubiya		51		
Kagombe	Yes	180		
Kalinzu	Yes	586	Production area	
Kasyoha-Kitomi	Yes	394		
Kitasi				
Mabira		298	Production area	Yes
Mpigi		284		
Sango Bay		187	Whole area	Yes
Ssese		85		

At present there is only one field team in TSS. The team comprises two field officers who recruit local labour and one person who does checks based in Kampala who has many other responsibilities. This team has to undertake all TSS fieldwork including timber volume sampling, line cutting, plot demarcation and enumeration of EI, ISSMI and PSP plots. At the present rate of work it took ten months to complete the inventory of Kalinzu. All field work on EI has stopped until August because of the priority given to timber volume sampling.

Although the intention is for EI to provide stocking levels for management planning there is little evidence that this is happening. The draft management plan for Echuya was prepared without any inventory taking place. In Sango Bay EI data is available but was not made available to the communities developing the CFM plans which were based on participatory inventories without any similarity to EI.

The questions that need to be answered before planning any further EI fieldwork are:

- Who is going to use the EI data – FD and/or the communities?
- When should the EI data be made available?
- How should the data be made accessible to the users?
- How will EI data inform the management plans?
- What decisions will be made based on EI data?

- What is the relationship between EI and CFM inventories?

Building on experience in other countries, it is **suggested that EI data could be used to stimulate management planning**. One way of doing this would be to undertake the inventory prior to management planning and be paid for as an investment in management by the FD. The objective of EI would be exploratory i.e. to find out what is there to be managed and to put this into a local and national context. **The data should be analysed and presented to the FD District staff and partner communities in CFM in a form accessible to them**. The maps and data would then form the background to development of the plans. In the event that a community wished to manage a particular resource they would need to make their own investment in inventory to determine the sustainable offtake for the desired resource.

In order to generate the data quickly enough to proceed with management planning and also to put the reserves in a national context (or bigger picture) would require that the rate of field work is dramatically increased. The ideal would be to set up inventory teams who would be able to visit all reserves within a period of, say, five years. It may be possible to request donor funding to undertake such a national inventory as a necessary investment in forest management.

A further consideration is that a 1% national inventory would look very generous as most large scale inventories now have sampling intensities of less than 1%. The sampling intensity of inventories in Ghana has been steadily decreasing 1955 – 5%, 1982 – 0.5%, 1986 - 0.25%, 2001 – 0.001% and have still been found useful for strategic planning.

However, the intention of this consultancy was not to design EI but to make recommendations on the inclusion of NTFPs which has been done.

10. NTFPs in ISSMI

The terms of reference required that the consultancy consider the inclusion of NTFPs in ISSMI. ISSMI is the detailed census, numbering and mapping of all trees > 40 cm in 200 x 200 m blocks. The data is used to select numbered trees for felling. The idea is that ISSMI would immediately precede logging. It is obviously very intensive and is soon to be followed by logging. Why then would it be useful to include NTFPs in ISSMI? One reason for NTFPs in ISSMI would be to determine if there were any useful plants present which might be damaged by logging and could therefore be harvested before this happens – in effect a salvage operation. NTFP inventory of this type would not need to be statistical inventory but rather an assessment of the quantities of resource in the vicinity of the trees marked for felling. Useful amount of resource could be offered under license. Perhaps the most important resource of this type is medicinal bark on prime timber species which could be sold to local herbalists.

Over long periods of time ISSMI would build up an extremely detailed picture of the reserves and this will be invaluable for learning about forest dynamics. Knowing how NTFPs fit into this picture would be very useful but it would be impractical to map and measure all NTFP plants within an ISSMI block. A better **suggestion would be to adopt the EI protocols including NTFPs for assessment of the four temporary sample plots located in the corners of the ISSMI block**.

One would not propose ISSMI for the regulation of NTFPs harvesting as it is likely the scale would be wrong and the level of detail inappropriate for herbs in particular. In might be **more appropriate to construe the CFM inventories as the equivalent of ISSMI for NTFPs**.

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Annex 1 – Terms of reference

REF. NO.	SC/08/2002
TITLE:	Non-Wood Forest Products, Assessment Methods and Plan of Action
DURATION:	Maximum 26 professional days.
TIMING:	May – June 2003.
LOCATION:	Based in Kampala, but with significant field work in rural areas
BACKGROUND:	The Forest Resources Management and Conservation Programme is actively involved with the conservation of key forest reserves in Uganda, particularly those with high biodiversity values. Many of Uganda's Natural High Forests (NHF) are a rich supply of timber and also numerous non-timber products such as rattan, medicinal plants and bamboo. Most of these areas, however are seriously threatened by ever increasing demand placed on them from surrounding communities. If such reserves are to stand any chance of survival, it is imperative to involve those stakeholders who have traditionally harvested various products and to provide them with information on sustainable harvesting methods and through participatory inventory and/or assessment methods.
OBJECTIVES:	To recommend participatory, reliable and practical methods of assessing selected NWFP in Uganda's NHF. To integrate NWFP assessment methods into standard Exploratory Inventory and/or Integrated Stock Survey and Management Inventory methods, and into the ongoing development of CFM Resource Assessment Guidelines.
SPECIFIC TASKS:	To carry out a general review of the various NWFPs within Uganda's key NHFs. Focusing on 1 or 2 Forest Reserves (to be selected in conjunction with FRMCP staff) to recommend and test / demonstrate methods of assessment of the most important NWFPs. To identify important NWFPs in (5) key focus Forest Reserves (and combined with the results of task 1, to identify national priority NWFP species for inclusion in general forest surveys. To document recommended methodologies for field survey and data analysis, ideally through integrating method into standard EI, ISSMI and CFM Participatory Resource Assessment methodologies. To assist the Technical Services Section of the EC-Forestry Programme to prepare a plan for inventory work within the selected FRs. To train key staff on survey and analysis methods.

Annex 2 – List of groups consulted

Site	Groups
Kampala	UWA (Eunice Nyiramahoro) WCS (Andy Plumtre) Faculty of Forestry and Nature Conservation, Makerere University (Dr Banana, Dr Kaboggoza +) Ministry of Water, Lands and Enviroment (David Hafashimana) EC-Forestry project (James Acworth) TSS, FD (Fred Ahimbisibwe, Jimton Acobo, George, Chris, Robert) CID (Vincent Barugahare & Evan Kalungi) MAFICO (Judith V??) ICRAF (Jean-Marc Boffa) Conservation of rare medicinal plants project (Anke Weisheit) Forest Sector Co-ordination secretariat (Mike Harrison) Uganda Agroforestry Development Network (Clement Okia) FORRI (Grace Rwabaingi) Natural Chemotheraputic Research Laboratory (Sophia Apio Kerwegi) NACOTHA - National Council of Traditional Healers and Herbalists of Uganda (Massy Bituraa)
Mabira	District Forest Office LVEMP Herbalist living next to forest
Budongo	District Forest Office Budongo Forest Programme BuCoDO (??) CFM community adjacent to compartment W38 Herbalist Craft maker
Mpanga	District Forest Office
Sango Bay	District Forest Office Mujanjabura village CFM committee Palm harvester
Kalinzu	District Forest Office Anke Weisheit Herbalist Herb collector
Kabale	District Forest Office ICRAF (Levand Turomurugyendo) Magahinga and Bwindi Impenetrable Forest Conservation Trust (Geo Dutki) KDF
Echuya	District Forest Office Batwa bamboo harvesters
Bwindi	ITFC (Robert Bitahiro) UWA

Annex 3 – Statistical notes

In any inventory it is important to determine the quality of the estimates being made of the number of stems per ha, volume of fruit etc.. The ideal is for the estimates to be precise and accurate.

Precision gives a measure of the spread of data and therefore the representativeness of the mean. Precision can be quantified as the sampling error or SE% and is often quoted along with the mean to give an indication of its quality. Conventionally in forest inventory the SE% is calculated as the 95% confidence interval of the mean expressed as a percentage of the mean and is calculated through the following steps:

$$\bar{x} = \frac{\sum x}{n}$$ mean

$$se = \sqrt{\frac{s_x^2}{n-1}}$$ standard error of the mean

$$SE\% = \frac{se100t}{\bar{x}}$$ sampling error

t t value at required probability (0.95) with n-1 degrees of freedom

There are several ways of using the variance of a test sample to estimate the number of plots required to obtain estimates with a specified sampling error. One of the simplest is that recommended by Wong et al (2001). This calculates the required number of plots in the following manner:

$$n_e = \frac{t^2 (CV\%)^2}{(AE)^2}$$

where:

n_e estimated number of plots required

t t value for the test sample. For most small samples this can be approximated as 2

$$CV\% = \frac{s_x 100}{\bar{x}}$$ the coefficient of variation

AE the sampling error required for the inventory. This has been taken as 20%.

Annex 4 – Summary of species identified as important in a range of locations

Life form / Common name	Product	Latin name	Total	Budongo	Bwindi NP	Echuya	Kalinzu	Kibale NP	Kigezi Highlands	Lira District	Luwera District	Mabira	Mtt Elgon	Mpanga	Mpigi District	Nebbi District	Sango Bay	Semuliki NP	Uganda	Victoria Lakeshore
Tree	Medicine	*Prunus africana*	11	1	2		1	1	1		1	1							2	1
Bamboo	Poles, craft, food	*Arundinaria alpina*	9		1	1							1			2			4	
Rattan	Craft	*Calamus deeratus*	9	1								1		1				2	4	
Tree	Medicine	*Zanthoxylum spp.*	8	1	1		1		1		1			1				1		1
Palm	Craft, poles	*Phoenix reclinata*	7					1				1		1			1	1	2	
Tree	Medicine	*Warburgia ugandensis*	7	1			1	1			1	1							1	1
Tree	Drums	*Polyscias fulva*	7		2									1	2				2	
Bushpig	Food	*Potamochoeros porcus*	7	3	1		1					1						1		
Tree		*Canarium schweinfurthii*	7	2				1						1					2	1
Duiker	Food	*Cephalophus spp.*	5	2	1							1							1	
Edible rat	Food	*Thryonomys swinderianus*	5	2								1						1	1	
?		*Citropsis articulata*	5	1				1				1		1					1	
Tree		*Alstonia boonei*	5	2								1							1	1
Herb	Craft	*Marantachloa*	5	1				1						1				1	1	
Tree		*Maesopsis eminii*	5	1	1							1			1				1	
Tree		*Erythrina*	5	1	1			1							1					1

Life form / Common name	Product	Latin name	Total	Budongo	Bwindi NP	Echuya	Kalinzu	Kibale NP	Kigezi Highlands	Lira District	Luwera District	Mabira	Mtt Elgon	Mpanga	Mpigi District	Nebbi District	Sango Bay	Semuliki NP	Uganda	Victoria Lakeshore
		abyssinica/excelsa																		
Bushbuck	Food	*Tragelaphus scriptus*	4	3															1	
Tree	Medicine	*Rauvolfia vomitoria*	4	1				1				1							1	
Tree	Medicine	*Ocotea usambarensis*	4		2				1										1	
Shea butter	Food	*Vitellaria paradoxa*	4							1									3	
Tree	Medicine	*Albizia coriaria*	4	1							1			1						1
Herb	Food	*Aframomum spp.*	4	1			1												2	
Tree	Medicine	*Kigelia africana*	3								1	1								1
Climber	Craft	*Smilax anceps/kraussiana*	3				1	1											1	
Tree	Medicine	*Combretum molle*	3								1			1						1
Tree	Cloth, drums	*Ficus sp.*	3	1										1	1					
Tree	Medicine	*Syzgium cordatum*	3								1			1						1
Tree		*Tamarindus indica*	3							1									1	1
Tree	Wood	*Dombeya spp.*	3					1					1					1		
Climber	Craft	*Loeseneriella apocynoides*	3		1														2	
Tree	Medicine	*Sapium ellipticum*	3	1				1											1	
Tall herb	Food	*Ensete ventricosum*	3			1		1											1	
Oil palm	Edible oil	*Elaeis guineensis*	3															2	1	
Tall palm	Craft	*Raphia farinifera*	3											1					2	
Gum arabic	Food	*Acacia spp. (seyal, senegal,*	3																3	

Life form / Common name	Product	Latin name	Total	Budongo	Bwindi NP	Echuya	Kalinzu	Kibale NP	Kigezi Highlands	Lira District	Luwera District	Mabira	Mtt Elgon	Mpanga	Mpigi District	Nebbi District	Sango Bay	Semuliki NP	Uganda	Victoria Lakeshore
		polyacantha, Commiphora abyssinica)																		
Fish	Food		3		1												1	1		
		Harungana madagascarensis	3									1							1	1
Tree	Drums, mortar, beer boat	*Cordia millenii/abyssinica*	2					1											1	
Tree	Mats, ropes	*Triumfetta macrophylla*	2		1			1												
Tree	Food	*Garcinia escuensis*	2																2	
Climber	Food	*Dioscorea spp.*	2	1	1															
Climber	Medicine	*Entanda abyssinica*	2					1			1									
Tree	Beehives	*Faurea salgina*	2																2	
Climber	Medicine	*Mondea whytei*	2								1								1	
Tree		*Parkia filicoidea*	2											1					1	
Tree	Medicine	*Desplatsia dewevrei*	2															1	1	
Tree		*Erythrophleum sauveolens*	2	2																
Tree		*Balanites wilsoniana*	2	1							1									
Tree		*Antiaris toxicaria*	2											1	1					
Herb	Food	*Solanum nigrum*	2	1															1	
Tall herb	Medicine	*Dracaena steudneri*	2								1									1
Shrub	Pole, craft	*Lasiodiscus*	2	1														1		

Life form / Common name	Product	Latin name	Total	Budongo	Bwindi NP	Echuya	Kalinzu	Kibale NP	Kigezi Highlands	Lira District	Luwera District	Mabira	Mtt Elgon	Mpanga	Mpigi District	Nebbi District	Sango Bay	Semuliki NP	Uganda	Victoria Lakeshore
		mildbraedii																		
Shrub	Medicine	*Vernonia amygdalina*	2								1								1	
Shrub		*Craterispermum schweinfurthii*	2				1										1			
Tree		*Olinia rachetiaba*	2		1								1							
Tree	Pole, tool handle	*Teclea noblis*	2					1										1		
Buffalo	Food	*Syncerus caffer*	2															1	1	
	Medicine	*Bridelia micrantha*	2					1												1
Francolin	Food	*Francolinus spp.*	2		1		1													
Tree	Medicine	*Newtonia buchananii*	2					1												1
	Food	*Physalis cortifolia*	2	1						1										
Tree	Medicine	*Entandrophragma excelsum*	2		1				1											
Guinea fowl	Food	*Numida meleagris/Guttera edouardi*	2	1			1													
		Phytolae dedecondrea	2	1	1															
	Pole	*Markhamia platycalyx*	2					1										1		
Porcupine	Food	*Hystrix cristata*	2	1								1								
?	Medicine	*Carissa edulis*	2								1									1
Tree	Medicine	*Hallea spp*	2	1																1
Shrub	Food	*Coffea canephora*	2	1				1												

Life form / Common name	Product	Latin name	Total	Budongo	Bwindi NP	Echuya	Kalinzu	Kibale NP	Kigezi Highlands	Lira District	Luwera District	Mabira	Mtt Elgon	Mpanga	Mpigi District	Nebbi District	Sango Bay	Semuliki NP	Uganda	Victoria Lakeshore
Papyrus	Fibre	*Cyperus papyrus*	2																2	
Tree	Medicine	*Parinari excelsa*	2		1			1												
Tree	Pole	*Disopyros abyssinica*	2					1										1		
		Maesa lanceolata	1		1															
Herb?	Craft fibre	*Clinogyne filipes*	1															1		
		Pyrenacrantha sylvestris	1	1																
		Myrica salicifolia	1		1															
Medicine		*Securidaca longepedunculata*	1																	1
		Phytolacca dodecandra	1	1																
	Medicine	*Acacia sieberiana*	1																	1
Tree		*Milicia excelsa*	1																	1
	Medicine	*Rhus vulgaris*	1																	1
		Spathodea campanulata	1																	1
Climber	Medicine	*Lantana camara*	1	1																
	Pole	*Agave sisilana*	1													1				
Tree		*Symphonia globulifera*	1		1															
		Clerodendron myricoides	1									1								
	Pole	*Thecocaris lucida*	1															1		
	Pole	*Tapura fischeri*	1															1		

Life form / Common name	Product	Latin name	Total	Budongo	Bwindi NP	Echuya	Kalinzu	Kibale NP	Kigezi Highlands	Lira District	Luwera District	Mabira	Mtt Elgon	Mpanga	Mpigi District	Nebbi District	Sango Bay	Semuliki NP	Uganda	Victoria Lakeshore
	Medicine	*Puncia granatum*	1																	1
	Pole	*Rinorea beniensis*	1															1		
	Medicine	*Albizia zygia*	1																	1
	Pole	*Melia azederach*	1													1				
	Pole	*Chaetacme aristata*	1															1		
	Pole	*Celtis spp.*	1															1		
Climber	Medicine	*Piper guineense*	1		1															
Herb		*Acalypha bipartia*	1								1									
	Medicine	*Hoslundia opposita*	1								1									
	Pole	*Senna siamea*	1													1				
B&W colobus	Food	*Colobus guereza occidentalis*	1															1		
Tree		*Pycnanthus angolensis*	1	1																
Tree	Pole	*Milletia dura / eetveldeana*	1															1		
Tree	Wood	*Aningeria adolfi-friederici*	1										1							
Tree	Wood	*Macaranga kilimandscharia*	1										1							
Tree	Wood	*Neoboutonia macrocalyx*	1										1							
Tree	Wood	*Podocarpus milianjianus*	1										1							
Tree	Wood	*Podocarpus spp.*	1		1															

Life form / Common name	Product	Latin name	Total	Budongo	Bwindi NP	Echuya	Kalinzu	Kibale NP	Kigezi Highlands	Lira District	Luwera District	Mabira	Mtt Elgon	Mpanga	Mpigi District	Nebbi District	Sango Bay	Semuliki NP	Uganda	Victoria Lakeshore
Tree	Wood, fibre	*Ficus natalensis*	1		1															
Tree	Pole	*Cynometra alexandri*	1															1		
Bamboo	Crafts, poles	*Oxytenanthera abyssinica*	1																1	
Tree	Pole	*Blighia unijuguta*	1					1												
Bush rat	Food	*Aethomys kaiseri*	1	1																
Chimpanzee	Food	*Pan troglodytes*	1															1		
Giant forest hog	Food	*Hylochoerus meinertzhageni*	1																1	
Hyrax	Food	*Dendrohyrax dorsalis?*	1	1																
Monitor lizard	Food	*Varanus niloticus*	1															1		
Partridge	Food	*Ptilopachus petrosus?*	1				1													
Red tailed monkey	Food	*Cercopithecus l'hoestii*	1															1		
Squirrel		*Xerus erythropus*	1	1																
Baboon	Food	*Papio anubis*	1															1		
Tree		*Strombosia scheffleri*	1		1															
Scrambling herb	Food	*Rubus guajava*	1	1																
Shrub	Food	*Annona senegalensis*	1							1										
Shrub	Medicine	*Euphorbia ticucalli*	1																1	
Shrub	Medicine	*Rytigynia kigeziensis*	1		1															
Tall herb		*Dracaena fraglans*	1																1	

Life form / Common name	Product	Latin name	Total	Budongo	Bwindi NP	Echuya	Kalinzu	Kibale NP	Kigezi Highlands	Lira District	Luwera District	Mabira	Mtt Elgon	Mpanga	Mpigi District	Nebbi District	Sango Bay	Semuliki NP	Uganda	Victoria Lakeshore
Tall palm	Food	*Borassus aethiopum*	1							1										
Tree		*Bosquiea phoberos*	1											1						
Tree		*Croton macrostachys*	1		1															
Tree	Pole	*Holoptelea grandis*	1															1		
Tree		*Olea chrysophylla*	1										1							
Root parasite	Medicine	*Thonningia sanguinea*	1																1	
Wild coffee	Food	*Coffea spp.*	1																1	
Tree	Drums	*Ficus exasperata*	1												1					
Tree	Drums	*Ficus mucuso*	1												1					
Tree	Drums	*Funtumia africana*	1												1					
Tree	Medicine	*Balsamocitrus dawei*	1																1	
Tree	Medicine	*Khaya anthotheca*	1	1																
Tree	Medicine	*Podocarpus latifolis*	1								1									
Tree	Medicine	*Spondianthus preusii*	1											1						
Tree		*Hagenia abyssinica*	1		1															
Total reports			29	4	3	1	1	2	1	1	1	1	1	3	2	1	1	2	5	1

Annex 5 - EI NTFP Forms

NTFP sheet 1 – Herbs, climbers, palms, shrubs and animal sign

Date:	Block:	Plot:	Sheet:	of:
Forest:		Site codes:		

HERBS	Estimate % cover if present
Marantachloa (used for baskets)	

PALMS	Only A	Whole plot			
	< 1 m tall	1-2 m tall	2-4 m tall	4-6 m tall	> 6 m tall
Rattan					
Raphia					
Phoenix					
Oil palm					

SHRUBS	Tally of stems per plant	Size of largest stem

CLIMBERS	Tally of useable plants

NTFP sheet 2 – Bamboo

Date:	Block:	Plot:	Sheet:	of:
Forest:		Stand type:		
Species:				

ONLY MEASURE IN SUB-PLOT A

Culm #	Diameter (cm)	Age class	Codes

Codes: BA – Borer attack; BT – Broken top; CU – Cut; DA – Damaged or diseased
Age classes: S – shoot; Y – young; M – mature; O – old; D - dead