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Crop Composition and Density after Thinnings and before Final Felling in the Matang Mangrove Reserve, Perak

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Key words: **Mangrove; Management;** *silviculture.*

RINGKASAN

Kajian ini melaporkan komposisi tanaman dan pola tumbesaran di dalam jangkamasa putaran beberapa himpunan produktif spesies penting Simpanan Bakau Matang Semenanjung Malaysia. Laporan ini adalah dari aspek-aspek tingginya, ketumpatan tanaman, tumbesaran diameter and keluasan pangkal.

Kesemua tujuh himpunan telah dibanci dari kawasan-kawasan sebelum penjarangan I, penjarangan II, penjarangan III dan sebelum penerbangan akhir. Kesemua kawasan tersebut mempunyai potensi untuk tumbuhan Rhizophora *spp. dari kelasifikasi banjiran Watson kelas II dan III.*

Tumbuhan telah didapati hampir tulin dan seragam dipenuhi oleh Rhizophora apiculata. *Sekutu yang terpenting,* Brugiera Parviflora *telah didapati merupakan kurang dari 10 peratus daripada jumlah tumbuhan bagi hampir kesemua daripada plot-plot yang dipilih. Purata bagi setiap hektar telah didapati sebanyak 3236, 2107, 1321 and 830 batang sebelum penjarangan I, II, III dan penebangan akhir. Min DBH untuk tiap-tiap peringkat adalah 8.28 cm, 9.65 cm, 13.90 cm, dan 17.45 cm. Apabila dibandingkan dengan anggaran-anggaran terdahulu, didapati taraf kematian yang meluas bagi tumbuhan di antara 2 hingga 15 tahun. Adalah didapati perlu untuk mengkaji kadar kematian dan sebab-sebabnya untuk jangkamasa ini yang mungkin bersangkutan dengan jadual penjarangan dan jangkamasa putaran tanaman.*

SUMMARY

The study reports the composition of the crop and growth pattern of important species in terms of height, density, diameter and basal area during the rotation period in some productive stands of the Matang Mangrove Reserve of Peninsular Malaysia.

In all, seven stands representing areas before thinning I, thinning II, thinning III and before final felling were sampled. All the sites were potential Rhizophora *spp. stands belonging to Watson's inundation classes II and III.*

The crop was almost pure and uniform, dominated by Rhizophora apiculata. Brugiera parviflora, *the most important associate was found to constitute less than 10 per cent of the crop in most of the sampled plots. On an average, there were 3236, 2107, 1321 and 830 stems per hectare before thinning I, II, III and final felling respectively. Mean DBH for the respective stages were 8.28 cm, 9.65 cm, 13.90 cm and 17.45 cm. When compared with earlier estimates, it appears that there is a large scale mortality between 2 and 15 years of crop. There is a need to study the mortality rate and its causes during this period which might have a bearing on the thinning schedules and rotation period.*

INTRODUCTION

The Matang Mangrove Reserve is a compact block of about 41,000 hectares, situated on the west coast of Peninsular Malaysia in the Straits of Malacca at approximately 5° N latitude. The mangrove belt in this locality varies in width from a few hundred metres to about 19 km at the mouth of the Larut river. The topography and soil are typical of mangrove swamps. The land mass is broken into bays of islands dissected by numerous tributaries of rivers and tidal creeks. As a

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renewable forest resource, about 33,400 hectares are productive – yielding wood for charcoal and firewood, pilings and poles for fishing stakes. *Rhizophora apiculata* and *R. mucronata* are economically the most important species. These forests control erosion and provide vital food links and breeding grounds for the marine fauna.

The Reserve has been managed since the early 1900s with the main object of producing fuel wood and poles of high quality on sustained basis. The Minimum Girth System was applied during 1904-1913 and 1924-1925. This was, however, replaced by the Standard System (1914-1923 and 1926-1940) on the grounds that understorey trees were destroyed during felling and suppressed trees were poor seed producers and often died or blown by wind. The Standard System was also abolished as the standards died fairly quickly and the cost of planting poorly regenerated areas fell short of the royalty value of the standards. Since 1952, these forests have been managed on a 30-year rotation with Clear-felling System. The reasons for lowering the rotation from 40 years to 30 years were two-fold; growth studies had indicated that MAI (Mean Annual Increment) of *Rhizophora* spp. culminated in about 23 years, and a 30-year rotation would produce less slash at the time of clear felling. Large quantities of slash are a problem in natural regeneration and planting (Noakes, 1952). There are three thinnings; first, at the age of 15 years with a 1.22 m stick, second, at the age of 19-20 years with 1.83 m stick and the third, at the age of 25-26 years with a 2.13 m stick. Lately there has been a tendency to avoid the last thinning in order to get a higher yield at the time of final felling. The poorly regenerated areas are planted with *Rhizophora* species (*R. apiculata* at 1.22 x 1.22 m and *R. mucronata* at 1.83 x 1.83 m) usually 2-3 years after clear felling when most of the slash has decomposed. Larger areas are under *R. apiculata.* In areas prone to *Acrostichum aureum* invasion after clear-felling, retaining of standards and immediate planting after final felling are recommended (Noakes 1951, 1952; Dixon, 1959; Mohd. Darus, 1969).

Object of the Study

Although the Matang mangroves have been under management for about eight decades, there is not enough information on the progress of the crop from the time an area had recovered (i.e. two years after final felling) until the time it is ready for the thinnings and final felling. The yield from final felling is expressed on a weight basis but the number of trees remaining after each thinning and those surviving at the final crop stage has never been determined. This study was undertaken to determine the progress of the crop from the time when it would be ready for the first thinning till the final felling. It was thought that the study would yield information on (i) number of trees per unit area before each thinning and the final felling, (ii) their size class distribution, and (iii) average crop diameter (DBH) and basal area (BA) at the four stages. It was hoped that it would be possible to comment, on the basis of this information, on (i) the minimum number of seedlings per millihectare which would give an adequately stocked stand at the time of final felling, and (ii) the realistic stocking at each of the four stages.

METHODS

The study was undertaken in the Kuala Trong and Port Weld ranges of the Matang Mangrove Reserve during August and November, 1977 (Table 1, Fig. 1 and 2).

TABLE 1
Locality features

Site No.	Locality	Compartment No.	Coupe No.	Stage	Area of Coupe ha	Area Sampled ha
1	Kuala Trong	81	–	Before Thinning I	20.23	1.01
2	Kuala Trong	81	KKJ 10/79	Before Thinning II	20.23	1.01
3	Kuala Trong	85	KKJ 33/70	Before Thinning III	20.23	1.01
4	Kuala Trong	69	KKJ 10/77	Before Final Felling	29.14	1.01
5	Port Weld	17	–	Before Thinning I	20.23	1.01
6	Port Weld	30	KKJ 44/75	Before Thinning II	20.23	1.01
7	Port Weld	30	KKJ 26/75	Before Final Felling	20.23	1.01

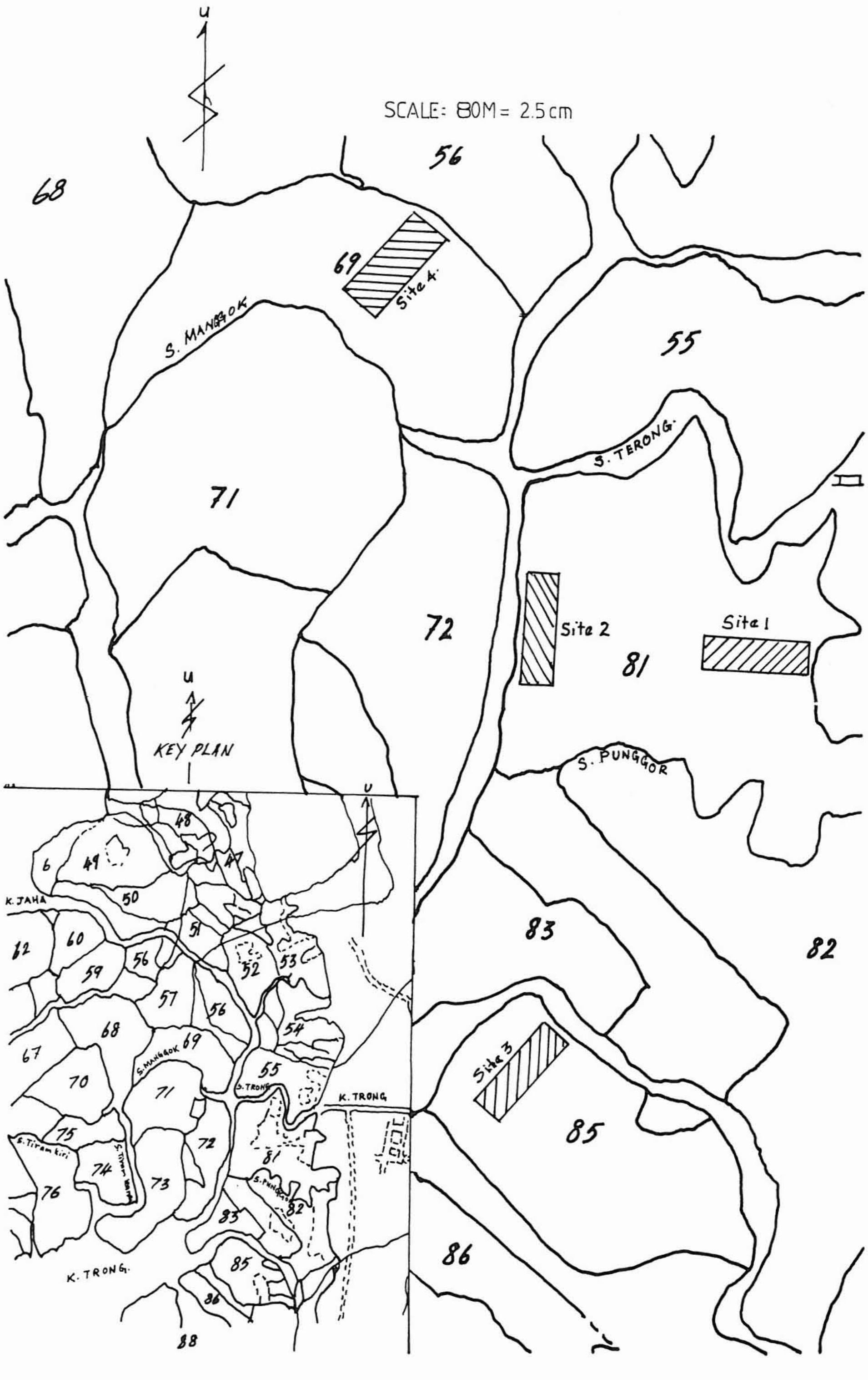

Fig. 1. Kuala Trong Range

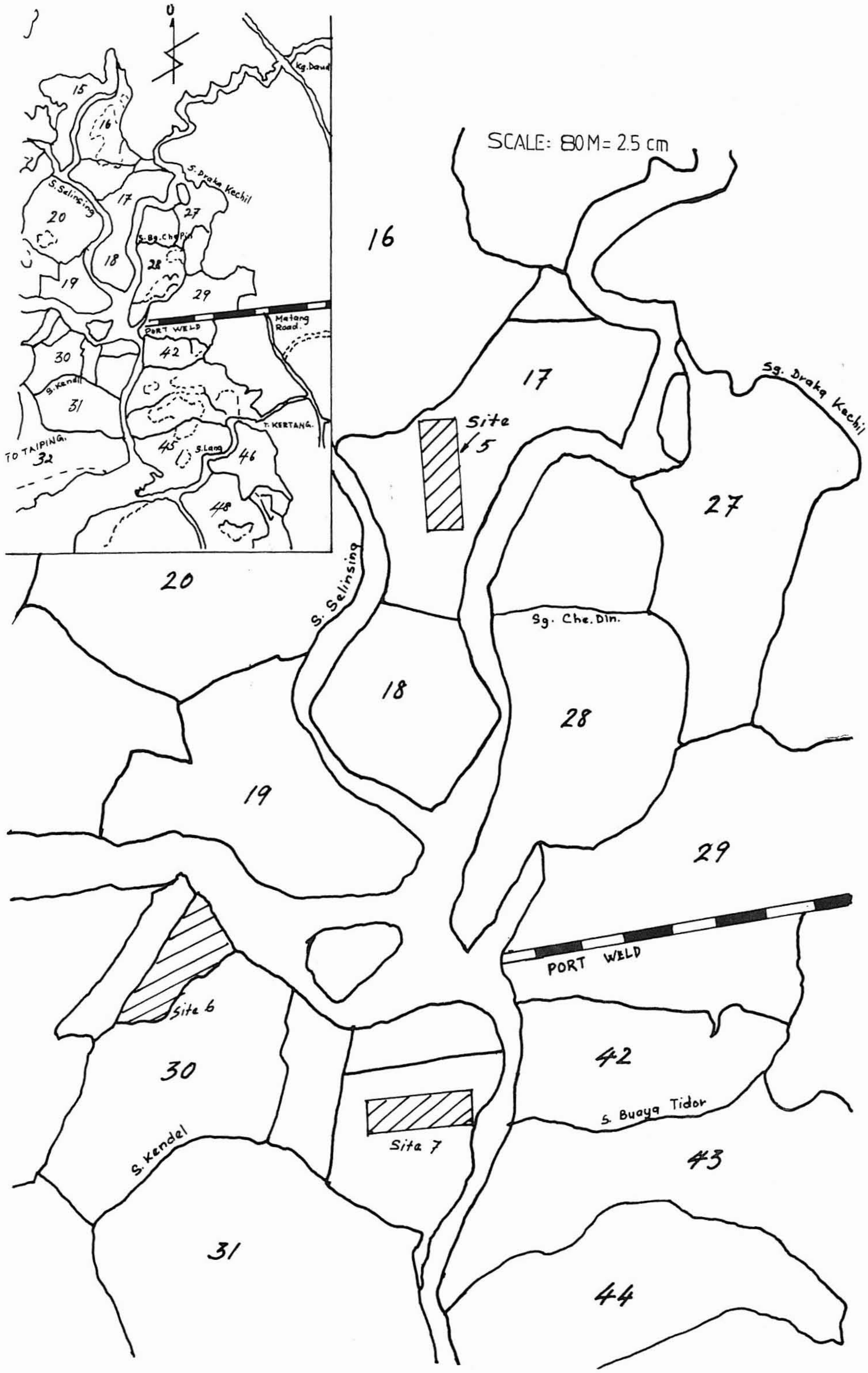

Fig. 2. Port Weld Range

Seven 1.01 ha plots were established. Four plots (1-4), representing each of the four stages in the rotation of the *Rhizophora* dominated stands (before each thinning and the final felling) were selected for study in Kuala Trong. In Port Weld, only three plots (5-7) were selected which represented the stages before thinning I, II and final felling, as thinning III is not carried out in this range. All the sites belong to Watson's (1928) inudation classes II and III. The prevailing conditions are suitable for the growth of *Rhizophora* species. *R. mucronata* generally occurs near water channels on soft mud, while *R. apiculata* reaches its optimum development and forms pure stands away from the streams or behind the *R. mucronatā* zone.

The procedure for the "Linear Enumeration of Big Trees" as recommended in the Manual of Malayan Silviculture for Inland Forest (Wyatt-Smith, 1962) was followed. One of the objectives of this enumeration in the inland forest is to provide accurate ecological and silvicultural data on frequency, density, composition, abundance and distribution pattern of important tree species. It was felt that this procedure could be used with equal effectiveness in the mangrove forests.

A base line was established along a convenient boundary, such as a channel or compartment limit. Sampling lines were then drawn straight and at right angles to the base line at intervals of 200 m. Sample plots of 20 m x 20 m were marked contiguously on each sampling line which bisects the plots. All the trees encountered in each plot were counted and their DBH recorded. Trees occurring on the forward and right side boundaries of the plot were included in the enumeration while those occurring on the left and rear end boundaries were excluded. Top heights of 5-10 trees were also recorded.

RESULTS

Crop Density and Diameter Size Class Distribution

In Kuala Trong, sites 1, 2, 3 and 4 had averages of 2553, 1929, 1302 and 934 of *Rhizophora* spp. stems per ha respectively (Table 2). The standard error of the mean for these figures was found to be less than 5% with a small difference in upper and lower confidence limits.

The average DBH of the trees on sites 1, 2, 3 and 4 was 9.86 cm, 9.35 cm, 13.9 cm and 18.3 cm respectively. The standard error per çent was less than 1%. This means that the uppêr and lower limits were very close (Table 2).

TABLE 2

Characteristics of *Rhizophora* spp. on different sites

KUALA TRONG

	1	2	3	4
Age (years)	15	17	27	30
Stocking (trees/ha)	2,553	1,929	1,320	934
Mean DBH (cm)	9.9	9.4	13.9	18.3
Basal Area (m^2/ha)	21.3	14.6	22.9	25.9
Average Height (m)	12.3	16.9	17.1	26.3

PORT WELD

	5	6	7
Age (years)	15	17	22
Stocking (trees/ha)	3,919	2,287	872
Mean DBH (cm)	6.7	9.9	16.5
Basal Area (m^2/ha)	15.4	19.8	20.3
Mean Height (m)	13.4	17.1	21.6

The frequency distributions of stems in diameter classes are shown in Figs. 3 and 4. On site 1 more than 60% of the stems were in the DBH classes of 6.0-11.9 cm. The modal class for sites 1 and 2 was 8.0-9.9 cm. Site 3 showed a bimodal distribution pattern. On site 4, about 50%

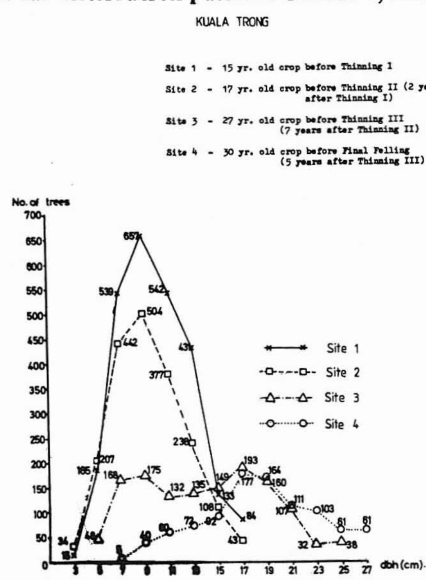

Fig. 3. ***Frequency distribution of trees with respect to diameter at breast height (DBH).***

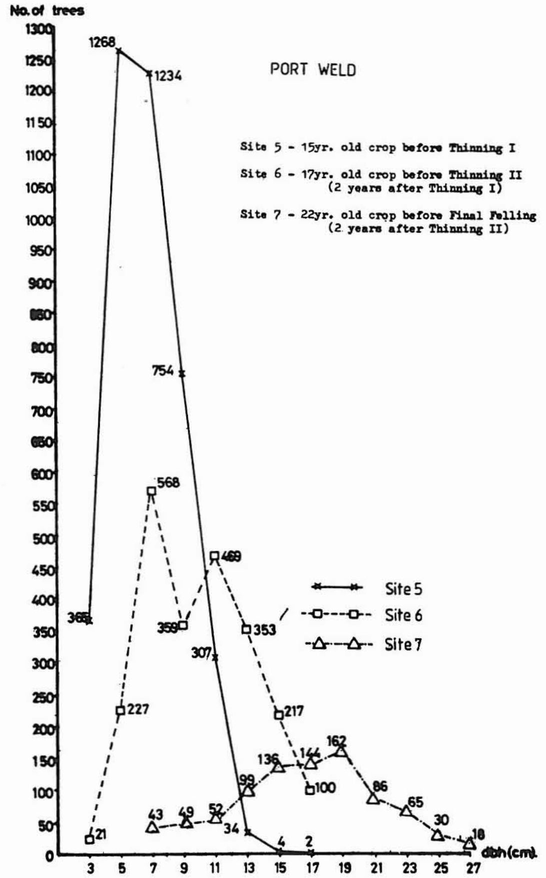

Fig. 4. Frequency distribution of trees with respect to diameter at breast height (DBH).

of the stems belong to a few size classes. The modal class was 16.0-17.9 cm.

In the Port Weld range, sites 5, 6 and 7 had 3919, 2287 and 872 of *Rhizophora* spp. stems per ha respectively. The standard error of the means for the three sites was about 6 per cent.

The average DBH was 6.7 cm for the stems on site 5, 9.9 cm for the crop on site 6, and 16.6 cm on site 7. The standard error per cent was around 1% for the three sites.

On site 5, about 50% of the stems were found in two DBH classes i.e. 4.0-5.9 cm and 6.0-7.9 cm. The modal class on this site was the smaller class. Site 6 showed a bimodal distribution pattern. On site 7, trees were uniformly distributed throughout the whole range of size classes.

Height

In Kuala Trong, the trees on an average attained the heights of 12.3 m, 16.9 m, 17.1 m and 26.3 m on sites 1, 2, 3 and 4 respectively. In Port Weld, the average heights of the trees on sites 5, 6 and 7 were 13.4 m, 17.1 m and 21.0 m respectively.

Other Observations

Acrostichum aureum was found to occur on sites 1, 3, 4 and 7 only. It appeared to flourish on dry areas and raised prawn heaps.

Bruguiera parviflora was rare; only on site 5 was it abundant. Less than 8 out of 25 plots had more than 10% stems in the stand. On site 2, only 3 plots had more than 10% stems of this species.

DISCUSSION

Stocking

There was much variation in stem density even on the sites of the same age. For example, on a 15-year-old site there was a 50 per cent higher density than on the other before thinning I. Similarly, the number of stems per unit area was higher on site 6 than on site 2. On the other hand, the next two age classes had a greater number of stems at Kuala Trong than at Port Weld.

The stocking on all sites was much lower than was approximated by Srivastava and Abdullah Sani (1979) who estimated more than 6,723 trees per hectare at about 15 years of age, before the thinning I. Based on these estimates, the stocking at each stage would be:

6723 trees/ha after thinning I with a 1.22 m stick.
2989 trees/ha after thinning II with a 1.82 m stick.
2195 trees/ha after thinning III with a 2.13 m stick.

These figures estimated the maximum density of trees under current silviculture practices at Matang, on the assumption that there was little or no net mortality from 2 years after final felling till the crop was 15 years old. However, when the figures obtained in the present study are compared with those of Srivastava and Daud (1978), the net mortality during this period appears to be 50%-70% of the number recorded 2 years after final felling (Table 3).

The reasons for this high mortality are not known. There is a need for this phenomenon to be studied to provide information which would have

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TABLE 3
Stocking per hectare at the different stages

Localities	12 months after logging	24 months after logging	Before thinning I	Before thin. II (after thin. I)	Before thin. III (after thin. II)	Before final felling after thin. III)
Kuala Trong	9141[a]	8339[a]	–	6723[b]	2989[b]	2196[b]
Kuala Trong	–	–	2554	1929	1320	934
Port Weld	–	–	3919	2287	872	–

a – Srivastava and Daud (1978)
b – Srivastava and Abdullah Sani (1979)

a great bearing on the silviculture of these forests. The present authors suggest that the high mortality rate could be due to natural thinning; and the period of highest mortality could be after the closure of the canopy. *Rhizophora* spp. are great demanders of light and are highly intolerant of shade. The spacing of 1.22 x 1.22 m, and the possible greater density in areas regenerated naturally, appear to support high stocking until the crop reaches the thinning I stage. It was observed on site 5, for example, that the crop was very dense and there were already suppressed trees before thinning I.

In the present study the stocking on all sites except one fell within the predictions of the Noakes (1952) Yield Table. The exception was site 7, which had 872 stems per hectare compared to 1320 stems per hectare on site 3 and 1307 stems per hectare in Noakes' Yield Table (Tables 4, 5). The lower stocking on site 7 could be attributed to increased illegal felling. This range is more intensely inhabitated than the Kuala Trong one. Secondly, it is widely believed that most of the sites in the Port Weld locality have a lower fertility than those at Kuala Trong. Studies on this have yet to be carried out. Past records show that the amount of wood removed at thinnings I and II from site 7 (8,742 and 14,037 kg ha^{-1}) was comparable to that removed at site 3 (6,859 and 13,464 kg ha^{-1}) in Kuala Trong. Thus the severities of thinnings I and II on sites 3 and 7 were more or less similar.

From the collation of present results and the Noakes' Yield Table (4 and 5), the tentative stocking and basal area for the four stages should be;

Before thinning I (15 year old crop) – 2500 stems/ha, 18 m^2/ha

Before thinning II (20 year old crop) – 2000 stems/ha, 20 m^2/ha

TABLE 4
Yield Table for Thinned Stand (Noakes 1952)

Age class (yr.)	DBH (cm)	Stems per ha	Basal area (m^2/ha)
14	10.67	2371	21.1
(15)	(11.18)	(2223)	(21.6)
16	11.68	2038	22.1
18	12.70	1775	22.8
(20)	(13.72)	(1561)	(23.3)
22	14.73	1307	23.9
24	15.75	1240	24.0
(25)	(16.26)	(1187)	(24.2)
26	16.51	1121	24.4
28	17.53	1023	24.7
30	18.29	939	24.9

Before thinning III (25 year old crop) – 1500 stems/ha, 23 m^2/ha

Before final felling (30 year old crop) – 1000 stems/ha, 26 m^2/ha)

Using these figures for a 15-year-old stand before thinning I and the expected mortality of 60% (mid-point of 50-70% mortality), the stocking of a two-year-old stand should be at least 6,250 stems per hectare. This is almost the same as 6723 stems/ha if the whole area is planted at 1.22 x 1.22 m spacing. In other words, a millihectare plot must have at least 7 seedlings in order to get a stocking of 2500 trees per hectare at 15 years. Srivastava and Abdullah Sani (1979) also suggested about 7 seedlings per millihectare plot for adequate stocking.

Basal Area

The basal area on site 1 was 5.9 m^2 ha^{-1} which was higher than what it was on site 5, suggesting

TABLE 5
Yield Table for Unthinned Stand (Noakes 1952)

Age class (yr.)	DBH (cm)	Stems per ha	Basal area (m^2/ha)
14	11.2	1677	15.9
(15)	(11.6)	(1674)	(17.0)
16	11.9	1670	18.0
18	12.7	1588	19.6
(20)	(13.5)	(1504)	(21.1)
22	14.2	1430	22.5
24	15.0	1359	23.8
(25)	(15.5)	(1326)	(24.2)
26	15.9	1292	25.0
28	16.5	1237	26.2
30	17.3	1186	27.4

Note – Values in parenthesis indicate timings of thinnings.

that site 5 might be over-stocked and suppressed. Site 2 showed an anomalous situation probably as a result of incomplete and selective thinnings. The basal area of site 7 (20.3 $m^2 ha^{-1}$) was quite high for a 22-year-old crop when compared to 22.9 $m^2 ha^{-1}$ recorded for site 3, (27-year-old). Both these stands had been thinned twice.

The basal areas of the stands on most of the sites fell within the estimate of Noakes (1952). On site 5, overcrowding suppressed diameter growth which resulted in a lower basal area.

Diameter (DBH) growth and distribution

The trees on site 1 were shorter but had better diameter growth than those on site 5. Trees on sites 2 and 6 had very similar diameter growths. On the other hand, trees at site 7 were larger than those on site 3 but were similar to those on site 4 (Table 2).

As is evident from Table 6, all the sites showed lower diameters than was predicted by Noakes (1952). The only exceptions were the last stages in both ranges (site 4 and site 7) which were almost within the limits of Noakes' prediction.

A strange situation was observed at Kuala Trong where DBH before thinning I was greater than before thinning II. These stands were both 17-years-old. When a crop is ready for thinning I, the stems have a DBH range from 3-12 cm; however, due to little demand for lower diameter class poles, only those of 8.0-10.0 cm DBH are extracted

TABLE 6
DBH of trees at various stages (cm)

Age (yr.)	15	20	25	30
Watson's unthinned stand	–	12.00	14.25	16.25
*Noake's unthinned stands	11.00	13.25	15.00	17.00
*Noake's thinned stands	11.00	13.50	13.50	18.00
Kuala Trong	9.75	9.25	13.75	18.00
Port Weld	6.50	9.75	16.25	–

*Partly based on Durant (1941) and Landon (1942)

(Mohd. Darus, 1969). This practice results in large number of trees of small diameter being left behind.

Althoug the DBH appears low, the increase in DBH between one stage and another on both ranges is impressive, far exceeding the predictions of Watson (1928) and Noakes (1952) (Tables 6, 7). Although these figures must be used with caution they provide a good indication of the effects of thinning on diameter growth of the remaining trees.

The increase in DBH is important, not only because a higher yield could be obtained from bigger trees but also because there is a minimum size preferred by the market. In thinning I, there is no market for the poles of less than 8.0 cm DBH.

The frequency distributions on sites 1 and 2 are very similar except that the number of trees in 8-12 cm diameter classes on site 2 is low by

TABLE 7
Increment in average DBH from one stage of crop to another (cm)

Age (yr.)	15-20	20-25	25-30
Watson's unthinned stands	–	2.25	2.00
*Noake's unthinned stands	2.25	1.75	2.00
*Noake's thinned stands	2.50	2.50	2.00
Kuala Trong	–0.50	4.50	4.25
Port Weld	–	6.50	–

*Partly based on Durant (1941) and Landon (1942) ɔmparison. This may be due to selective thinning. :igher extraction of the favoured size class, if it appens to be the modal class, may change the ormal distribution pattern into a bimodal one; tes 3 and 6 exhibit a bimodal pattern. However, ıe curve for site 3 is quite flat and is not very istinct while it is marked for site 6. Again this ıay be due to selective extracting of the favoured ıBH class. The flattened pattern on site 3 which 'as thinned 7 years previously probably indicates :covery from incomplete and selective thinning. ite 5 shows the concentration of stems in smaller iameter classes which reflect intense intraspecific ɔmpetition.

'hinning

On the whole, thinnings in Matang appear to ave been irregular, incomplete and selective. trict adherence to timings and spacing is not ossible. Hence current thinnings cannot be :garded as a true silvicultural operation (Noakes 952; Mohd. Darus, 1969). For example, thinning [I on site 3 is overdue. The timings for first two ıinnings are very dependent upon the market emand for poles; and in many cases, areas are not ıinned fully. Only the areas to the right and left f the channels are thinned. The rest of the coupe :nds to be left unthinned because of the problems f access and transportation. Thinnings are also :lective; often only trees of a DBH required by ıe market are extracted. Thus in many cases, ıe whole coupe is not thinned according to the ɔecifications.

The present study showed that the first ıinning is important, particularly if the site is ensely stocked. Its importance was substantiated y earlier studies in which thinning I was omitted nd the subsequent yield was lower than that btained from the normal three thinnings schedule Mohd. Darus, 1969). Using the present results nd Noakes Yield Tables as a guide, the timing of ıinning I should be at 12-17 years old. It would ary from area to area depending on stocking, asal area and DBH range. A 1.22 m stick should e used in thinning I to a desired stocking of about 000 trees per hectare.

The second and third thinnings may be one concurrently and in so far as their timings nd spacing are concerned the operation could e considered 'a hybrid'. In essence there should e two thinnings. In Port Weld the third thinning 'as abolished in 1975 due to low stocking which ad resulted in poor yield at the time of final :lling. While the second thinning is commercial, ıe third one (also sometimes called regeneration :lling) is aimed at enhancing and stimulating the establishment and growth of seedlings and saplings (Dixon 1959, Mohd. Darus 1969). There are many arguments for and against a third thinning (Noakes, 1952; Mohd. Darus, 1969; Srivastava and Abdullah Sani 1979). Although the density of seedlings and saplings was not assessed quantitatively in the present study, it was observed that regeneration was ample on site 3 (after the second thinning) on site 4 (after the third thinning) and on site 7 (after the second thinning). This shows that with sufficient canopy opening, regeneration can be obtained even after thinning II. It is suggested that a 'hybrid' second thinning be carried out between 20-25 years with a 1.83 m or 2.13 m stick. The desired stocking should be about 1000 trees per hectare.

However, further studies are needed to find out the best thinning schedule for the Matang Mangrove Forests.

Productivity Classes

All the Working Plans up to 1969-1979 have treated the Matang Mangroves as one homogenous block. Yield regulation was carried out on an area basis probably because of the lack of reliable data on growth and volume. Sometimes yield figures were adjusted to allow for variation in stocking and quality of the stands. However, records of out-turn from completed sub-coupes showed wide variations (Noakes, 1952).

The present study showed wide variations in terms of stocking, basal area, mean DBH and height even on apparently similar sites. This indicates the presence of site quality classes. In order to put the management of these forests on a sounder footing, it is suggested that the Reserve should be divided into quality (productivity) classes. Studies should be directed to determine the optimum stocking and basal area for each class at every stage during the rotation.

Bruguiera parviflora

The most important associate of *Rhizophora* spp. was *Bruguiera parviflora,* an undesirable species mainly because of the inferiority of its wood for charcoal. In most plots sampled in the present study, it formed less than 10% of the crop. In older stands, it was almost absent. Plots with more than 10% *B. parviflora* were near the channels which crisscross these forests.

It has been reported that there is an increase in *B. parviflora* after clear felling (Dixon, 1959; Mohd. Darus, 1969; Abdul Manap and Srivastava, 1975). The lowering of the rotation period is also a cause for its increase (Noakes, 1952; Dixon, 1959). It was not found in abundance on any site in the present study because these sites were well managed. Most of the *B. parviflora* trees were removed during thinning so that the stand became a pure crop of *Rhizophora* spp.

Acrostichum aureum

Acrostichum aureum was found on the forest floor on sites 3, 4 and 7. In Kuala Trong, it was also found before thinning I, because this site is adjacent to the inland forest and is on higher ground. In the areas sampled it does not pose a serious problem to natural regeneration.

CONCLUSIONS

On the basis of this study, the following conclusions can be drawn:

(i) The realistic stocking of *Rhizophora* spp. after thinning I, II and III appears to be 2000, 1500 and 1000 stems per hectare respectively.

(ii) The net mortality of *Rhizophora* spp. seedlings from the time the area is passed as regenerated until it is ready for thinning I, i.e. from 2 years to 15 years, appears to be 50 to 70 per cent.

(iii) In the Port Weld range, since the stocking after thinning II is very low, abolishing thinning III could be justified economically. The question of the thinning schedules needs re-examination which might have a bearing on the current rotation cycle.

(iv) Most of the sites surveyed carried a low density of *Bruguiera parviflora.*

(v) In these sites, *Acrostichum aureum* does not pose a serious problem for natural regeneration.

(vi) Further studies need to be carried out on:

- (a) the rate of mortality, survival and growth of *Rhizophora* spp. 2-15 years after final felling;
- (b) the causes of mortality;
- (c) alternative thinning schedules; and
- (d) the classification of the Matang Mangrove Reserve into different quality classes.

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