

# The Growing Stock and Sustainable Utilization of White Bamboo, *Bambusa membranacea* (Munro) C.M.A. Stapleton & N.H. Xia in the Natural Mixed Deciduous Forest with Teak in Thailand: A Case Study of Huay Mae Hin Community Forest, Ngao District, Lampang Province

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**Abstract:** The growing stock and the utilization of white bamboo (*Bambusa membranacea* C.M.A. Stapleton & N.H.Xia) were studied at Huay Mae Hin Community Forest, locating in the natural Mixed Deciduous Forest with Teak of Mae Nam Ngao Watershed. Results showed that the bamboo growing stocks consisting of 760,760 culms by which 43,696 culms of about 5.74 percent of the total growing stock was harvested. The relationship between the bamboo utilization and the growing stock in the community forest was found significantly correlated. More enrichment planting to restore Mae Nam Ngao Watershed and intensive management of bamboo forests were suggested.

**Keywords:** *Bambusa membranacea*, Growing stock and utilization of bamboo, Huay Mae Hin Community Forest

## INTRODUCTION

There are about 75 genera and 1,250 species of bamboo found in the tropical, subtropical and temperate zones of the globe (Sharma, 1980). Tropical Asia has been recognized as the centre of bamboo diversity with 45 genera and 750 species found (Biswas, 1988). As in the case of the Southeast Asia region, Thailand seems to be rich in bamboo resources. Bamboos can be found throughout the country, mostly in Mixed Deciduous Forests. Recent research indicated that there are 15-20 genera or 80-100 native bamboo species in Thailand (Sungkaew *et al.*, 2011). The most common bamboo species are *Bambusa blumeana*, *B. membranacea*, *B.nana*, *B. vulgaris*, *Dendrocalamus asper*, *D. strictus*, *Thyrsostachys oliveri* and *T. siamensis*. It was estimated earlier that the annual production of native bamboo was 600 million culms or about 7 million US\$ equivalent (Boontawee, 1988). The latest survey in 1998 showed that natural bamboo forest covers about 800,000 ha. With the basis of an average annual yield of 0.1 tons/hectare green weight, the potential annual production of bamboo from natural sources in Thailand would be about 500,000 tons (FAO, 2009).

As regards Huay Mae Hin Community Forest at

Ngao District in Lampang, Thanakitrunreung *et al.*, (1900) reported the existing bamboo resources in an area of 193.32 square kilometer. There were 7 bamboo species with the total amounts of 14.77 million clumps and 114.17 million culms. Among these bamboo species, white bamboo (*Bambusa membranacea*) is somehow a promising bamboo species. Native utilize white bamboo for their household uses. The extra bamboo culms will be sold to the local factories to generate more extra earning. Ketanondet *et al.*, (2003) also mentioned that white bamboo in Huay Mae Hin Community Forest was the most dominant and the most important economic specie for people in community.

This white bamboo is commonly used in various kinds of construction, including houses, fences, bridges, and rafts. It is also used for making agricultural tools, for weaving, for making chopsticks, and even toothpicks. Many handicraft products are made from various parts of white bamboo. Bamboo shoots of white bamboo are an excellent raw material for healthy food. It can be eaten either in fresh, pickle, or dry. Young leaves are acceptable to feed livestock as fodder (Le, 2009).



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In any clump of white bamboo, there are various ages of culms. Chaturvedi (1988) suggested that all bamboo culms above 3 years old should be harvested for uses. Selective Cutting System is required for bamboo harvesting. In any bamboo forest, it is necessary to survey the potential bamboo production and record the allowable cut. It is true that the annual allowable cut may vary from year to year. Therefore, a proper management practices to manage bamboo forest sustainably should be set up and make use to control the amount of bamboo to be cut and should not exceed the allowable cut. In any unproductive clump, it is necessary to control cutting and it should be done in alternate years. In case of unproductive bamboo forest left over for long time, the management should be reset so as to start the redevelopment of the clump as Kigomo (2007) suggested that all dead and dry culms should be cut and removed. Heavily congested clumps may not be salvaged to productive state and should be clear felled. Current years and 1-year-old culms should never be cut unless in cases where they are curved and twining around other culms or are infected by disease or insects. The number of older culms retained should not be less than the number of current year's culms. In order to avoid future congestion, all clumps should be worked, even though they may not produce usable or saleable material. All cutting debris should be collected and removed away from the clump. In case of sporadic or gregarious flowering, all flowered clumps which have shed their seeds should be clear felled. No cutting of culms should be done during the growing season, from May to October. Therefore, culm cutting should be done only during the dry seasons. The areas under bamboo should be strictly fire protected. Prasad (1988) also stated that clear felling of congested clumps should be carried out. Sporadically flowered clumps should be worked on a priority basis irrespective of whether the particular coupe is due for working or not. The flowered areas should be treated so as to retain the number of seedlings necessary for restocking the area and their growth ensured by opening up the canopy, soil working and weeding.

For the management of bamboo forest in Huay Mae Hin Community Forest where was selected for this

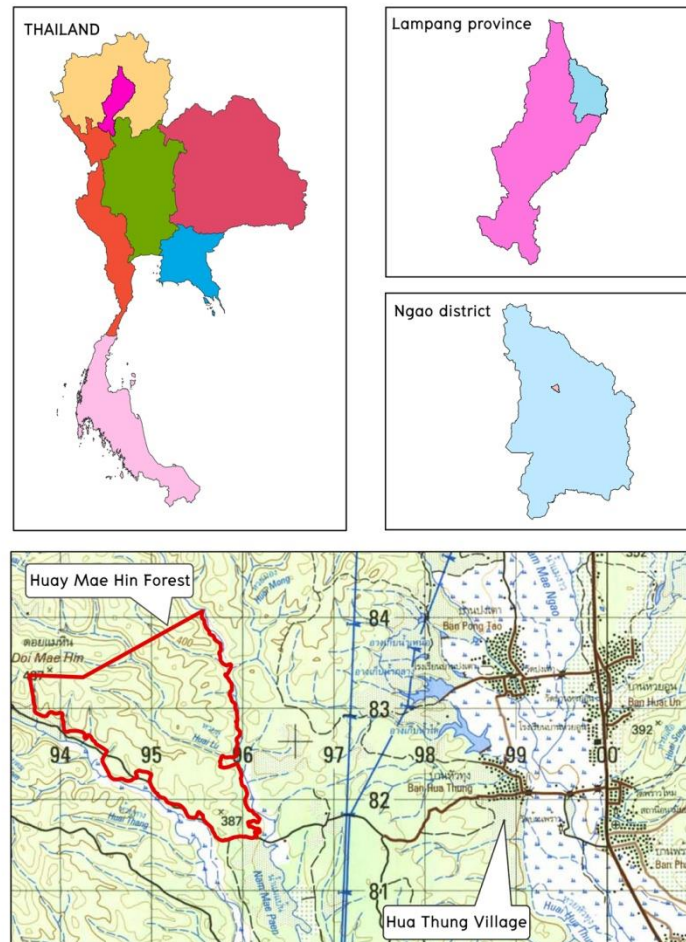
study, the management began in 1996-1997 after there had been the invasion of forest and deforestation due to illegal logging of teak and over harvesting of bamboo. After long years of over exploitation, Existing forest remained unproductive.

Moreover, the mismanagement has caused the shortage of water for domestic and agricultural consumption. Therefore, people have realizing the main causes of the problem and turn their attitude toward forest conservation since 1998. To share their responsibility they ban the illegal logging of teak and help in protecting the remaining forest as the upgraded watershed area. The existing forest was registered as community forest with Royal Forest Department (RFD) in 2007.

The objective of present study is aimed to study the outcome of the new management practices from the study of the bamboo growing stock and the utilization according to the activities of bamboo harvest in 2006 in order to plan the community forest management. The changing trend of forest management. It is also expected that the study of relationship between the growing stock of bamboo and the utilization of the community in the community forest is important for the effective community forest management and sustainable to the community in social, economic, and environmental benefits.

#### STUDY AREA

The study area is located in Ban Hua Thung Village (village no.8), Phong Tao Sub-district, Ngao District in Lampang, between the 18° 49' and 18° 50' North latitudes and the 99° 53' and 99° 56' East longitudes (Figure 1). The total area of Huay Mae Hin Community Forest is 308 ha. The elevation of this community forest is about 300-480 meters above the mean sea level. The forest type is classified as the Mixed Deciduous Forest with Teak. There are six main bamboo species including: *Bambusa membranacea*, *B. tuda*, *B. bambos*, *Dendeocalamus hamiltonii*, *Gigantochloa albociliata*, and *Cephalostachyum pergracile*. Among these bamboos, *Bambusa membranaceus* the main dominant species.



**Figure 1** Study area of Huay Mae Hin Community Forest in Lampang

## METHODS

### Data Collection

The total of 12 sample plots was set up in an area of 308 ha of Huay Mae Hin Community Forest, using Stratified Sampling Method. The sample plots were classified into 4 categories based on elevation above mean sea level: 420 m, 400 m, 380 m and 360 m. The size of each sample plot was 40x40 m (0.16 ha). There were 3 sample plots in each elevation above mean sea level. The data was collected by counting the numbers of culms of bamboos in each age class, as follows: 1 year old, 2 years old, 3 years old and over 3 years old, and by counting the numbers of culms (both living and dead culms) in each clumps.

A survey on white bamboo utilization was conducted in all households (126 families) in the community (Ban Hua Thung Village) by using questionnaires. The survey was conducted with the head of each family.

### Data Analysis

The analysis of the bamboo growing stock in the community forest area was applied from Curtis and McIntosh (1950).

The quantity of bamboo in selected sites was estimated with the use of the following equation:

$$\text{Density} = \frac{\text{Number of culms of bamboo}}{\text{Total area of the sample plots}}$$

$$\text{Growing stock} = \text{Density (culms/ha)} \times \text{Total area (ha)}$$

A survey of the utilization of bamboo in the community was calculated from the average value of each household uses. Similarly, the bamboo sale was evaluated by based on household income.

The relationship between the bamboo utilization by the community and the bamboo growing stock in the community forest was analyzed by GLM (Generalized Program). All statistics were performed with the use of software R v 2.11.1 (R core Development Tiena, Austria).

## RESULTS AND DISCUSSION

### The growing stock of bamboo in Huay Mae Hin

### Community Forest

The present study showed the variation in the density of white bamboo, ranging between 263-481 clumps/ha with the average value of 349 clumps/ha (Figure 2). Culm density varied from 1,163-3,738 culms/ha with the average value of 2,470 culms/ha. The study also showed the overall average numbers of culm ranging from 4-10 culms/clump with the average number of the present study was 7 culms/clump (Table 1). Previously, Ketanond *et al.*, (2003) reported that community relied much on illegal teak logs and paid least attention toward the bamboo growing stock and this undisturbed bamboo forest showed the average number of 14 culms/clump. The culm density varied from 3,212.5-4,293.75 culms/ha.

The study was also reported the average number of alive bamboo to be 2,470 culms/ha and of dead bamboo was 4,635 culms/ha. The number of death bamboo was mainly caused by natural death when the bamboo reached maturity stage (2,469 culms/ha) and the death as caused by the harvesting of bamboo (2,166 culms/ha).

The present study showed large variation in density of white bamboo in each age classes, as follows: 1 year old (31-788 culms/ha with the average of 387 culms/ha), 2 years old (244-838 culms/ha with the

average of 466 culms/ha), 3 years old (188-975 culms/ha with the average of 530 culms/ha) and over 3 years old (506-1,644 culms/ha with the average of 1,087 culms/ha). The average number of total culms was reported to be 618 culms/ha (Table 2).

After analyzing the growing stock of white bamboo in Huay Mae Hin Community Forest, it can be concluded that the total growing stock was 107,492 clumps and 760,760 culms. The majority 334,796 culms (44.01%) were bamboo at the age over 3-year-old class, followed by the class of the age at 3 years old (163,240 culms, 21.46%), at the age of 2 years old (143,528 culms, 18.87%) and bamboo aged at 1 year old (119,196 culms, 15.67%) respectively. When comparing with Phatsong and Duangsathaporn (2010), the total growing stock was 560,338 culms when using Line Plot System.

The comparison between alive and dead bamboo of white bamboo population, the number of alive bamboo was 760,760 culms (35%) which was smaller number than the dead bamboo which caused by either the harvested and the death from natural maturity (1,427,580 culms, 65%). The causes of the natural death of white bamboo were pests, diseases, wind and maturity. It was told that many bamboo clumps in the study area flower enormously. After flowering, the white bamboo will definitely die off.

**Table 2** The growing stock of white bamboo in each age class at Huay Mae Hin Community Forest in Lampang in 2013

Age classes (yrs)	Growing Stock		
	Number of culms/ha	Total number of culms	Percentage
1	387	11,9196	15.67
2	466	143,528	18.87
3	530	163,240	21.46
> 3	1,087	334,796	44.01
Total	2,470	760,760	100

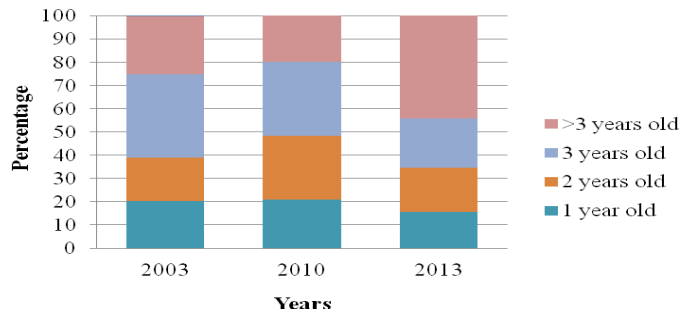
Figure 3 showed the percentage of the bamboo growing stock in each age class in the years 2003, 2010 and 2013. It can be seen that in 2013, the quantity of bamboo in 1, 2, 3-year-old-age classes decreased from 2003 and 2010 whereas the quantity of bamboo at the age over 3-year-old class highly increased. Ketanond *et al.*, (2003) also reported that in Huay Mae Hin Community Forest, each culm had the capability to produce up to six shoots, but most (71.5%) produced one shoot. 1-year-old clump produced most of the shoots (69.6%) while the 2,3-year-old culm produced 20.20% and 9.90% of the shoots respectively. For the bamboo over 3 years old had capability to produce only 0.50% of shoots and were not developed to be culms. Therefore, in 2013

the quantity of bamboo in 1, 2, 3-year-old-age classes which had the capability of producing culms was 56.00% when compared with the quantity of bamboo at the age over 3-year-old-age class which was 44.01%.

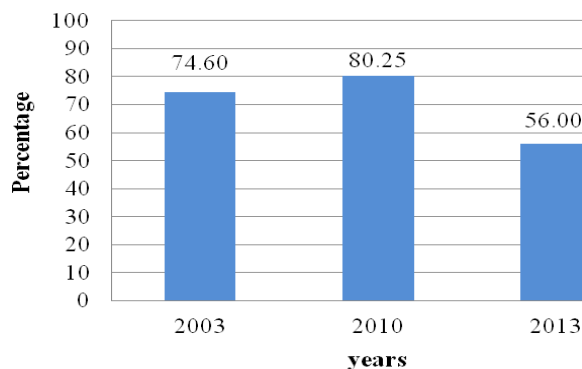
Figure 4 showed that the percentage of produced bamboo culms increased 5.56% from 2003 to 2010 and decreased by 24.25% in 2013. Therefore, the percentage of bamboo which was producing culms in Huay Mae Hin Community Forest decreased from 2003 and 2010. In common practices of Pgazgeryor Karen community at Ban Huay Hin Lad Nai (Anonymous, 2008) in Chiangrai, one has to understand the nature of bamboo shoot production. White bamboo produce bamboo shoot in pairs for

three successive months, July, August, and September. If there is no removal of bamboo shoot, the first pair of bamboo shoot is rather weak and cannot fully support the clump development. If the first pair of bamboo shoot was removed, then, the second pair of bamboo shoot appears with bigger size. And if the second pair of bamboo shoot was

removed, then the third pair will appear with bigger size and can support the clump development much better. The left over natural clump, even without fire problem and human disturbance, cannot support better clump development. It is necessary to improve the management practices of Huay Mae Hin Community Forest.



Concerning the died bamboo from maturity problem in 2012, white bamboo once produce flower will be died and it needs natural regeneration. Generally, the percentage of bamboo good seed is about 1% and the seeds have a great amount of biotic enemies like ants and birds. Seed collection and seedling preparation is required for future replanting at the site. In some cases, tissue culture is needed if mass production is needed.



**Figure 3** The comparison between the growing stocks of bamboo in each age class in 2003, 2010 and 2013

**Figure 4** The percentage of the bamboo to produce culms from 2003 to 2013

#### Bamboo utilization for household uses at Ban Hua Thung Village

The study showed that only 24.60 % of people at Ban Hua Thung Village rely on bamboo utilization harvested from the community forest. 87.10 % of the case sold the harvest bamboo to the local factories. Nearly 10% of them utilized bamboo at home and sold the rest. 3.22% of the case utilized bamboo for household uses only.

Bamboo harvesting has been annually conducted for 1-3 months. It was found that most of them conducted harvesting of bamboo for 1 month (61.29%) followed by 2 months (25.81%) and 3 months (12.90%) respectively. In each month, most people (77.42%) harvested bamboo 1-10 times/month while 16.13% of the case harvested bamboo 11-20 times/month and only a few people (6.45%)

harvested bamboo 21-30 times/month. The majority (51.61%) harvested bamboo between 51-100 culms per one time while others harvested bamboo 35.48%, 9.68% and 3.23% harvested bamboo  $\leq 50$  culms,  $\geq 151$  culms and between 101-150 culms respectively. Periods of the bamboo harvesting were from March to May. The majority (55.22%) harvested bamboo in May while others harvested bamboo in March (28.36%) and April (16.42%) respectively.

In the present study, people utilized bamboo ranging from 3-8,000 culms/household while the majority (54.84%) harvested bamboo between 1-1,000 culms/household. Others harvested 1,001-2,000 culms/household (29.03%) and more than 2,000-8,000 culms/household (16.13%) respectively. The average number of harvested bamboo was found to be 1,409 culms/household.

The income of selling bamboo, it was ranged between 21.30-3,409.44 US\$/household by which 66.67% of people had income from selling bamboo less than 304.41 US\$/household. The rest had income about 304.41-608.83 US\$ (16.67%) and more than 608.83US\$ (16.67%).The average income of harvested bamboo was 620.39 US\$/household.

Concerning the age and the method of the harvested bamboo, it was found that 41.94% of people harvested more than 2 years old bamboo meanwhile 58.06% of the people harvested more than 3 years old bamboo. Nobody harvested bamboo which was younger than 2 years old bamboo. Over half of the people (62.29%) harvested the culms both the outside edge and the inside edge of the clump while the equivalent percentage of the people (19.35%) harvested the culms around the outside edge and the inside edge of the clump.

After analyzing the quantity of the bamboo utilized in one year, it was found that 43,696 culms of bamboo were harvested in Huay Mae Hin Community Forest. Nearly all of the bamboo was sold (43,673 culms, 99.95%). Only a few culms of bamboo (23 culms, 0.05%) were utilized in household.

**The comparison of the quantity of bamboo growing stock in the community forest with the quantity of the bamboo utilization of the community**

In the present study, it was found that the quantity of

bamboo growing stock in Huay Mae Hin Community Forest was 760,760 culms. The quantity of the bamboo utilization of the community was found to be 43,696 culms of bamboos. The quantity of the bamboo utilization was about 5.74% of the quantity of bamboo growing stock in the community (Figure 5). Therefore, the quantity of bamboo growing stock was sufficient for utilization.



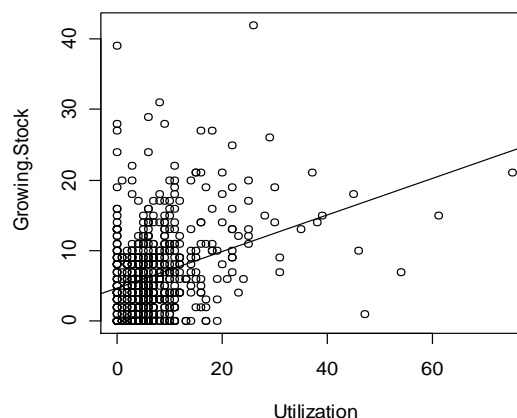
**Figure 5** The comparison of the growing stock with the utilization

The relationship between the utilization of the community and the growing stock of bamboo in the community forest was found that utilization of Ban Hua Thung Village was positively correlated with growing stock of bamboo in Huay Mae Hin Community Forest statistically significant at  $p < 0.001$  (Table 3 and Figure 6).Therefore, it indicated that the preceding of utilization in Ban Hua Thung Village was proper management with the growing stock in Huay Mae Hin Community Forest.

**Table 3** The relationship between utilization and growing stock

Estimate	Std. Error	T value	Pr (> t )
0.26065	0.02849	9.149	<2e-16 ***

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1



**Figure 6** Scattered plot of relationship between utilization and growing stock of white bamboo

**CONCLUSION**

The main aim to establish community forest was to develop the community based forest management via community forest activities. The joint effort of people

help in maintaining the existing forest resources and restore the watershed area at Mae Nam Ngao Watershed. After 17 years of development (1996-2013), illegal practices of teak in community forest

was under control and make uses of bamboo both for household and industrial uses.

The study showed the present situation of white bamboo growing stock and the trend of bamboo utilization in the village. It was found that the enrichment planting of teak and other species suitable for Mixed Deciduous Forest is needed. Intensive management practices of bamboo forest is also needed for future bamboo supply and generate more income to the community.

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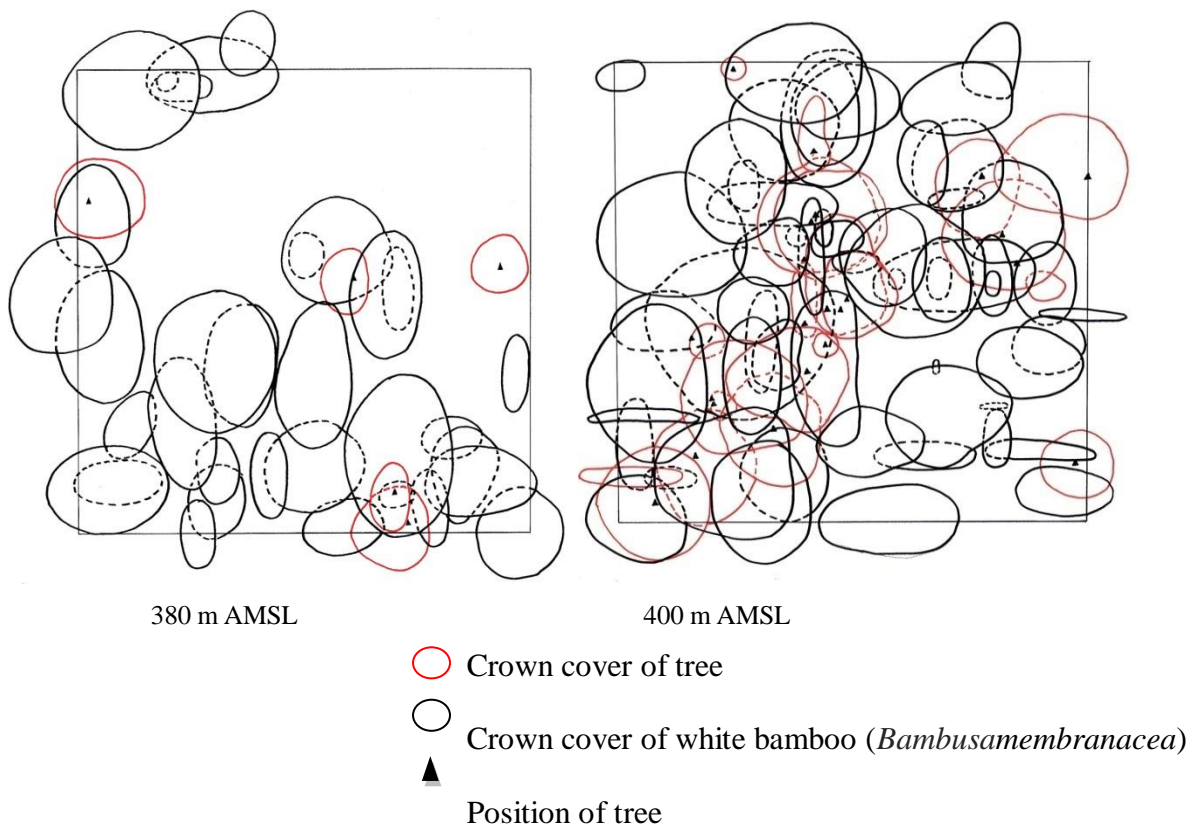
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**Table 1** The density of white bamboo (*Bambusa membranacea*) in Huay Mae Hin Community Forest, Ngao District, Lampang

Plots	Clumps/ha	Culms/ha	Average of	Alive (culms/ha)	Dead (culms/ha)
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		culms/clu mp	1 yr	2 yrs	3 yrs	> 3 yrs	Total	Harvested	Natural	Total
1	269	1,163	4	219	250	188	506	1,163	2,650	4,969
2	319	2,981	9	231	506	600	1,644	2,981	1,344	3,744
3	275	2,488	9	406	538	588	956	2,488	2,525	3,769
4	269	1,431	5	306	306	288	531	1,431	1,513	3,188
5	425	2,119	5	588	256	400	875	2,119	1,813	3,269
6	406	2,238	6	619	244	275	1,100	2,238	2,644	4,294
7	450	2,275	5	788	406	431	650	2,275	2,513	4,619
8	375	3,438	9	175	756	975	1,531	3,438	2,831	6,019
9	481	2,669	6	706	356	500	1,106	2,669	2,569	4,763
10	263	2,188	8	31	475	563	1,119	2,188	1,631	5,981
11	294	2,919	10	225	663	600	1,431	2,919	1,950	5,450
12	369	3,738	10	350	838	956	1,594	3,738	2,013	5,556
Total	4,194	29,644	87	4,644	5,594	6,363	13,044	29,64	25,994	55,61
Average	349	2,470	7	387	466	530	1,087	2,470	2,166	2,317



**Figure 2** The crown covers of white bamboo (*Bambusa membranacea*) on elevation above mean sea level in 380 m and 400 m of 40 x 40 m