Community-Based Natural Resource Management: Layout and Inventory of a Village Management Area in Nam Sabi, Sagaing Region, Myanmar

Report of Research

Charles M. Peters, Ph.D.
The New York Botanical Garden

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Acknowledgments

A sincere thank you to everyone for an incredibly productive and rewarding session of community-based natural resource management (CBNRM) in northern Myanmar. I must say, the level of collaboration and the intensity of the fieldwork that occurred during this trip–and shortly thereafter–were remarkable. Remarkable for the quantity and quality of the information collected; and, perhaps, even more remarkable for the incredible potential that the work has for laying the foundation of a viable, long-term, community-based program of sustainable resource use in the region. There are numerous people and institutions that pulled together to make this happen, and I deeply appreciate the strong show of support by all involved.

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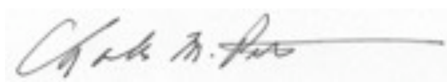


Charles M. Peters

Executive Summary

From October 18 to November 1, fieldwork was conducted in the village of Nam Sabi (N25.36182°, E95.34253°; 143 masl) in Hkamti District, Sagaing Region and in a small tract of forest located south of the village. The basic objective of the village work was to finalize the list of useful plant species and to select an appropriate location for the establishment of a Village Management Area (VMA); forest work was focused on laying out a baseline for the VMA and sampling two transects to train local crews in the inventory methodology.

Building on the initial household interviews in Nam Sabi (see *Report of Research*, June 2014), a list of the useful plant species to be included in the inventory was compiled with 27 timber species, 2 species of thatch palm, 3 species of bamboo, 5 species of rattan, and 26 species of medicinal plants. Consensus was also reached concerning the location of a 0.5 kilometer by 2.0 kilometer (100 hectares) VMA and its associated basecamp within a tract of forest approximately 5.0 kilometers southeast of the village (N25.31760°, E95.35147°).

After first building the basecamp to service the VMA, the northern border of the management area was located in the field, the line carefully cleared, and transect stakes (n=20) set every 100 meters to provide a systematic 10% sample

The basecamp at the Nam Sabi Village Management Area (VMA) was situated next to Taw-htan stream. The first and last steps of fieldwork each day were taken in the middle of this stream.

of the area. The resource inventories on transects 1 and 2 were finished after laying out the baseline; the remaining 18 transects were completed by local field crews working from November 13 to November 27.

A forest typology of the area including six habitat classes, i.e. closed forest, closed forest with bamboo, young secondary forest, rattan thicket, yone (*Salacca secunda* Griff,) thicket, and taw-htan (*Livistonia jenkinsiana*) stand, was developed using the forest-type observations recorded from each inventory plot.

The inventory transects revealed that 10.0 hectares of VMA forest contain 2 species of palm thatch, 3 species of bamboo, 2 species of rattan, 15 species of timber, and 18 species of medicinal plants, i.e. about 70% of the important plant resources required by the village. In terms of timber trees, *ka-nyin* (n=394, 481.8 m^3) was the most abundant species, followed by *thin-bone* (n=61, 292.2 m^3)and *thit see* (23, 46.9 m^3). *Wa-net* was the most abundant bamboo with 11,487 culms recorded; *yamata kyein* (n=1,330 canes) and *kyet-au-kyein* (n=752 canes) were the most common rattan. species. *Yone*, which comprised about 95% of all the thatch palms recorded, was represented by 4,538 stems.

In addition to measuring the diameter of each timber tree, data on tree height were also collected from 672 trees. These measurements were used to construct diameter vs. height curves for each timber species so that height could be estimated allometrically based on a diameter measurement in subsequent work. Wood volumes (m^3) were then calculated using heights and diameters and a tree taper estimate of 0.80.

During the main inventory work in late November, field crews affixed stainless-steel dendrometer bands around the trunks of 82 sample trees from 12 different timber species to measured growth rate. The growth trees were selected from a range of diameters and canopy positions, e.g. dominant, co-dominant, and suppressed, to obtain a representative estimate of tree growth in the VMA.

The basic conclusion to be drawn from the VMA inventory is that there is still an abundance of timber, thatch, bamboo, rattan, and medicinal plants in the forest, but that controlled harvesting and management are needed for some species and resources to insure a continual supply. **An additional conclusion from the recent fieldwork, of perhaps even greater long-term importance, is that the villagers of Nam Sabi are very capable of collecting the quantitative data required to manage a community forest sustainably–and they seem very motivated and enthusiastic to do so.**

Taking measurements and photos of a tiger track encountered along the bank of Taw-htan stream at the end of plot 25, transect 1 in the Village Management Area (VMA).

Introduction

Collaborative work with WCS and the Myanmar Forest Department on community forestry in northern Myanmar has been underway since 2005. Initial efforts were based on documenting the rattan resource in the Hukaung Valley Wildlife Sanctuary (*Hukaung Valley Rattan Survey Trip Report*, April 2005), followed by preliminary resource surveys in three villages (*Community-Based Natural Resource Management in the Hukaung Valley Wildlife Sanctuary*, June 2009), and, finally, the establishment of a 100 hectare management area outside of the village of Shinlonga (*Community-Based Natural Resource Management in the Hukaung Valley Wildlife Sanctuary: Phase* 2, December 2009). Unfortunately, the political situation in this part of Kachin State started to deteriorate and the community forestry work was put on hold.

The present report continues the community-forestry narrative that was started five years ago in Shinlonga. The venue has changed, but the underlying philosophy and core management concepts have remained the same: 1) compile a list of important forest resources that the community depends on (i.e. the demand), 2) assess the current distribution, abundance, and regeneration status of these resources in the forest (i.e. the supply), and 3) balance the local supply and demand for forest resources at the community level through the sustainable harvest and participatory management of a small tract of forest designated the "Village Management Area" or VMA. The fieldwork described herein outlines the layout and inventory of such a management area by the community of Nam Sabi in the Hkamti District of Sagaing Region. **This is a remarkable achievement, and it represents a major step forward for community-based natural resource management in Myanmar.** [NOTE: For useful background information about the village of Nam Sabi, the reader is referred to *Community-Based Natural Resource Management: Data Collection in Nam Sabi and Training in Htamanthi, Sagaing Region, Myanmar*, June 2014].

The report opens with a brief description of the survey teams followed by a detailed explanation of the different methodologies used in the fieldwork. An annotated list of the forest resources selected by villagers to be included in the VMA inventory is then presented. The results from the participatory forest inventory, one of the first of its kind in northern Myanmar, are then summarized, and the total density and/or volume, merchantable stock, and spatial distribution of timber, bamboo, rattan, thatch palms, and medicinal plants within the management area are discussed in detail. Size-class histograms showing the regeneration status of selected resources are presented and height/diameter and diameter/volume curves and regression equations are included for most of the important timber species.

The quantitative growth studies initiated in the VMA as part of the inventory work are discussed in a following section, and the species, diameters, and canopy positions of all sample trees are outlined. [NOTE: The results from the forest inventories as well as the growth studies will eventually be incorporated into a comprehensive management plan for the VMA].

A final section examines the subsequent steps needed to actualize the community forestry program at Nam Sabi. What systems and regulations need to be in place at the village level to insure that the designated harvest prescriptions are respected? How to best monitor the actual offtake of timber, bamboo, rattan, and thatch from the management area and allocate the harvest each year? And, perhaps most importantly, what is the most effective way to recognize–and institutionalize through forest policy–the conservation benefits of the community-based natural resource management efforts underway at Nam Sabi.

U Aung Kyi (Assistant Village Leader of VMA) sets stake 14 (a transect stake) along the baseline..

The survey team was composed of scientists and resource professionals from the Htamanthi WS, the WSC Myanmar Program, and NYBG, together with field assistants and cooks from Nam Sabi.. Key members of the team included:

U Myint Thein is a Ranger at the Htamanthi Wildlife Sanctuary and has previously collaborated on community forestry work at Tikon and Nam Sabi. He ran compass flawlessly during the baseline layout and inventory transects and headed the field crews during the November inventory.

Daw Myint Myint Oo is Technical Coordinator (Community and Sustainable Natural Resource Management) in the WCS Myanmar Program. She played a key role in the initial surveys at Nam Sabi, arranged logistics for the current fieldwork, and recorded the data for transects 1 and 2.

Dr. Charles Peters is the Kate E. Tode Curator of Botany at the New York Botanical Garden. Dr. Peters is a plant ecologist and a forester specializing in the ecology, use, and management of tropical forest resources. He has written extensively on various aspects of community forestry.

U Sein Day Li is Assistant Project Manager in the WCS Myanmar Program. He helped with logistics, took pictures, ran compass, measured tree heights and played a key role in all of the fieldwork at Nam Sabi.

U Ohn Hlaing was the designated Village Leader of the VMA from Nam Sabi.. He was invaluable in the field. He cut line, identifiedtrees, and always came up with the shortest way back to the basecamp.

As shown in the photo above, the entire survey team included (back row ,l-r): Dr. Charles Peters (NYBG), U Naing Oo (Nam Sabi), U Ohn Hlaing (Nam Sabi), Daw Myint Myint Oo (WCS), Myo Myo Thi (cook), U Linn Zaw (Nam Sabi), Daw Aye Kyai (cook), Sein Day Li (WCS), Thei Thei Mu (cook), Myint Thein (Htamanthi WS), U Aung Kyi (Nam Sabi); (front row, l-r): U Aung Myint Sein (Nam Sabi), and U Sau Mon Htay (Forest Guard).

Additional staff (not pictured) who were part of the field crew during the November inventory included: U Kyaw Win (Ranger FD), U Yin Htan Sin Bay (Assistant Project Manager, WCS), U Han Sein Myint (Nam Sabi), U Ba Kyaing (Nam Sabi), U Than Tun (Nam Sabi), and U Moe Thu Aung (Chief Cook)

Methodology

The overall workflow at Nam Sabi was to first hold several community meetings to finalize the list of useful plant species (in both Myanmar and Shan language) and to select a suitable tract of forest within which to locate a 100 hectare Village Management Area (VMA). A basecamp was then constructed in the forest near the VMA site, and a 2.0 km long baseline was cut to demarcate the management area and to establish the starting points of the inventory transects. Finally, the transects were laid out and inventoried for all of the resources included in the list of useful plant species. The specific details of each of these field procedures are described below.

Selecting the Species

The initial list of the plant resources compiled for Nam Sabi during the May, 2014 visit (see *Community-Based Natural Resource Management: Data Collection in Nam Sabi and Training in Htamanthi, Sagaing Region, Myanmar*, June 2014) contained 40 species organized into five basic groups: 1) thatch (2 spp.), 2) timber (16 spp.), bamboo (3 spp.), rattan (2 spp.), and medicinal plant (17 spp.). This list was amended to produce a catalogue of species that more closely reflected the actual needs and patterns of resource use in the village, i.e. species of marginal utility or those that occur as only scattered individuals in the VMA forest were removed, and a few new species were added based on a general consensus of local value and abundance.

Locating the VMA

Several different locations were considered for the Village Management Area. We needed a tract of forest of at least 100 hectares that was not in area that would be cleared for farming. The site needed to be far enough from the village to avoid disturbance, yet close enough to the village to provide an accessible resource base that could be harvested and managed with relative ease. . Ideally, the area should be near enough to the boundary of the Htamanthi WS to be considered as part of the "buffer zone" habitat. There was a lengthy discussion during the community meetings about the location of a basecamp that would service field operations within the VMA. Some wanted to use the basecamp established during our last visit, while others opted to build a new facility that was closer to the forest where the inventories would be conducted.

Cutting the Baseline

The first step in establishing the management area was to clear a baseline along the northern boundary of the plot. The 100 hectare VMA measures 2.0 x 0.5 kilometers; the resultant baseline was 2000 m long and oriented due east. The coordinates of the first and last points on the baseline were recorded using a GPS device; the location of the remaining two corners of the area were determined by positioning a 100 hectare polygon on the satellite image of Nam Sabi and the Htamanthi WS using ArcGIS 10.

Using nylon transect ropes with knots tied at specified intervals to correct for slope (Peters, 1996), the field crews took a compass bearing and headed due east for 20 meters. Several crew members with bush knives went in front clearing the line to a width of about one meter to enhance visibility and open the way for the crewmember pulling the transect rope. The compassman was continually orienting the line clearers as they moved through the forest. On completing the 20m segment, a clinometer was used to take a slope reading, and, if necessary, a correction was made to adjust the actual distance traveled to 20 meters. A stake was then cut, planted, and flagged with orange plastic tape on which the stake number had been written in indelible ink. (see image, p.3).

The baseline proceeded East in 20 m increments; every 100 m a larger, pole-sized stake was set. These stakes represent the starting points for each of the twenty, 500 m long inventory transects that would later bisect the management area running north to south. To facilitate orientation within the area, the 20 transect stakes and the 80 baseline stakes were number consecutively in a nested sequence, i.e. 1.1, 1.2, 1.3, 1.4, **2** (transect stake), 2.1, 2.2, 2.3, 2.4, **3** (transect stake). Notes were recorded on the condition of the forest and photographs taken as the field crews moved eastward through the forest.

Running the Inventory Transects

A series of parallel, 10 meter wide inventory transects was run through the management area. [NOTE: The first two transects were sampled during the October 18 - November 1 fieldwork; the remaining 18 transects were completed by field crews from November 13 - November 27].. The transects were separated by 100 m to provide a constant sample intensity of 10%, i.e. 10 hectares of forest were surveyed. Each of the 500 meter transects was divided into twenty-five, 10 x 20 meter contiguous plots. By subdividing the transects into individual plots, the survey results provide a much higher degree of resolution about the actual floristic and structural changes that occur in the forest.

Starting from the transect stakes set on the baseline, a bearing of 180° was determined with a compass and the transect crews started clearing the line and pulling the transect rope. After traversing 20 meters, a stake was cut and a clinometer reading taken to see if a slope correction was needed. The plot stake was the set and flagged; the transect rope was left in place to mark the centerline of the plot. The overall workflow in the inventory was very similar to that used in laying out the baseline.

Within each plot, field crews carefully surveyed each side of the transect line looking for individuals of species on the survey list. Different types of data were recorded for different resource groups. Medicinal plants were only noted if present in a plot, bamboo culms were counted, and rattan canes were counted and assigned to 1.0 meter height classes. All timber trees ≧5.0 centimeters in diameter (DBH) were measured for diameter and commercial height (to the first branch or deformity) was estimated using a clinometer. In the case of border trees, alternative individuals were tallied, i.e. the first tree was recorded, while the second tree was considered "out". Observations on tree form and condition were recorded as appropriate.

Stand of taw-htan (Livistonia jenkinsiana Griff.) palms in the Nam Sabi Village Management Area.

U Myint Thein takes a bearing and Daw Myint Myint Oo tallies the data from transect 1.

With the objective of producing a forest type map of the Village Management Area, each plot was assigned to a habitat class based on the general condition of the forest. The six habitat classes used in the inventory were :1) closed forest, 2) closed forest with bamboo (*wa-net*), 3) taw-htan (*Livistonia jenkinsiana*) stand, yone (*Salacca secunda*) thicket, rattan thicket, and young secondary forest. In the order listed, the different habitats represent a gradient of canopy closure and light levels from closed forest (dark) to secondary forest (light). In the case of a change in forest type within a single plot, only the dominant habitat class was recorded.

Data Analysis

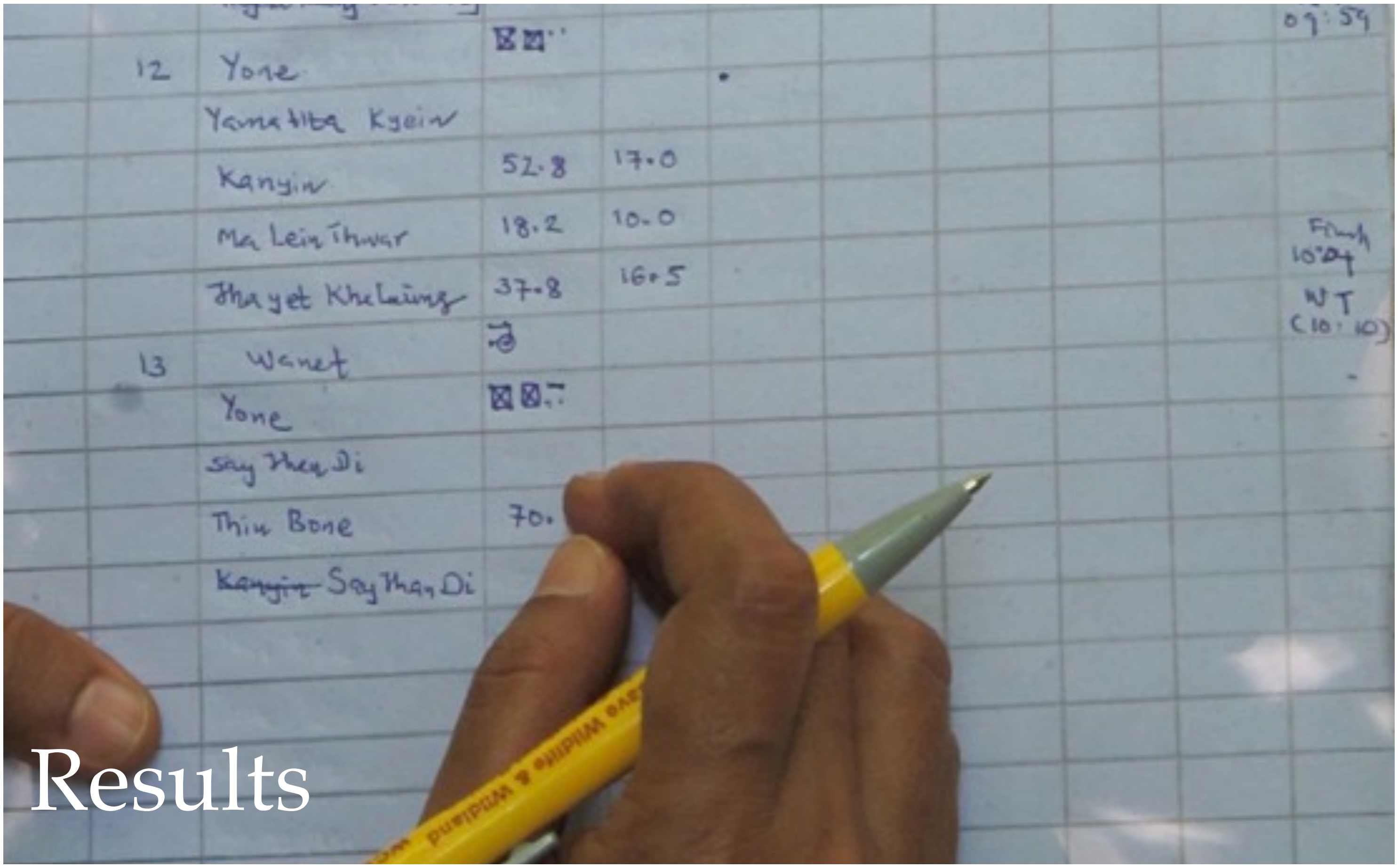
The plot results from the forest inventory were entered directly into an Excel spreadsheet soon after finishing the transects; the original tally sheets were safely archived. To obtain a clearer understanding of the phyto-sociology and distribution of dominance among different species on the site, Importance Value (IV) indices were calculated for all of the timber species based on the density, frequency, and basal area of each taxa. [NOTE: The Importance Value index is an estimate of the relative dominance of a species based on the number, spatial arrangement, and size of the different individuals in its population (Krebs, 1999)].

The commercial wood volume of each sample tree was calculated from the plot data using the general biometric equation:

Commercial wood volume (m^3) = basal area (m^2) x commercial height x 0.80 form factor

Basal area values were calculated from diameter measurements; commercial heights were taken from the clinometer readings. The form factor coefficient of 0.80 is a representative average for tropical trees (Lamprecht, 1989; Philip, 1994). Size-class histograms were also constructed for timber and rattan species with a sufficient number of individuals of varying size, and height X diameter and diameter X commercial volume scatterplots were constructed for many of the timber species as a first start in developing a volume table (Husch *et al*., 2003)] for the VMA.

Several maps were made to display the distribution of forest types throughout the management area, as well as the spatial distribution of timber, rattan, palm thatch, and medicinal plant resources. The maps were created using ArcInfo 10.1 and the plot results from the inventory transects. Habitat classifications, volume estimates, and stem counts were first plotted and then the resultant surface interpolated using the Inverse-Distance Weighted tool in Spatial Analyst.



Results

The results from the inventory work at Nam Sabi provide one of the most detailed, finely-grained descriptions of what a closed forest growing along the Upper Chindwin River looks like that has ever been collected. In terms of both forest ecology and resource management, these data are invaluable. The specific findings from the work are presented below in the following order: the plant names, the management area, and the current stock of the different resource groups surveyed.

Final List of Species

The final list of plant resources for the forest inventory contained 63 taxa: 27 timber species, , 2 species of palm thatch, 3 bamboos, 5 species of rattan, and 26 species of medicinal plants. These species are listed in the table to the right by local name and, if known, the scientific (Latin) name. Voucher specimens have been collected for many of the species, but until such time that all of the taxa have been collected and the material carefully reviewed, the taxonomic determinations in the table should be viewed as tentative. Nomenclature is based on Kress *et al*. (2003), and Hundley and Chit KoKo (1987).

Several points of interest should be noted in the table. First, and perhaps most important, no taxonomic information is available for 25 of the species, i.e. 39.7%, included on the list of

List of useful species (n=63) included in Village Management Area inventory at Nam Sabi; VMA column indicates whether species was encountered. All taxonomic determinations should be viewed as tentative.

Resource	Local Name	VMA	Scientifc Name
Thatch	Taw-htan	*	*Livistonia jenkinsiana* Griff.
	Yone	*	*Salacca secunda* Griff.
Timber	Ka-nyin	*	*Dipterocarpus* sp.
	Ka-nyin phyu	*	*Dipterocarpus* sp.
	Kha-laung	*	*Dysoxylum binectariferum* Hook f.
	Kyauk ka-nyin	*	
	Kyauk ta-mar		
	Lauk yar	*	*Schima wallichii* (DC) Korth.
	Ma-au-latlan	*	*Duabanga grandiflora* (Roxb. ex DC) Walpers
	Ma-lein-htwa	*	
	Ma-khone-phat		
	Mal-hau		
	Ma-u		*Neolamarckia cadamba* (Roxb.)

important plant resources for Nam Sabi. Even assuming that the tentative scientific names assigned to some of the plants based on local nomenclature prove to be correct, there is still a significant amount of plant collecting and species identification work that needs to be done in the VMA. This need is especially pronounced in the case of the timber trees, which are tall trees, frequently have small flowers, and are hard to collect, and the medicinal plants, many of which are small, herbaceous plants with scattered distributions that can be hard to find. [NOTE: The recent floristic work initiated by The New York Botanical Garden in the Htamanthi WS (see *Community-Based Natural Resource Management: Data Collection in Nam Sabi and Training in Htamanthi, Sagaing Region, Myanmar*, June 2014) will be invaluable in resolving these taxonomic deficiencies and providing a strong botanical foundation to the management operations at Nam Sabi].

Second, a majority of the forest resources contained on the list were actually encountered in the inventory transects . All of the palm thatch and bamboo species, over 60% of the timber and medicinal plant species, and two of the five local rattan species were recorded in the VMA. This is a good sign, because it suggests that the villagers selected an appropriate place within which to set up their management area.

Finally, the list of species compiled at Nam Sabi can be usefully compared to a similar list that was put together in 2009 to guide the inventory of a 100 hectare VMA at Shinlonga in the Hukaung Valley (see *Community-Based Natural Resource Management in the Hukaung Valley Wildlife Sanctuary: Phase 2*, December 2009). Based on identical methodologies, the Shinlonga list contained 14 timber species, 7 species of

Nam Sabi VMA forest showing thatch palms (yone) and bamboo (wa-net).

Table (con't).

Resource	Local Name	VMA	Scientific Name
Timber	Myauk-la-khauk		*Artocarpus chaplasha* Spreng.
	Ngu		*Cassia fistula* L.
	Shaw		*Sterculia angustifolia* Jack
	Taung-tha-pyay	*	*Syzigium diospyrifolium* (Wall ex. Duthie) S.N. Mitra
	Taw-sa-gar	*	*Polyalthia sp.*
	Taw-thayet	*	*Mangifera caloneaura* Kurz
	Tha-pyay		*Syzigium* sp.
	Tha-ti		*Disopyros kaki* L. f.
	Thayet kha-laung	*	
	Thin-bone	*	*Alstonia rostata* Fisch.
	Thit-ka-do		*Toona ciliata* M. Roemer
	Thit-nan	*	*Dalbergia nigrescens* Kurz
	Thit-see	*	*Melanorrhoea usitata* Wall.
	Ye-ma-ne		*Gmerlina arborea* Roxb.
	Ye-mein		*Aporosa* sp.
	Yway-ni-thar	*	*Adenanthera pavonina* L.
Bamboo	Myet-san-kyei	*	
	Wa-net	*	*Gigantochloa wanet* E.G. Camus
	Wa-ni-par	*	*Pseudostachyum polymorphum* Munro
Rattan	Kyein-ni		*Calamus guruba* Buch.-Ham.
	Kyet-au-kyein	*	*Calamus gracilis* Roxb.
	Taung kyein		*Calaums cf. wailong* S.J. Pei & S.Y. Chen
	Ya-ma-hta kyein	*	*Calamus palustris* Griff.
	Yei kyein		*Calamus floribundus* Griff.
Medicinal Plants	Ak-kyaw-paung-ta-htaung	*	*Aquilaria agalllocha* Roxb.
	Bon-ma-yar-zar	*	*Rauvolvia serpentina* (L.) Benth.
	Hin-pote-nwe	*	
	Htote-lin-sai	*	
	Ka-baung-nwe	*	*Strychnos sp.*

Large ka-nyin tree (Dipterocarpus sp.) encountered during the VMA inventory.

Last stake (for transect 20) on the baseline at the Nam Sabi Village Management Area.

Table (con't)

Resource	Local Name	VMA	Scientific Name
Medicinal Plants	Ka-baung-ye-kyi		*Strychnos potatorum* L.f.
	Kant-kaw-nwe		
	Kanyin-nwe	*	*Aleurites moluccana* (L.) Willd.
	Khwe-ee		
	Kyaung-sha		*Oroxylum indicum* (L.) Kurz.
	Kyaw-law-mei	*	
	Na-lin-kyaw	*	*Neolitsea lanuginosa* (Nees) Gamble
	Pwint-ma-kyay-say	*	
	Sa-nwin	*	*Curcuma* sp.
	Say-than-dai	*	
	Sin-done-ma-nwe	*	*Tinospora cordifolia* Miers
	Taw-say-palae	*	
	Than-da-hel		
	Thei-gyay-le-phone		
	Thin-bone-nwe	*	
	Thit-ka-doe-nwe		
	U-pa-tha-kar		*Hemidesmus indicus* (L.) W.T. Aiton
	Win-u		*Milletia eriocalyx* Dunn
	Win-thei-chay	*	
	Yar-nan-thet		
	Yar-tei-set	*	

medicinal plants, and only one commercial species of rattan,.i.e. pyant kyein or *C. palustris*, which also grows in the Nam Sabi VMA. While there are undoubtedly several factors at play here, the differences noted between the two villages are largely the result of the type of forest found at each site. The Shinlonga forest is relatively flat, soils are more poorly-drained and less fertile, and the overall species diversity is less than that observed in the Nam Sabi VMA. Not surprisingly, local ethnobotany and patterns of resource use are a direct reflection of the available resource base.

Village Management Area

A 100 hectare (2000 meters x 500 meters) management area was established in a hilly, well-preserved tract of forest located about 5.0 kilometers southeast of the village. The area is bisected by numerous streams, one of which, the hway taung kaw or taw-htan stream provides convenient access to the baseline and several of the transects. The topography is extremely steep in many parts of the VMA, and slopes in excess of 100% were occasionally measured when laying out the baseline and doing the inventory work.

A new basecamp was constructed to service operations in the village management area. The camp, a temporary structure constructed of split bamboo and plastic tarps, was located closer to the VMA than the basecamp used during previous fieldwork at Nam Sabi, and had the additional benefit of being right next to taw-htan stream so that water for cooking and bathing was easily accessible. From the basecamp to the northeast corner of the VMA and the baseline was about a 1.0 km walk.

Location of the 100 hectare Village Management Area (VMA) near the village of Nam Sabi in the Hkamti District of Sagaing Region. The eastern boundary of the VMA is about a kilometer from the Htamanthi Wildlife Sanctuary.

A satellite image showing the location of the VMA is provided above. The original baseline composed of the twenty transect stakes that was cut through the forest is shown as the white horizontal line running east and west along he northern boundary of the VMA. The first two “training” transects that were run during the initial fieldwork are shown as vertical white lines along the western border of the VMA. The upper, northwest corner of the area is georeferenced as N25.3176° and E95.35147° on the image. Open areas shown to the north and northeast of the VMA are the main ricefields for Nam Sabi; the boundary of the Htamanthi Wildlife Sanctuary is shown to the east and southwest of the VMA

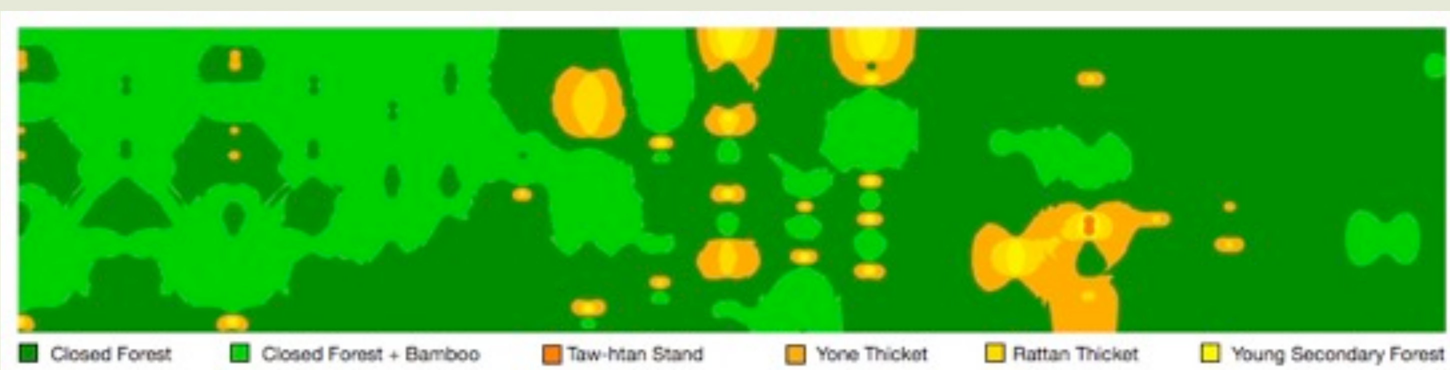
ForestTypology

As is shown in the forest type map below, the Village Management Area at Nam Sabi contains a course mosaic of the six different habitat classes. Closed Forest (61.08%), comprising over half of the VMA, is the most common class, followed by Closed Forest + Bamboo (31.17%), a similar habitat in which small gaps in the canopy are filled with clumps of bamboo. Both of these habitats exhibit a relatively closed canopy and a shady understory. The remaining four habitat classes, i.e. Taw-htan Stand (0.04%), Yone Thicket (5.43%), Rattan Thicket (1.7%), and Young Secondary Forest (0.6%), are much more restricted and occur as nested clumps in larger canopy gaps.

Interestingly, the spatial arrangement of these classes seems to clearly follow a light gradient.. The edges, or peripheries of the larger canopy gaps are mostly occupied by dense stands of yone palm (*Salacca secunda*), or Taw-htan (*Livistonia jenkinsiana*); both palm species are apparently intermediate in their its tolerance for shade.. Moving further into the center of a gap toward higher light levels thickets of ya-ma-hta kyein (*C. palustris*) and kyet-au-kyein (*C. gracilis*) develop. Both of these rattans are highly light demanding. Finally, the center of many of the larger canopy breaks are developing into Young Secondary Forests, with short-lived light demanding tree species starting to form a canopy and more shade-tolerant species moving into the understory.

The distribution and areal extent of different habitats in the VMA provide a preview of the type of management that will be needed to maintain the supply of important resources and to conserve the composition and structure of the forest. Over 90% of the forest in the management area is closed canopy, multi-storied, and mature (*sensu* Whitmore, 1998).. Light levels in the understory are characteristically low, and the species that regenerate in these environments, e.g. timber trees and some medicinal plants, are generally shade-tolerant, primary or late secondary species. Management operations will need to ensure that the canopy stays relatively closed, i.e. that only small gaps caused by the felling of individual trees are created, to facilitate the continual regeneration of these resources and to suppress the growth of light-demanding competitors.

The remaining area of forest is open to varying degrees and largely reflects the periodic occurrence of natural treefalls; a cumulative gap area of around 10% compares well with reports from other mature tropical forests around the world (e.g. Hartshorn, 1978). This stochastic, high-irradiance gap environment is where thatch



Forest type map of the Village Management Area (VMA) at Nam Sabi. Map based on 500 sample points located systematically along 20 parallel transects. Forest type contours interpolated using the Inverse-Distance weighted tool in Spatial Analyst.

palms and rattans and some medicinal plants thrive. Increasing the areal extent of canopy gaps, and perhaps some enrichment planting, will be required to increase the abundance of these resources. It should be noted that opening up a closed forest to let in more light is considerably easier and quicker from a silvicultural perspective, than trying to decrease excessive light levels in a forest subjected to high levels of disturbance. The forest mosaic represented by the Nam Sabi VMA seems ideally suited for sustainable forest use.

Timber Resources

The timber resources in the Village Management Area can be assessed in several ways. A table summarizing the main ecological characteristics of the 15 timber species recorded in the inventory as ranked by Importance Value is shown below. [NOTE: These data are the results from a 10 hectare sample of the VMA. To obtain an estimate of the total density or volume of a species within the entire management area, the tabular values should be multiplied by 10, e.g. there are an estimated 110 kha-laung trees representing a total of 270.3 m^3 of wood in the . 100 hectare VMA].

As is shown in the table, ka-nyin is by far the most abundant and dominant timber resource in the VMA. This species has the highest density, e.g. more than half of all the trees recorded were ka-nyin, the highest basal area, the highest Importance Value, and contains the largest volume of wood. It should be noted that this species was tallied in 259 of the 500 total plots, i.e. it is ubiquitous throughout the management area. Fortunately, ka-nyin is a desirable and much-used wood resource. The second most important species, thin-bone, occurs in significantly lower densities and exhibits an important value that is less than a third of that shown by ka-nyin. The total basal area and volume of thin-bone, however, is over half that of ka-nyin; most of the 61 individuals recorded in the inventory are all large-diameter trees. Thin-bone is also a desirable and commonly-used timber species.

The most sought-out and desirable timber tree of all, kha-laung, occurs at densities of only about one tree per hectare. Although the intensity of local harvesting may be partially responsible for the low density of this species, it seems likely that regeneration problems, perhaps tied to the stochastic occurrence of treefall gaps, may also play a role here.

The wood volumes shown for each species in the table were calculated based on diameter and height measurements. For some of the more abundant species, e.g. ka-nyin, thin bone, yway, and thayet kha-laung, scatterplots were made to examine the relationship between diameter and height, and an additional series of graphs showing the relationship between diameter and wood volume were also constructed. . The main

Ecological characteristics and volume of important timber species in the Nam Sabi Village Management Area. Values represent the results from 10.0 hectares of forest inventory; expand by 10 to estimate total density or volume of a species within the entire VMA. .

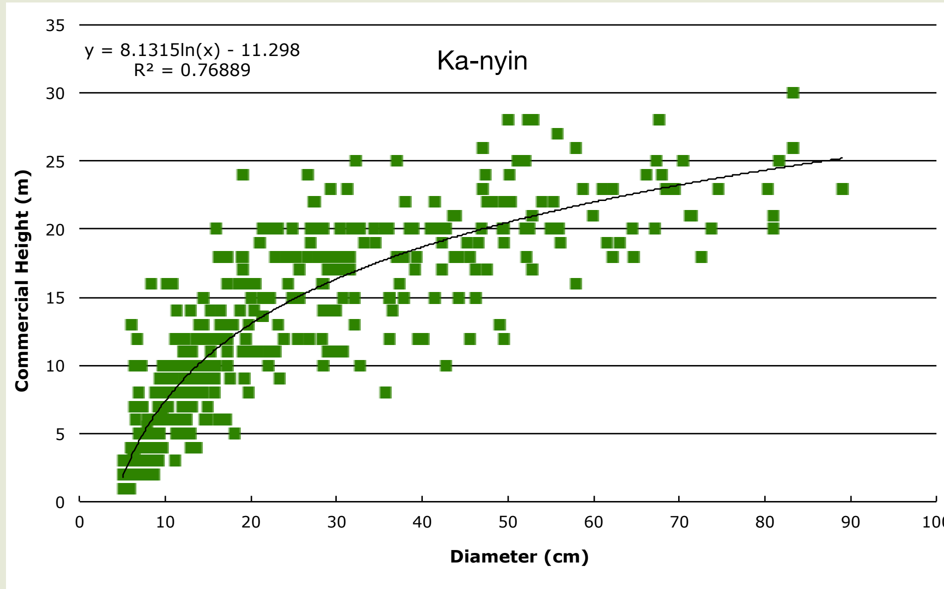
Species	Density	Basal Area (m^2)	Frequency	Importance Value	Volume (m^3)
Ka-nyin	394	30.76	259	146.45	481.85
Thin-bone	61	17.66	57	42.47	292.21
Yway	62	4.54	56	25.54	45.64
Thayet kha-laung	59	3.47	53	23.17	43.70
Ka-nyin phyu	27	9.15	22	19.91	180.43
Thit-see	23	3.58	22	12.15	46.91
Taw-sa-gar	8	2.18	8	6.62	37.99
Kha-laung	11	1.68	11	5.86	27.33
Ma-lein-thwar	13	0.32	13	4.78	2.67
Taung-tha-pyay	6	0.79	6	3.03	8.05
Taw-thayet	6	0.61	6	2.80	5.23
Ma-au-latlan	3	1.24	3	2.60	9.67
Lauk yar	3	1.18	3	2.52	15.23
Kyauk ka-nyin	2	0.38	2	1.16	3.98
Thit-nan	2	0.19	2	0.91	1.63
TOTALS:	680	77.74	529		1202.55

reason for doing this is that diameter (DBH) is a much easier and quicker parameter to measure than tree height. If a good relationship between diameter and height is detected for a species, tree height can be estimated based on a measurement of diameter. Additionally, if there is a strong relationship between diameter and wood volume, a regression equation can be used to estimate the volume of selected species based on diameter measurements alone. As can be appreciated, both of these allometric relationships, i.e. height:diameter and diameter:volume can be very useful management tools.

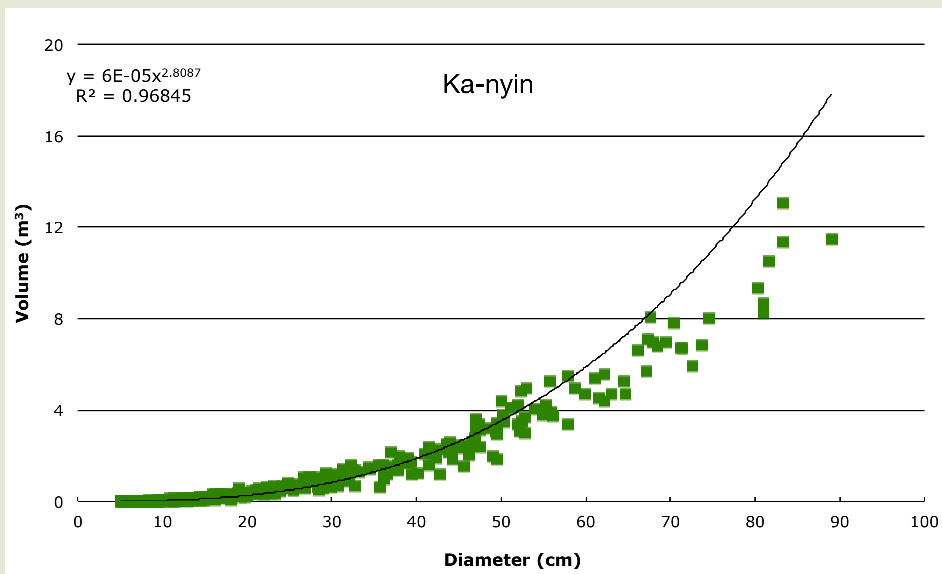
As illustrated by the two scatterplots for ka-nyin shown to the right, the height and diameter data collected during the Nam Sabi inventory are surprisingly robust. The top graph, which shows the observed relationship between height and diameter for this species, suggests that trees grow relatively fast in height up to a diameter of about 20 to 30 centimeters at which point the rate of height growth starts to slow down. The trendline offers a useful expression of the growth of ka-nyin trees as they move up through the canopy. Furthermore, the R^2, i.e. the coefficient of determination, produced by the regression equation suggests that this growth pattern explains the dynamics of over 75% of the trees measured. This level of correlation in biological data is rarely encountered, and it says a lot about the care and precision with which the growth measurements were collected.

The lower graph, produced by calculating the wood volume of each tree based on height, diameter, and taper, shows that the diameter of a ka-nyin tree is also closely related to total wood volume and that, as such, diameter measurements offer a useful surrogate for estimating this important parameter. It is worth noting how well the data points conform to the trend line and the incredible precision of the coefficient of determination calculated for the power function regression line. The is little question that the total wood volume of a ka-nyin tree can be reasonable estimated by measuring its diameter.

The relationship between diameter and volume was also quite good for several of the other timber species. Reasonable diameter/volume equations were calculated for: 1) ka-nyin phyu, n=27,$y=0.0001x^{2.58}$, $R^2=0.968$; 2) kha-laung, n=11, $y=0.0002x^{2.4343}$, $R^2=0.9594$; 3) ma-lein thwar, n=13, $y=0.000002x^{3.1078}$, $R^2=0.9606$; 4) thayet kha-laung, n=59, $y=0.000008x^{2.6912}$, $R^2=0.9702$; 5) thin-bone, n=61, $y=0.0001x^{2.5684}$, R^2=0,9705; 6) thit-see, n=23, $y=0.0003x^{2.3521}$, $R^2=0.8948$; and 7) yway, n=62, $y=0.0001x^{2.4957}$, R^2=9239. All equations are second-order power functions where y = volume, x=diameter, the first coefficient is the *y-intercept*, and the second coefficient, the exponent, is the *slope* (Sokal and Rohlf, 1981). Diameter measurements are entered in centimeters (DBH); volume estimates are calculated in units of cubic meters.



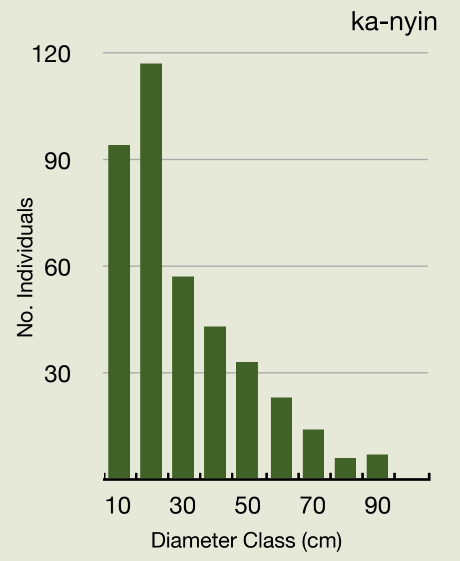
Scatterplot showing relationship between diameter (cm DBH) and commercial Height (m) for 394 kanyin trees measured in Nam Sabi VMA. Trendline is logarithmic; R^2 shows goodness-of-fit of equation and trendline.



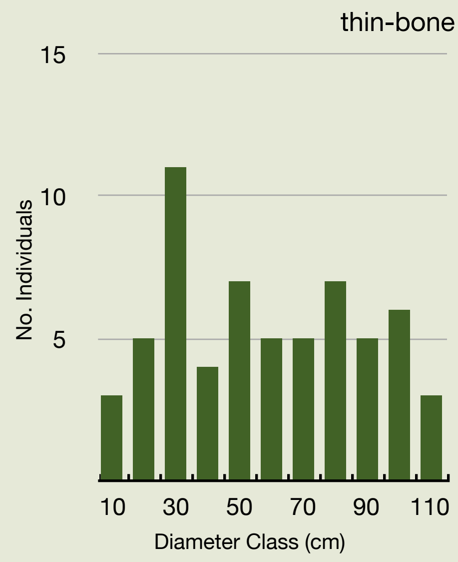
Scatterplot showing relationship between diameter (cm DBH) and wood volume (m^3) for 394 kanyin trees. Trendline is a power function.; R^2 shows goodness-of-fit of equation and trendline.

The timber resources growing in the VMA can also be assessed by looking at the degree to which different species are replacing themselves in the forest. This information is very important from a management perspective, perhaps more so than the actual composition of the current growing stock, because it provides some indication of how the composition of the forest might change and what future yields might look like. This type of analysis is also very useful to highlight which species are in the greatest need of management interventions to insure a continual flow of wood products.

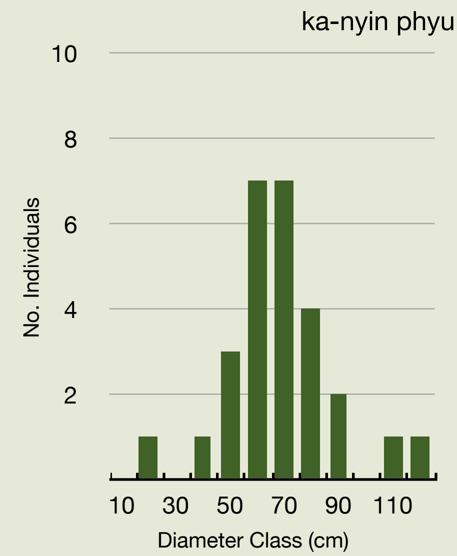
Size-class histograms showing the number of individuals in each of a series of sequential diameter classes provide a useful way to look at the regeneration success of a species. Different species vary in the abundance and periodicity of seedling establishment they experience, and



Size-class histogram for ka-nyin. Data are from a 10% sample of the VMA; expand by a factor of 10 for size-class totals for the entire area.



Size-class histogram for thin bone. Data are from a 10% sample of the VMA; expand by a factor of 10 for size-class totals for the entire area.



Size-class histogram for ka-nyin phyu. Data are from a 10% sample of the VMA; expand by a factor of 10 for size-class totals for the entire area.

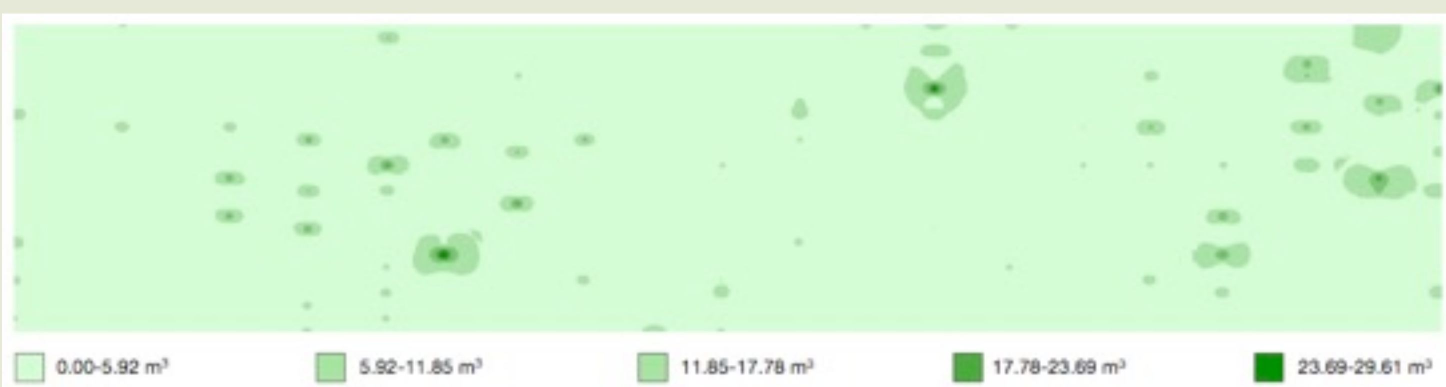
changes in levels of recruitment become apparent when the overall distribution of individuals within a population is graphed. Seedling establishment may be continual, i.e. each year, periodic, i.e. every couple of years, or infrequent or non-existent due to some ecological constraint.

One example of a tree population which appears to experience regeneration on a more or less continual basis is provided by the size-class histogram for ka-nyin shown above. The population structure of this species closely approximates a negative exponential distribution , i.e. one with more individuals in the larger size classes than the smaller size classes. [NOTE: A negative exponential distribution is considered by many authors (e;g; Leak, 1964; Peters, 1996) to be the ideal for stable, self-maintaining plant populations]. Based on its size distribution, the ka-nyin populations appears be recruiting seedlings every year such that the inevitable mortality of trees in the larger size classes is replaced by the in-growth of individuals in the smaller size classes.

The size distribution for thin-bone , shown in the middle histogram, suggests a different recruitment dynamic; note change of scale on the y-axis. This species appears to be regenerating itself in the VMA, but only sporadically, and there are distinct peaks and valleys in the size-class histogram. In all probability, the periodicity of seedling recruitment exhibited by this species is somehow linked to treefall gaps and increased light availability for seedling development.

A third type of diameter distribution is offered by ka-nyin phyu (upper right histogram ; note scale change on the y-axis. This species exhibits a very small number of individuals in the smaller size classes and most of the population occurs as large trees in the 50 to 90 centimeter diameter classes. Apparently, most of the population was recruited decades ago, and since that time the species has had difficulty getting its seedlings established. This is worrisome, because once the large individuals are either harvested or die, the probability of seedling recruitment will decrease even further.

An additional way to evaluate the timber resources in the VMA is to look at the spatial distribution of wood volume throughout the area. By taking the volume totals from each sample plot (n=500; 25 plots per transect x 20 transects), plotting the values using ArcGIS, and then interpolating between the points, a timber map showing contours of wood volume was constructed. As can be appreciated in the map shown below, there is a low-level foundation of timber volume (up to 5.92 m^3/200 m^2 plot; shown as light green) extending throughout the



Spatial distribution of timber volume throughout the 100 hectare Village Management Area at Nam Sabi. Wood volume calculated using diameter (basal area) and height measurements and an estimated taper coefficient of 0.80. Color ramp based on interpolation of inventory results from 200 m^2 plots, i.e. values represent timber volume / 200 m^2.

management area interspersed with islands of higher volume (usually clumps of tall, large diameter trees, e.g. ka-nyin phyu and thin-bone). The densest of these volume clumps may contain almost 30 m^3 of wood; the even, 2.0 - 3.0 m^3 of wood per plot baseline is largely the result of the homogenous distribution of ka-nyin.

It is noteworthy, and of great relevance to timber harvesting within the VMA, that many of the high volume pockets of timber are located in the extreme eastern part of the management area. These tracts of forests are the furtherest away from the village and are somewhat difficult to access. The fact that there are still many clumps of large diameter timber trees here may largely reflect the operational difficulty of getting sawlogs out of this part of the forest. ,

The preceding analyses have all focused on the current *stock* of forest resources in the VMA.. From a sustainability perspective, however, a parameter of even greater importance is the growth or annual *yield* of timber from the forest.How much new wood is produced by the timber trees in the 100 hectare management area each year? How does this volume increment vary from species to species and what effect does harvesting have on the growth of residual trees? The answers to these questions will ultimately be used to define a sustainable rate of timber harvest from the management area at Nam Sabi.

As a first approximation of what the annual yield of timber might be from the Nam Sabi VMA, a simple stand table projection was performed using the inventory data and a composite height/diameter curve constructed using the measurements for all sample trees. [NOTE: A stand table projection uses the existing stock of timber in a forest and "grows" it for a year. The difference between the original volume and the volume calculated for YEAR 1 represents the estimated volume growth of the stand (Husch *et al*., 2003)]. An estimated annual diameter increment of 0.5 cm was assumed for all species based on preliminary data collected from the eight trees at Nam Sabi that were initially fitted with dendrometer bands in May 2014 (see *Community-Based Natural Resource Management: Data Collection in Nam Sabi and Training in Htamanthi, Sagaing Region, Myanmar*; June 2014 and later section on Tree Growth). Height growth was estimated by calculating commercial height for the new diameter of each tree using the equation derived from the height/diameter curve, i.e. $y=7.2408(\ln x)-9.4507$; $R^2=0.667$. A YEAR 1 volume was then calculated by using the new diameter, i.e. basal area, and commercial height of each tree, multiplying the two parameters, and then summing the results.

The results from the stand table projection suggest that the 100 hectare Village Management Area could produce almost 160 m^3 of wood/year.. About 25% of the new wood growth is produced by ka-nyin, an additional 25% is produced by thin-bone (which has fewer trees growing in the VMA but many of them are very large), and the remaining 50% of the wood production is divided among the other 15 timber species.

It is important to emphasize that these rough estimates are subject to several sources of error. The assumed growth rate of 0.5 cm/yr, while reasonable for tropical trees (Lamprecht, 1989), may be a clear overestimate given the open canopy condition of most of the original group of sample trees. Additionally, the diameter/height curve displays a considerable amount of variability as indicated by the moderate coefficient of determination (R^2) of the regression line. [NOTE: Occasionally, the new height calculated using the regression equation was less than the actual height of the tree. In these cases, commercial height was held constant, i.e. no height growth was assumed for the tree]. It is clear that a larger sample of height and diameter measurement are needed and that the actual size-specific diameter growth of all the timber species in the VMA need to be quantified over several years.

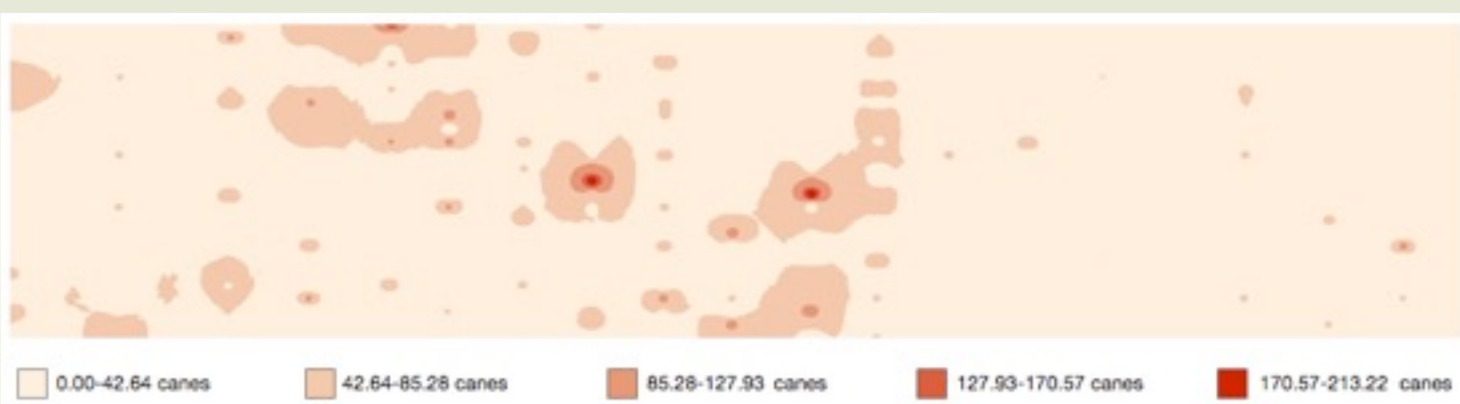
These caveats notwithstanding, the results from the stand table projection are useful because they highlight the great potential of the Village Management Area. The VMA contains a considerable amount of timber, these resources could be harvested and managed to produce a sustained-yield flow of wood products, and 100 hectares seems to be an appropriately-sized resource base to satisfy the annual demand for timber by the residents of Nam Sabi.

Bamboo

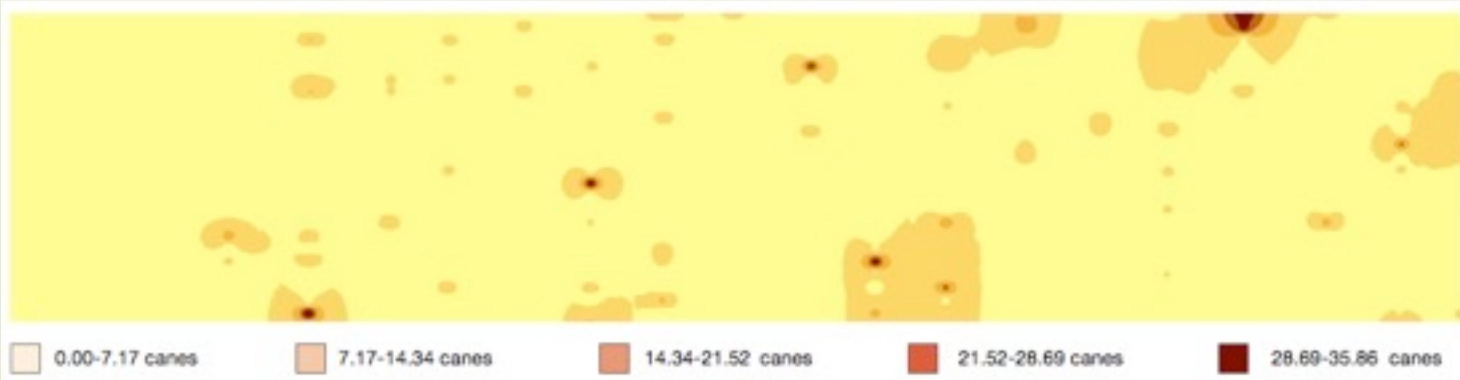
There is a lot of bamboo in the VMA, and wa-net, wa-ni-par, and myet-san-kyei culms were all encountered in the inventory transects. Of the 11,635 bamboo culms recorded, however, over 98% was wa-net.

Using the plot data and the GIS for the management area, resource-density contour maps (such as previously presented for timber) were constructed for bamboo (all species combined). The results are shown in the map below. As can be appreciated, there are very few areas in the VMA that don't have bamboo. Most of the area contains a low-level density of about 20 culms/plot, there are several large expanses of forest with 50 - 60 culms/plot, and a few dense patches exhibit over 200 culms/plot, i.e. one bamboo culm in every square meter.

Interestingly, the bamboo resource has a spatial distribution that is almost a mirror image of that of timber. For example, most of the high volume patches of timber are found in the eastern part of the VMA, while the densest stands of wa-net are located more centrally in the management area. .This pattern is undoubtedly a manifestation



Spatial distribution of bamboo culms throughout the 100 hectare Village Management Area at Nam Sabi. Color ramp based on interpolation of inventory results from 200 m^2 plots, i.e. values represent number of bamboo culms/200 m^2.



Spatial distribution of rattan canes throughout the 100 hectare Village Management Area at Nam Sabi. Color ramp based on interpolation of inventory results from 200 m^2 plots, i.e. values represent number of rattan canes/200 m^2.

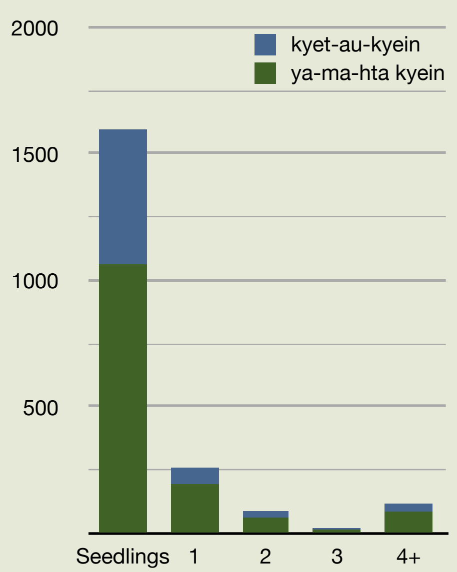
of the sharing of light resources. Bamboo, which requires a lot of light, does not grow well in the shade of large timber trees.

Rattan

Although densities are not as high as that of bamboo, there is also an abundance and a relatively even distribution of rattan cane throughout the VMA. Densities range from an average of about 3 - 4 canes/plot to small thickets that may contain over 30 canes/plot. The areal distribution of the rattan resource in the village management area is shown in the map above. Like bamboo, rattan is also a light demanding plants that grows best in relatively open forest. Careful comparison of the contour maps for timber, bamboo, and rattan, reveals that these three resources seem to partition the light environment within the VMA, neither resource occurring in high densities in the same area as another. For example, if you have high densities of rattan, you have low densities of bamboo, and conversely, high densities of timber invariably resulted in low densities of both bamboo and rattan.

Stems counts alone are somewhat misleading for the rattan resources in the VMA, because the great majority of the canes recorded in the inventory are of pre-commercial size, i.e. less than 4 m long. This pattern is illustrated in the histogram to the right that shows the size-class distribution of kyet-au-kyein and ya-ma-hta kyein. The distributions of both species conform to a negative exponential, i.e. a lot more small individuals than big individuals ; the slight peak in the 4+ m class is an artifact of lumping all of the canes longer than 4 meter into a single class. What this means from an operational standpoint is that both species are vigorously regenerating themselves in the forest, but there is currently a shortage of long, commercial canes. Only 87 harvestable ya-ma-hta kyein canes were encountered, and only 30 commercial-length kyet-au-kyein canes were recorded.

The rattan resource will clearly need to be managed to increase local abundance. Fortunately, rattan grows all over the VMA and efforts to promote the growth of selected large clumps would gradually spread as periodic timber and bamboo harvests create patchy canopy conditions. Any of the small dark-brown clumps of rattan shown on the resource-density map (above) would be ideal locations for initiating this type of management activity. The main objective would be to refrain from harvesting these clumps while the canes continued to grow, set seed, and produce new sprouts. Rattan could be carefully harvested from other clumps to satisfy the village need for cane until such time as rattan stocks within the VMA had recovered. Both ya-ma-hyta kyein and kyet-au-kyein are clustering rattans (Henderson, 2009), and controlled harvesting of these species would involve, for example, not clearing all of the stems to gain access to the merchantable cane, and always making sure to leave several healthy pre-commercial canes per clump (Peters and Henderson, 2014).

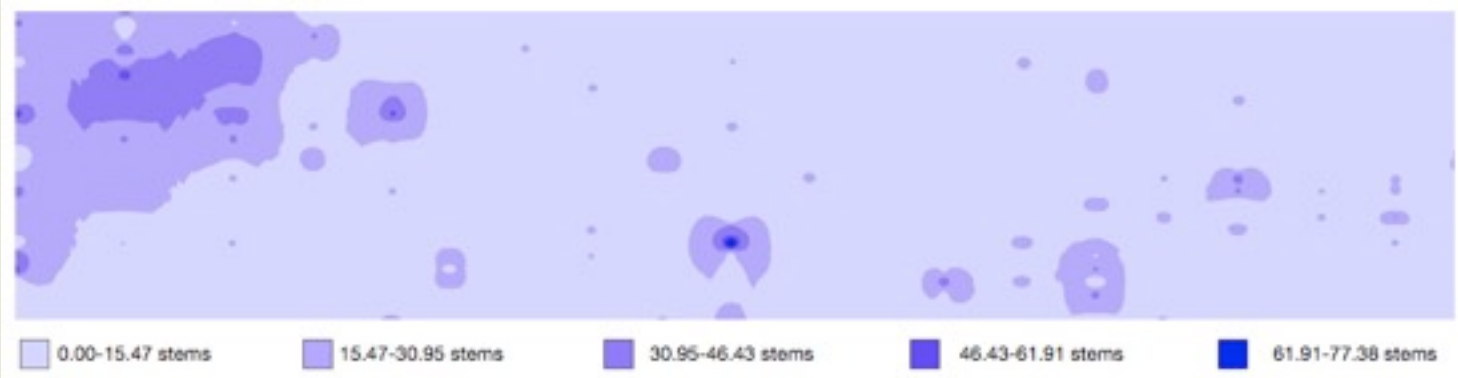


Size-class distribution of rattan canes recorded in the VMA inventory; values represent number of canes in 10.0 hecatres.

Thatch

Both taw-htan and yone palms occur in appreciable densities in the VMA, but yone is clearly the most common and widely distributed. [NOTE: Taw-htan leaves are much more desirable than yone leaves as thatch, especially young yone leaves, because the leaves last longer and don't have to be replaced as frequently]. Both species form dense communities that were identified as distinguishable habitats during the inventory and mapped as forest types (see map p.9). Taw-htan forms small, isolated stands of a few large palms,

Leaf and stems of yone palm (Salacca secunda Griff.) a common source of thatch for roofing.



Spatial distribution of palm thatch throughout the 100 hectare Village Management Area at Nam Sabi. Color ramp based on interpolation of inventory results from 200 m^2 plots, i.e. values represent number of taw-htan and yone palms/200 m^2.

while yone can form either a high-density thicket or occurs as scattered individuals along the periphery of canopy gaps. As is shown in the resource-density contour map above, yone palms occur at relatively low but constant densities of about 10 stems/200m^2 throughout the VMA and may form thickets containing almost 80 stems/200m^2 in selected areas.

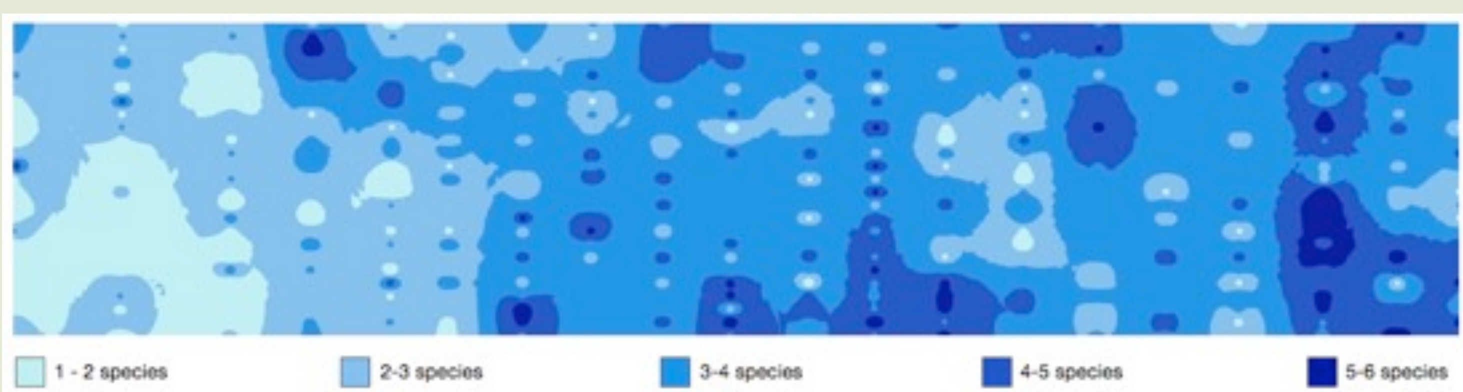
Medicinal Plants

A total of 16 species of medicinal plants were recorded in the inventory. As is shown in the table to the right, say-than-dai was the most frequently encountered species (n=304 plots), followed by na-lin-kyaw (n=239 plots), kyaw-law-mei (n=223 plots, and kanyin-mwe (n=125 plots). Htote-lin-sai (n=3 plots) was the most rarely encountered medicinal plant. Although the overall pattern shown by these data offers a useful picture of the relative abundances of different taxa, suffice it to say that locating small medicinal plants in a forest inventory is very difficult.

Number of plots in which different species of medicinal plants were recorded in the 100 hectare Village Management Area at Nam Sabi.

Species	No. Plots	Species	No. Plots
Ak-kyaw-paung-ta-htaung	50	Pwint-ma-kyay-say	107
Bon-ma-yar-zar	53	Sa-nwin	46
Hin-pote-nwe	16	Say-than-dai	304
Htote-lin-sai	3	Sin-done-ma-nwe	116
Kabaung-nwe	115	Taw-say-palae	71
Kanyin-nwe	125	Thin-bone-nwe	16
Kyaw-law-mei	223	Win-thei-chay	63
Na-lin-kyaw	239	Yar-tei-set	19

A resource-density contour map for medicinal plant resources within the VMA is provided below. It is important to note that the map is displaying the number of taxa encountered in each plot, i.e. the species richness, not the number of stems or individuals counted as presented for the other resource groups. That said, it is clear that there are a lot of species of medicinal plants in the VMA, and they are spread out all over the area. It is of interest that the highest diversities of



Spatial distribution of medicinal plant species throughout the 100 hectare Village Management Area at Nam Sabi. Color ramp based on interpolation of inventory results from 200 m^2 plots, i.e. values represent number of medicinal plant species/200 m^2.

medicinal plants are found in the tracts of closed forest located along the eastern border of the VMA. A lower species richness of medicinal plants is found in the plots located in the closed forest + bamboo habitat found in the western quarter of the area.

Growth Studies

After quantifying the number and size of individuals within a particular resource group, the next critical step in the sustainable management of that resource is to determine how fast different individuals grow each year, i.e. the size-specific, annual growth rate. This is the number that will ultimately determine how much of a particular resource can be harvested from the forest each year.

As a means of starting to collect these important baseline data, during the second forest inventory period (November 13 -November 27), field crews affixed stainless-steel dendrometer bands around 82 timber trees of varying diameter and representative of 13 different species in the VMA. [NOTE: See *Community-Based Natural Resource Management: Training and Data Collection in Tikon, Naga Self-Administered Zone, Myanmar;* December 2013, and *Community-Based Natural Resource Management: Data Collection in Nam Sabi and Training in Htamanthi, Sagaing Region, Myanmar;* June 2014 for additional details on the construction and use of dendrometer bands to measure tree growth]. The sample trees were located in the more westerly transects in the VMA, i.e. transects 3 to 13, to facilitate access and re-location for reading the bands in November 2015.

The diameter (DBH) and crown class, i.e. dominant, co-dominant, suppressed, of the growth trees are presented in the table to the right. The growth study offers a representative range of species and diameters, and the field crews are to be congratulated for taking the time and effort to fit a band around a 95.7 cm diameter thin-bone tree. The re-measurement of these trees will provided invaluable data on the growth and yield of the timber resources in the VMA and allow the calculation of an annual rate of sustainable timber harvest.

During a previous trip to Nam Sabi in May of 2014, nine trees were banded as a training exercise (see *Community-Based Natural Resource Management: Data Collection in Nam Sabi and Training in Htamanthi, Sagaing Region, Myanmar*; June 2014; p.9. for information on the species, size, and location of these trees). Although only five months had passed since the trees were banded, all nine trees were located and the bands were re-measured on eight of them (the spring was missing on one tha-pyay tree) . The

Species, diameter (DBH), and crown class (CC) of timber trees fitted with dendrometer bands to measure growth in the Village Management Area at Nam Sabi. Crown classes: C=Co-dominant, D=Dominant, and S=Suppressed.

Species	DBH	CC		Species	DBH	CC
Ka-nyin	6.4	S		Taung-tha-pyay	35.9	S
Ka-nyin	12.2	S		Taung-tha-pyay	40.2	S
Ka-nyin	16	C		Taung-tha-pyay	40.2	C
Ka-nyin	20	C		Taung-tha-pyay	46.8	C
Ka-nyin	23.1	C		Taw-sagar	57.7	D
Ka-nyin	27.3	C		Taw-thayet	17.1	S
Ka-nyin	29.3	C		Taw-thayet	85	D
Ka-nyin	32	C		Thayet kha-laung	11	S
Ka-nyin	32.1	C		Thayet kha-laung	11.1	S
Ka-nyin	32.6	S		Thayet kha-laung	13.8	S
Ka-nyin	37.8	C		Thayet kha-laung	13.8	S
Ka-nyin	46.5	D		Thayet kha-laung	18.4	S
Ka-nyin	50	C		Thayet kha-laung	20.8	C
Ka-nyin	52.1	C		Thayet kha-laung	21.5	S
Ka-nyin	67.6	D		Thayet kha-laung	25.2	C
Ka-nyin Phyu	51.4	C		Thayet kha-laung	28.7	S
Ka-nyin Phyu	65.5	D		Thayet kha-laung	32.6	D
Kha-laung	13.5	S		Thayet kha-laung	41.3	C
Kha-laung	20.7	S		Thayet kha-laung	54	C
Kha-laung	23	C		Thin-bone	14.9	S
Kha-laung	35	D		Thin-bone	15.7	S
Kha-laung	45.2	D		Thin-bone	27.1	S
Kha-laung	69.2	D		Thin-bone	27.4	C
Kyauk ka-nyin	51.6	C		Thin-bone	29.7	S
Ma-lein-htwa	17.3	C		Thin-bone	33.2	D
Ma-lein-htwa	20.2	S		Thin-bone	37.7	S
Ma-lein-htwa	22.3	S		Thin-bone	44.1	C
Ma-lein-htwa	23.1	C		Thin-bone	45.4	C

results were surprising–and encouraging, to say the least. During the five month period, for example, one 37.6 cm DBH thin-bone tree had grown 0.72 cm in diameter, for an estimated annual growth rate of 1.7 cm, and a large (72 cm DBH) Ma-u tree had grown 1.37 cm in diameter for an estimated annual growth rate of 3.3 cm.. Taken together, the eight trees exhibited an estimate annual growth rate of 1.42 centimeters/year. Although none of these individuals were growing in shady, closed forest conditions together with other canopy trees, suffice it to say that it will be very interesting to review the growth data collected from the 82 sample trees banded in the VMA.

Finally, the 15 trees banded outside of the village of Tikon were also re-measured during this trip. These trees were banded in late October of 2013 and re-measured almost exactly a year later on October 29, 2014 (see *Community-Based Natural Resource Management: Training and Data Collection in Tikon, Naga Self-Administered Zone, Myanmar*, December 2013; p. 9 for details on these sample trees). One of the tree species banded at Tikon, thit-nan, is also found in the VMA. The average annual diameter growth of the two thit-nan trees banded at Tikon (one 80.3 cm DBH and the other 31.8 cm DBH) was 0.78 cm/year. In all probability, the 0.5 cm growth rate used in the stand table projection (p.13) may actually be quite reasonable.

Table (con't)

Species	DBH	CC		Species	DBH	CC
Thin-bone	48.8	D		Yway	15.4	S
Thin-bone	53.1	D		Yway	18.2	S
Thin-bone	57.5	C		Yway	19.1	S
Thin-bone	71.8	C		Yway	19.8	C
Thin-bone	93.4	D		Yway	21.3	S
Thin-bone	95.7	D		Yway	21.5	S
Thit-nan	20	S		Yway	31.6	C
Thit-nan	44.8	S		Yway	32.4	C
Thit-see	24.4	S		Yway	32.6	C
Thit-see	28.5	C		Yway	38.6	S
Yway	9.4	S		Yway	39.9	S
Yway	11.8	S		Yway	46.7	C
Yway	13.1	S		Yway	66.4	C

Daw Myint Myint Oo (WCS) and U Linn Zaw (Nam Sabi) carefully review the caliper before recording the diameter increment of the kyauk ta mar tree outside of Nam Sabi that was fitted with a dendrometer band (shown upper right). [NOTE: The tree had grown 0.37 cm in diameter in the five months since the band was placed around the tree].

Next Steps

The fieldwork at Nam Sabi is a major step forward in establishing a viable program of community-based natural resource management. We now have a very good idea about the actual resource supply and demand dynamics for the village, a 100 hectare management area has been delineated, and one of the most intensive and detailed community inventories of timber and non-timber resources ever conducted in Myanmar has been completed. There is now an official Natural Resource Management (NRM) committee in Nam Sabi, capable field crews of villagers have been trained in the mechanics of forest inventories and yield studies, and good collaborative partnerships have been developed with local Forest Department personnel. Clearly, many of the pieces of the CBNRM vision are falling into place at Nam Sabi, but there are still several critical steps that need to be taken. These are listed below.

1. The boundaries of the Village Management Area should be "officially" demarcated. The village NRM committee and representatives from the Forest Department, the Nature and Wildlife Conservation Division, and WCS should ideally be involved in this activity. The original line cut for the baseline (northern E-W boundary), transect 1 (western N-S boundary), transect 20 (eastern N-S boundary), and the final flags on plot 25 from all of the transects (southern E-W boundary) are useful guides for this boundary demarcation exercise.

2. Discussions with the village Natural Resource Management committee should be initiated to start figuring out the rules and regulations governing the use of forest resources within the VMA. Once the allowable harvest of a given resource group has been defined, e.g. timber, rattan canes, or bamboo, who will be allowed to exploit this material? What systems will be put in place to avoid elicit or uncontrolled harvesting? What are appropriate sanctions for different infractions and how will they be levied? The annual harvest of material from the VMA will also need to be carefully recorded as part of a village-based monitoring system. . Additionally, the monitoring system should include a network of permanent sample plots to assess changes in the structure and composition of the forest over time.

3. During talks with the village, promising local entrepreneurs should be identified and ideas for small-scale forest or agro-forestry enterprises should be solicited. The development of local enterprises based on the forest resources produced sustainably in the VMA should be a key component of the community forestry activities at Nam Sabi.

4. Using the baseline data collected during the initial village surveys, the VMA inventory, the boundary demarcation, and the administrative framework developed by the village NRM committee, WCS, NYBG, and the village should collaboratively develop a detailed management plan for the VMA. This plan should: 1) outline the actual village demand for forest resource– and perhaps the external market demand for the resources that would be developed as part of a local enterprise, 2) describe the actual stock of plant resources currently found in the VMA, 3) estimate the annual growth of different resources of importance and define an annual sustainable harvest level for each one, 4) explain the systems that have been put in place to insure that harvests are controlled and conform to the annual, sustainable yield, and 5) provide an overview of the monitoring system, both in the village and in the forest, that has been developed to assess the ecological, economic, and social impacts of forest use within the Village Management Area.

5. Apply for a Community Forestry Certificate for Nam Sabi to insure the long-term stability of their CBNRM activities. and guarantee the permanence of their forest stewardship.

These five steps represent a critical part of the implementation phase of the community-based natural resource management efforts in Nam Sabi. **We have collected the necessary baseline data, and now we need to work with the village to develop a detailed plan of operations about how they will actually use, manage, and conserve their 100 hectare management area. The village has an unprecedented opportunity here, and there is much that can be learned–all of it of unquestionable policy relevance–from what happens next.**

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Field crew taking a break from running the baseline at the Nam Sabi Village Management Area. From l-r: U Myint Thein (Htamanthi WS), U Aung Kyi (Nam Sabi), U Sein Day Li (WCS), U Ohn Hlaing (Nam Sabi), U Aung Myint Sein (Nam Sabi), U Naing Oo (nam Sabi), Daw Myint Myint Oo (WCS), Dr. Charles Peters (NYBG), and U Linn Zar.