RAPID ASSESSMENT OF THE AGGREGATE LENGTH AND VOLUME OF RATTAN AND OTHER CLIMBERS IN NATURAL TROPICAL FORESTS

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ABSTRACT

This paper presents methods for rapid assessment of the aggregate length and volume of rattan and other climbers, based on line intersect sampling (LIS) and fixed-area plots. The methods include sampling climber canes using LIS, which is a significant contribution, and climber regeneration using fixed-area plots. The methods were developed as part of an International Tropical Timber Organization (ITTO) project in Thailand. The LIS method is illustrated with an artifical data set.

Keywords: Rattan inventory; line intersect sampling, climbers

INTRODUCTION

Climbers are an important biodiversity component of the natural tropical forests. Some of the climbers, such as rattan, which we shall use for illustration in this paper, are economically important. Rattanís flexible canes are used to manufacture highly priced furniture items, and some young shoots are edible. Rattans are recognized as spiny palms with scaly fruits; most have long flexible climbing stems and others are non-climbing. They may grow in clumps or solitary state, and some young climbers may be initially erect. There are about 50 species of rattan occurring in Thailand in swamp, evergreen, dry evergreen, and mixed deciduous forests at elevations of up to 1,000 m (Bhodthipuks and Ramyarangsi, 1987).

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One common approach to inventory rattan in the tropics is to use fixed-area plots (Evans and Oulathong, 2001; Nur Supardi, *et al.* 1999; Williams, *et al.* 1999). However, this approach, while suitable for estimating seedling and erect rattan density, can be quite time-consuming for estimating rattan length or volume.

We present in this paper a rapid sampling method for assessing the aggregate length and volume of rattan and other climbers, based on line intersect sampling (LIS) theory (see, e.g., Kaiser, 1983). In forestry, the LIS was developed to efficiently estimate the volume of coarse woody debris (CWD) left after logging (Warren and Olsen, 1964). Our adaptation of the LIS method to estimate rattan length and volume follows the CWD application. This application of LIS to inventory rattan and other climbers, while it seems intuitively obvious, has not been published before.2

The methods described in this paper were developed as part of the International Tropical Timber Organization (ITTO) Project PD 2/99 Rev. 2 (F) (Thailand). The objective of this ITTO project was to develop efficient techniques for monitoring Thailandûs national forest resources. The forest resources to monitor included timber and non-timber forest products (NTFPs). Further details on this project are available in the Royal Forest Department of Thailandûs World Wide Web site (www.forest.go.th).

ASSESSMENT METHODS

Previous approaches to inventory rattan used one common fixed-area plot to estimate various attributes of the resource. We adopted a mixture of methods to sample seedling, climbing and erect rattan and other climbers (Table 1; Figure 1).

Table 1 Sampling methods for rattan in Thailand

Data Gathered	**Sampling Method**			
	Method	**Number**	**Radius (m)**	**Total Area**
Seedling (<1.3m tall) density	Fixed-area plot	4	0.631	0.0005 ha
Erect rattan (≥ 1.3 m tall) density, length or volume	Fixed-area plot	1	12.62	0.0500 ha
Climbing rattan length or volume	Two, 17.84-m long line-intercepts			

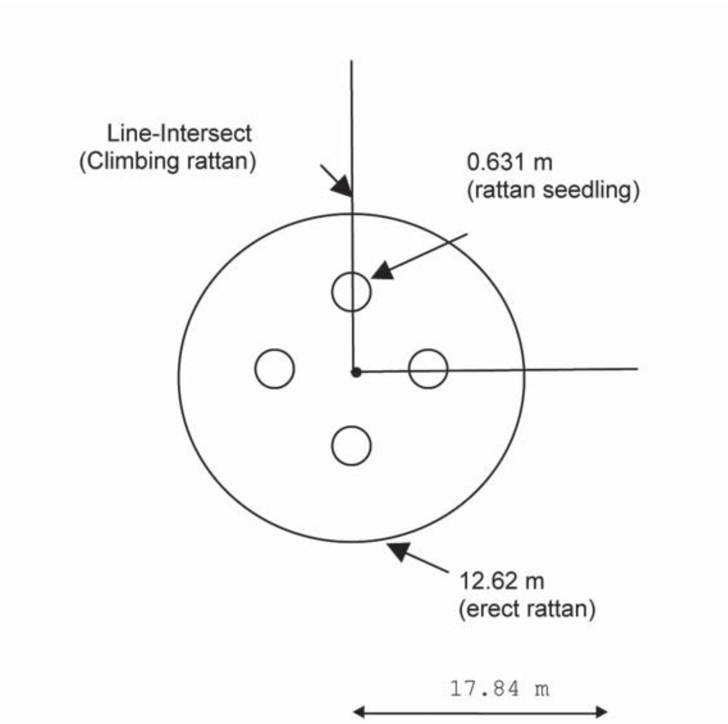

Figure 1 Sampling methods for rattan

Under this approach, density of seedlings (under-growth < 1.3 m tall) is sampled using 0.0005-ha fixed-area plot, and the density and length of erect rattan ($\geq$ 1.3 m tall) are estimated from a 0.05-ha fixed-area plot. That is, we estimate the total length (height) of all the canes in the clump that fall inside the plot. If the clump is too dense then estimate the length of a sub-plot of the clump (one-half, one quarter, etc.) and expand the results (multiply by 2, 4, etc.). This total length is added to that of the climbing rattan, which is determined using LIS.

LINE INTERSECT SAMPLING

Suppose the inventory objective is to estimate the total length and volume of rattan canes in a population such as a forest compartment or forest management unit (FMU). The LIS sampling and estimation would proceed as follows.

SAMPLING

The field sampling procedures for rattan are identical to those described in the literature for CWD (e.g. Marshall, *et al*., 2000). They involve the following steps:

1. Establish a random or systematic set of sample locations or points in the compartment or FMU.

2. At each sample location, establish a line intersect of an arbitrary length, e.g., an L-shaped horizontal line each arm 17.84 m long and emanating from a sampling point and at right angles (Figure 1).

3. At each line intersect, count each cane of rattan intercepted, and record the rattan species, the tilt angle of the cane in degrees from the horizontal, and the diameter of the cane. To measure the tilt, use a clinometer placed on the surface of the cane at the point of intersection.

4. Intersect lines must cross the centreline of the cane; the centre line is the physical centre of the cane. Do not count the cane if the sample line is right over the centerline of the cane. If the sample line intersects near the centre (borderline cases), you must decide whether the cane is çiné or çouté. If the line intersects the cane more than once, then re-count that cane.

5. Rattan may be suspended on nearby trees or branches. Count the rattan that is coiled on tree branches or boles, if the line (vertical plane, in this case) intercepts the rattan, and estimate the diameter and tilt angles. Densely coiled rattan may be sampled as an accumulation, a compacted volume of rattan.

ESTIMATION

The estimated total length and volume of rattan in the population at the ith sampling point are given by the following formulae (see, e.g., John Bell and Associates, 2002):

$$Length(m) = A * 15,707.963268 * \frac{1}{L} * \sum_{j=1}^{m_i} \frac{1}{\cos(h_{ij})} \quad ....Eq.1$$

$$Volume(m^3) = A * 12,337.0055014 * \frac{1}{L} * \sum_{j=1}^{m_i} \frac{d_{ij}^2}{\cos(h_{ij})} \quad ....Eq.2$$

where,

n = number of sampling points

m_i = number of pieces intersected at the ith sampling point

h_{ij} = tilt angle (degrees) of the jth piece at the ith sampling point

$\cos(h_{ij})$ = cosine of the tilt angle h_{ij}

x_{ij} = estimate of the attribute of interest for jth piece at the ith sampling point

d_{ij} = diameter of the jth piece (m) at the ith sampling point

L = total transect length (m)

A = total area of population (ha)

$t_{(0.025, n-1)}$ = value of the Student t-distribution at the 95% probability level with $n-1$ degrees of freedom

Table 2 Example of LIS calculations

Population & objectives

Compartment area, A = 250 hectares.
Transect length, L = 35.68 metres.
Number of sampling points or locations = 3.
The objective is to estimate the total rattan length and volume in the compartment.
D is diameter at intersection point.

Sample Data

Sampling Point #1			Sampling Point #2			Sampling Point #3		
Piece No.	Tilt angle (degrees)	D (m)	Piece No.	Tilt angle (degrees)	D (m)	Piece No.	Tilt angle (degrees)	D (m)
1	40	0.01	1	0	0.01	1	0	0.04
2	0	0.02	2	50	0.02	2	25	0.03
3	0	0.01	3	0	0.01	3	0	0.01
4	0	0.09	4	0	0.09	4	0	0.01
5	40	0.01	5	0	0.01	5	11	0.01
6	0	0.01	6	0	0.01	6	0	0.02
7	0	0.01	7	5	0.01	7	0	0.01
8	0	0.01	8	15	0.01			
9	10	0.01	9	0	0.01			
10	0	0.02	10	0	0.02			
11	0	0.03	11	0	0.02			
12	10	0.03						
13	0	0.03						
14	0	0.03						
15	0	0.08						

Analyses and Results

Estimated totals at the sampling points:

Sampling Point	Total Length (m) (Eq. 1)	Total Volume (m^3) (Eq. 2)
#1	1,721,543.89	1,700.88
#2	1,276,142.13	883.97
#3	783,867.72	293.46

Statistics for the population (compartment):

Statistic	Length (m)	Volume (m^3)
Estimated total (Eq. 3)	1,260,517.91	959.44
Standard error of the estimated total (Eq. 4)	270,796.5	408.0
Confidence interval of estimated total (Eq. 5)	± 1,165,144.12	± 1,755.63

Note that if the pieces are horizontal, then the rattan length is simply a function of the number of intersections and the length of the line intersect. If interest is in only length, then it is unnecessary to measure the diameter at the intersection point.

The estimated total length or volume for the population based on the n sampling points is:

$$\hat{X} = \frac{1}{n} * \sum_{i=1}^{n} \hat{x}_i ....Eq.3$$

where X is either total length or total volume.

The estimated (squared) standard error of the estimated population total length or volume is:

$$Va\hat{r}(\hat{X}) = \frac{1}{n(n-1)} * \sum_{i=1}^{n} (\hat{x}_i - \hat{x})^2 ....Eq.4$$

The approximate 95% confidence interval for the estimated population total is:

$$\hat{X} \pm t_{(0.025,n-1)} \sqrt{Va\hat{r}(\hat{X})} ....Eq.5$$

An example of the rattan length and volume calculations, based on artificial data set, is given in Table 2. The intent of the example is to provide data to check the formulae implementation, and also to show the ease of calculation.

DISCUSSION

We have successfully tested the application of LIS to inventory and monitor rattan and other climbers in Thailand. The main problems that may be encountered with this application are missing rattan that is very high up or in dense canopy, and when there are too numerous slender canes. These problems cause measurement error, and possibly bias. To reduce the error due to rattan being very high up the canopy or in dense canopy, perhaps, we could use binoculars to count the rattan and estimate the tilt angle. For the case of numerous slender canes, perhaps we could sub-sample the transect length.

We did not compare LIS and fixed-area plots for sampling climbers, but we believe that LIS is a much superior technique. Our belief is based on studies reported in the literature on CWD and logging residue applications (e.g. Bailey, 1970; Pickford and Hazard, 1978). As part of the ITTO project PD 2/99 Rev.2 (F), we conducted time studies for measurements on all attributes at a sampling location; however, we were not able to isolate the time for LIS sampling. Practitioners may wish to conduct time studies before applying our technique operationally.

Finally, we illustrated the application of LIS to inventory aggregate length and volume of climbers. The LIS technique can also be applied to estimate biomass (kg/ha). In this case we would need to know the density of climbers (gm/m^3), and then modify Eq. 2 by multiplying it by the density.

CONCLUSION

Climbers are an important component of the tropical forest ecosystems, and it is uncertain if the stocks of wild rattan are increasing or declining. Therefore, for sustainable management of this non-timber resource, it is necessary to ascertain the amount of this resource. We recommend the inventory practitioners in the tropics apply the LIS to inventory climbers.

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