MANAGEMENT OF SECOND GROWTH JARRAH FOREST.

By: A.C. Van Noort, A.D.F.O.

16.6.60

060167 Copy for Mr F. Podger. DWP.

Graphs to be drawn.

MANAGEMENT OF SECOND GROWTH JARRAH FOREST.

The heavy exploitation cutting in the jarrah forest prior to treemarking has resulted in large areas of dense even aged regrowth. In the Dwellingup division some of these stands are approaching 50 years of age.

Plot measurements over a period of 16 years in a high quality, unthinned regrowth stand have yielded some interesting information. on the behaviour of this type of forest. In the following notes, some suggestions for management of the regrowth forest are put forward, based primarily on information obtained from this plot and my present ideas on the subject.

A. Stand Behaviour in Unthinned Regrowth Forest

The one acre sample plot which is located in Holmes 10, has been measured periodically from 1943 to 1959. This is a high quality site, (100 load jarrah bush) and the regrowth is now approximately 44 years old. A number of facts arising from the measurements are relevant to a study of the behaviour of such stands.

(1) The number of stems per acre has remained constant at 387, over the 16 years of measurement. None of the suppressed trees have died.

(2) The sorting out into canopy classes is progressing. The number of overstorey trees (dominants and co-dominants) has fallen from 130 in 1943 to 83 in 1959.

(3) There is a considerable range of size classes but, as can be seen from Graph A, the smaller sizes are understorey trees (sub-dominants, dominated and suppressed) with no future in the stand.

(4) The early, rapid height growth of the sapling stage had slowed down before measurements commenced. In 1943, at age 28 years, the mean height of 30 sample trees was 64', giving an M.A.I. of approximately 2½ feet per annum. A constant increment of 1' per annum has been maintained since 1943.

(5) Total basal area has reached a high level of 180 square feet per acre. Basal area increment has declined since 1947, from 4.2 square feet per acre per annum to 2.0 square feet per acre per annum in recent years, apparently due to mutual suppression brought about by the heavy stocking. See figures 1 and 2. The fall-off in increment as the total basal area builds up is shown in the following table:

Year	Age	Total Basal Area	B.A. Incrt. p.ac. p.an.
1943	28	135 sq.ft.	
1947	32	152 sq.ft.	4.2. sq.ft.
1953	38	168 sq.ft.	2.7. sq.ft.
1959	44	180 sq.ft.	2.0. sq.ft.

(6) The basal area of the overstorey has been maintained at a fairly constant level between 80 and 100 square feet over the 16 years of measurement, due to the reduction in the number of stems in the overstorey.

(7) Volume increment has fallen from 50 cubic feet per acre per annum in 1943-1947, to 23 cubic feet per acre per annum in recent years. The stand now carries approximately 40 loads of regrowth per acre at age 44 years. Four overmature veterans were excluded in this calculation, and their crown area allowed for.

(8) The girth increment of both overstorey and understorey trees has declined considerably.

Sixteen trees on the plot were growing at more than 1 inch of girth per annum during the period 1943-47, before the decline in growth rate began. They are now averaging 0.43" per annum.

The mean girth increment of the 83 present overstorey trees has fallen from 0.66" per annum in 1943-47, to 0.28" per annum in 1953-59.

The mean girth increment of the 304 present understorey trees has fallen from 0.30" per annum in 1943-47, to 0.075" per annum during the last period of measurement.

(9) The growth of 32 potential crop trees has been traced over the period, and, although their increment has fallen, they are producing a progressively greater percentage of the total plot increment each year - from 24% in 1943-47 to 32% in 1953-59. The average girth increment of these trees was 0.81" per annum in 1943-47 and 0.41" per annum in 1953-59.

From the information obtained on this plot, a number of conclusions can be drawn regarding the behaviour of this regrowth stand.

A high rate of growth was maintained for the first 25 years, with a height increment approaching 3' per annum and a volume increment in excess of 1 load per acre per annum. The stocking of 387 stems per acre would allow free growth in the sapling stage.

A differentiation into canopy classes had begun by age 28 years. Further sorting out occurred between 28 and 44 years with a marked increase in the understorey group, but no trees had died. The persistance of the understorey trees has led to a build-up of a very high stocking, mutual suppression and a decline in the production per acre by more than 50%. Growth rates of both overstorey and understorey trees have slowed down considerably.

It seems likely that both crown competition and root competition play a part in the mutual suppression. Crown competition would become most severe when rapid height growth ceased and new crown development became dependent on lateral extension. With a crown-shy species such as jarrah, this alone could account for the decline in growth rate. During the summer months, availability of water probably becomes an important factor limiting growth in a heavily stocked stand. When over three-quarters of the trees form a non-productive but persistent understorey, a large proportion of the available water and nutrients must be used in sustaining life in trees which have practically ceased growing.

Although a small number of the overstorey trees are producing an increasing percentage of the total increment on the plot, their increment rate has fallen considerably. Whether these trees will eventually take over the site and resume a fast rate of growth is not known. It seems more likely that, without treatment, the stocking will be maintained at a high level with a large number of trees per acre, and a consequently slow growth rate on individual trees.

B. Management of the Regrowth Forests

The foregoing notes indicate that overstocking may lead to a serious decline in production in the regrowth jarrah forests and that thinning is necessary in these stands if reasonable rates of growth are to be maintained. There are a number of problems associated with thinning in the jarrah forest and research is needed to determine the most suitable methods.

An important benefit to be obtained from thinning is the opportunity of controlling and improving the stand structure. The regrowth stands are generally even-aged and it is suggested that thinnings should be directed towards the eventual conversion to all-age selection forest. The following notes are submitted in support of this suggestion.

a. Advantages of the Selection System

Jarrah grows naturally as an irregular forest due to its fire resistance, its method of regeneration and its ability to persist as an understorey. It is therefore a suitable species for management under the selection system.

A number of advantages of the Selection System, as opposed to even-aged systems, which could be of great importance in the future management of the jarrah forest are:

1. The Selection System affords a high degree of protection to the site. This becomes very important in Watershed Management and must therefore be considered for much of the northern jarrah forest. With problems such as Dieback already present, it may be that protection from exposure is vital to the health of the forest.

2. With selection forest, a high proportion of the timber is removed as larger sizes. It seems likely that mill logs will be the main commercial product of the jarrah forest for many years. Even-aged stands require a large number of trees per acre to stock the area in the young stages and repeated thinnings are necessary if good growth rates are to be maintained. Thinnings in the smaller sizes are not likely to be saleable from the bulk of the forest area.

3. Regeneration should be assured, with the more frequent cutting, soil disturbance associated with logging, and the abundant seed trees.

4. The form of jarrah is improved when the young trees grow up in gaps brought about by selection cutting.

5. Although logging operations are required to become more flexible, selection cutting will provide good roading throughout the whole forest. Frequent cutting and the associated tending will ensure that the whole forest receives the benefit of some silvicultural treatment periodically.

b. <u>The desirable stem distribution for Selection Forest</u>

Opinions regarding the desirable or normal stem distribution for managed all-age forest have changed.

The early concept of a normal distribution was based on the even-aged forests where each size class (age class) occupied an equal area of the forest (Schlich). This gives rise to extremely high numbers of small stems in proportion to the large stems.

De Liocourt's theory for a normal distribution, in which the number of stems in each size class bears a constant ratio to the number in the next larger class is more realistic but can still result in very large numbers of small trees if a large number of size classes are used.

The latest trends in selection forest management are towards a stem distribution giving as high a proportion of large trees as possible.

R.R. Reynolds of the Southern Forest Experiment Station, in an article in the Journal of Forestry, October 1954, suggests that where large saw logs are the main end product it is logical to conclude that as much of the growth capacity of the site as is consistent with sustained production should be concentrated in the larger size classes.

Reynolds points out that it is ~~unreliable~~ unrealistic to allow for an almost 30% loss of trees in the few years taken to grow from one 2" diameter class to the next (as in De Liocourt) and asks, "Is it necessary to have from 150 to 250 trees per acre in the 4-12" d.b.h. group in order to provide replacements for the few larger trees that will be removed at the end of each 5 or 10 year cutting cycle?"

C. <u>Suggested Stem Distribution for Jarrah</u>

A theoretically suitable stem distribution for all-age jarrah forest has been prepared. See Graph B.

Factors which decide the most favourable stem distribution are:

1. The size of tree to be grown.
2. The rate of growth of individual trees.
3. The rate of growth on a per acre basis.
4. The desirable stocking levels.

1 and 2 determine the "rotation" age.

3 and 4 determine the cutting cycle.

It is assumed for the purpose of discussion that the major product from the jarrah forest will be 90" mill logs.

In the Holmes 10 stand, before growth rates slowed down, the better trees were growing at more than one inch of girth per annum. With treatment, this growth rate should be maintained, giving a "rotation" of 90 years for this site.

Under the selection system, the aim is to remove the increment periodically and maintain the stocking at an optimum level. In any forest there is an optimum range of basal area per acre for maximum volume production and stockings of less than, or in excess of, this optimum range result in a reduced increment per acre. The fastest growth rate on individual trees, together with the maximum increment per acre, will be obtained by thinning to the lower end of the range of optimum stocking.

The optimum range of stocking for jarrah is not known but, considering the climate and soils of the jarrah forest, it could be expected to be of a low order. In Holmes 10, the overstorey stocking was maintained at a level between 80 and 100 square feet. In the theoretical proposal which follows, a range of 60 to 110 square feet has been used.

In Holmes 10, the maximum cutting cycle commensurate with desirable stocking would be 15 years. Before the decline in growth rate, basal area increment was over 4 square feet per annum and has now fallen to 2 square feet. At least 3 square feet increment per annum should be maintained under management. Cutting this increment every 15 years would mean, removing 45 square feet of basal area, or approximately 15 loads.

With a 15 year cutting cycle and a maximum age of 90 years the stem distribution should be made up of 6 size classes each with a 15" range.

Graph B is a form of the De Liocourt distribution. Six size classes with a class to class ratio such that the number of stems in each size class bears a ratio of 125% to the number of stems in the next larger size class, have been used. This results in a low number of stems in the small size classes, as recommended by Reynolds.

Using 7 trees in the largest size class (75"-90") a total of 81 stems per acre, and 107 square feet of basal area, results. Every 15 years the trees in the largest size class are removed and a thinning treatment carried out to adjust the size class distribution. This will yield 7, 90 inch mill logs (31 square feet B.A.) and an assortment of thinnings (15 square feet B.A.).

d. Conversion of even aged stands to all-age selection forest

On present knowledge of the regeneration habits and coppicing powers of jarrah, it is theoretically possible to convert the even-aged regrowth stands to all-age selection forest in 90 years by thinnings directed to this end, and the use of coppice control. A heavy thinning at age 40 years reducing the stocking to the best 60 trees per acre, followed by a coppice cleaning in which all coppice except the best 40 per acre are eradicated, would lay the foundations for the development of an all-age stand.

By keeping the stocking at a low level the maximum growth rates will be maintained on individual trees, resulting in a yield of mill logs from the regrowth at the earliest possible date.

Graph A shown the stem distribution in a 44 year old unthinned, overstocked stand.

Graph B sets out a theoretically ideal distribution for all-age selection forest.

In Graphs 1 to 8, using the premise that the increment on all girth classes is maintained at 1 inch of girth per annum, the steps are set out by which a conversion from A to B could be achieved by thinning and coppice control. These graphs show how repeated cuttings at 15 year intervals, each reducing the stocking to the order of 60 square feet per acre, could bring about the conversion in 90 years.

The following is an explanation of the treatments depicted in the graphs:

Graph 1 The stem distribution of an unthinned even-aged stand. Total basal area is 130 square feet of which 86 square feet make up the overstorey.

Graph 2 A heavy thinning leaving the best 60 well spaced trees per acre. Coppice cleaning 3 to 4 years later leaving the best 40 coppice stems and eradication of the remaining coppice.

Basal area - reduced to 61 square feet.

Graph 3 15 years after the first thinning. A second heavy thinning in the larger trees leaving the best 30 trees per acre. Stumps to be sprayed for coppice control.

Basal area - 103 square feet reduced to 63 square feet per acre.

Graph 4 30 years after first thinning. A trade cut removing 9 mill logs per acre and a light thinning in the coppice. All stumps to be sprayed.

Basal area - 107 square feet reduced to 71 square feet per acre.

Graph 5. 45 years after first thinning. Removal of 7 mill logs and a light thinning. Regeneration resulting from the previous cut may require slashing to reduce the numbers. All stumps to be sprayed.

Basal area - 110 square feet reduced to 68 square feet per acre.

Graphs 6,7 and 8 At 15 year intervals a trade cut and light thinning are carried out, reducing the stocking to approximately 60 square feet per acre each time. In Graph 8 the stand is at a stage where the "ideal distribution" can be maintained.

With selection forest, the concept of a "rotation" disappears. Once a suitable stem-distribution is achieved, periodic cutting removes the increment for the cutting cycle and maintains a desirable level of stocking. Regeneration is continuous.

The foregoing plan is designed for a top quality jarrah site. For poorer sites the cutting cycle would be increased and the level of stocking maintained at a lower figure. A theoretical stem distribution could be calculated for any site from an estimate of the maximum girth increment per tree and the optimum level of stocking to be carried on the site.

Discussion

Thinning, in some form, appears to be necessary to the maintenance of reasonable growth rates, in regrowth jarrah stands. It is suggested that thinnings directed towards conversion to irregular forest, may be the most suitable method.

Thinning can be expected to yield considerable returns in volume production on crop trees. The main commercial product of the jarrah forest is log timber with little prospect of a profitable sale for small sizes from the bulk of the forest area. Unthinned regrowth may carry over 500 stems per acre of which only 30 or 40 can be regarded as final crop trees. Thinning plots at Mundlimup (Wallace and Podger, ANZAAS Paper) have shown that, by concentrating the growth capacity of the site on fewer trees by thinning, the production per acre, on final crop trees, can be more than doubled. As well as a greater production per acre, the increased growth rate on individual trees means that mill logs will be available in a much shorter time.

More information is required on many aspects of thinning. Some of the more important problems appear to be the determination of:-

1. The optimum range of stocking for maximum increment in each site quality.

2. The most suitable type of thinning for the jarrah forest.

3. The cheapest methods of carrying out thinning and coppice control.

4. The possibilities of marketing of small sizes.

A.C. van Noort.
A.D.F.O.

ACvN:IB
16.6.60.

Unthinned Regrowth Plot.

Figure 1.

Basal Area per Acre.

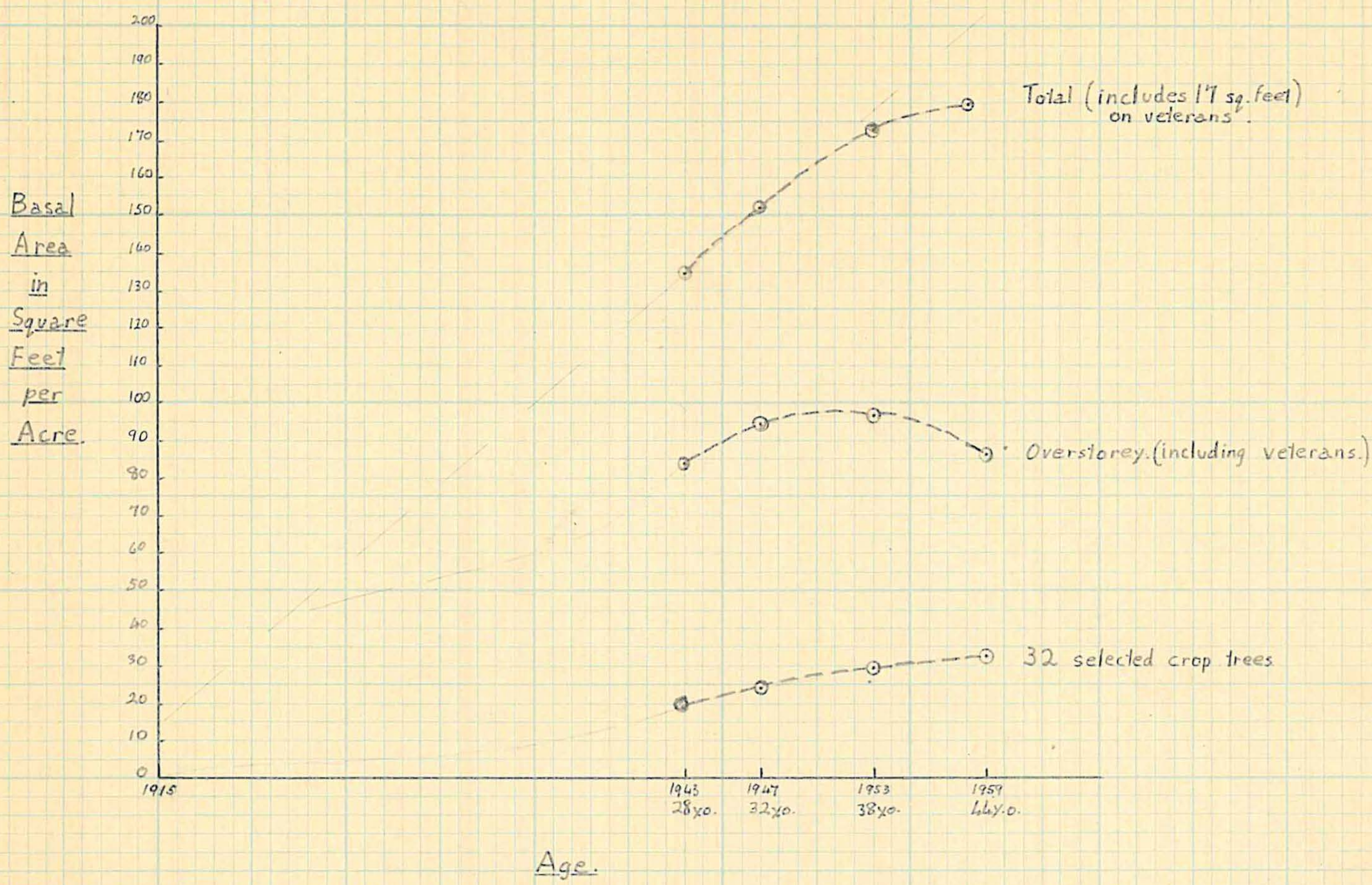
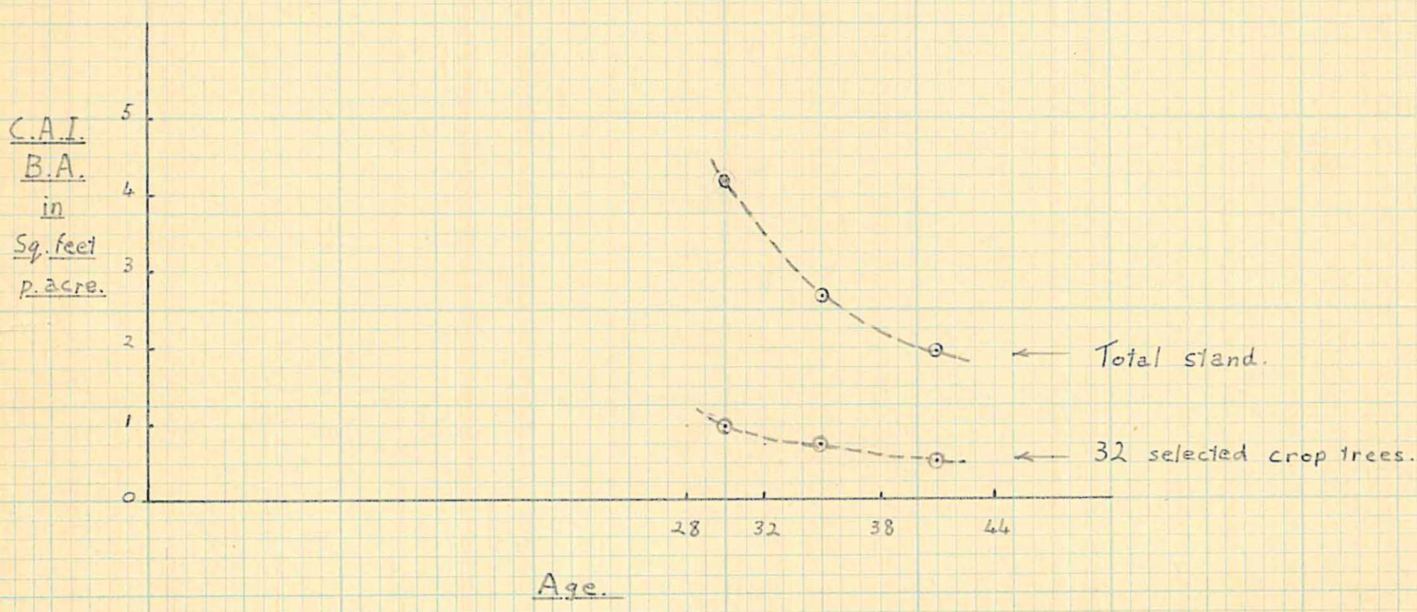


Figure 2.

Basal Area Increment. per Acre.



Graph A.

Stem Distribution by 15" Girth Classes.

Holmes 10 Litter Plot 1959 (44 y.o.)

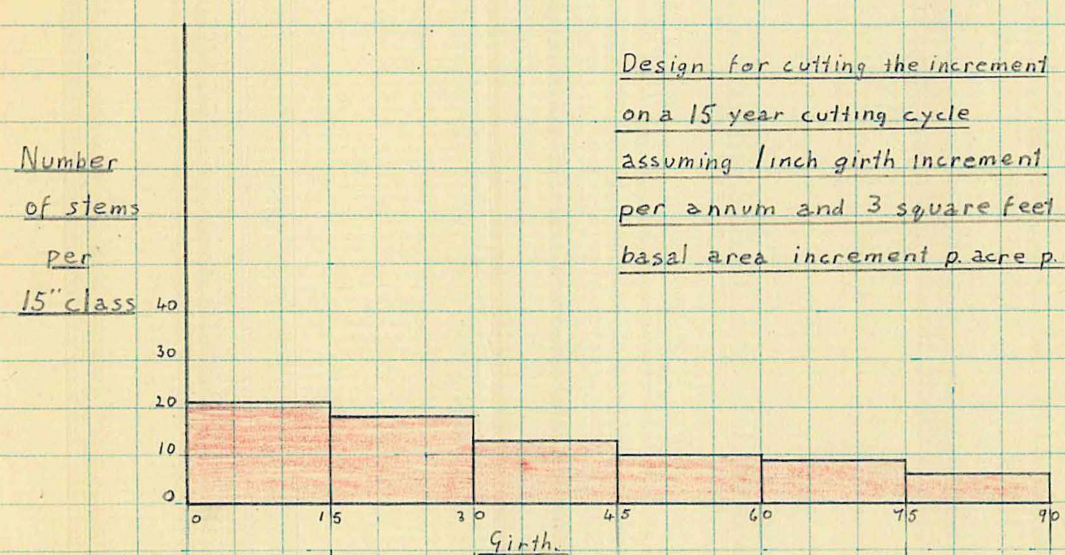
An unthinned stand on a high quality site.

Graph B.

Ideal Distribution for Managed Forest of High Site Quality.

A form of the De Liocourt Distribution using 6 size classes and a ratio of 125 %.

Design for cutting the increment on a 15 year cutting cycle assuming 1 inch girth increment per annum and 3 square feet of basal area increment p. acre p. annum.



	0–15	15–30	30–45	45–60	60–75	75–90	Totals.
B.A. per class at end of cutting cycle	2	9	15	22	28	31	107 sq'
B.A. per class at start of cutting cycle.	0	2	17	12	18	22	61 sq'

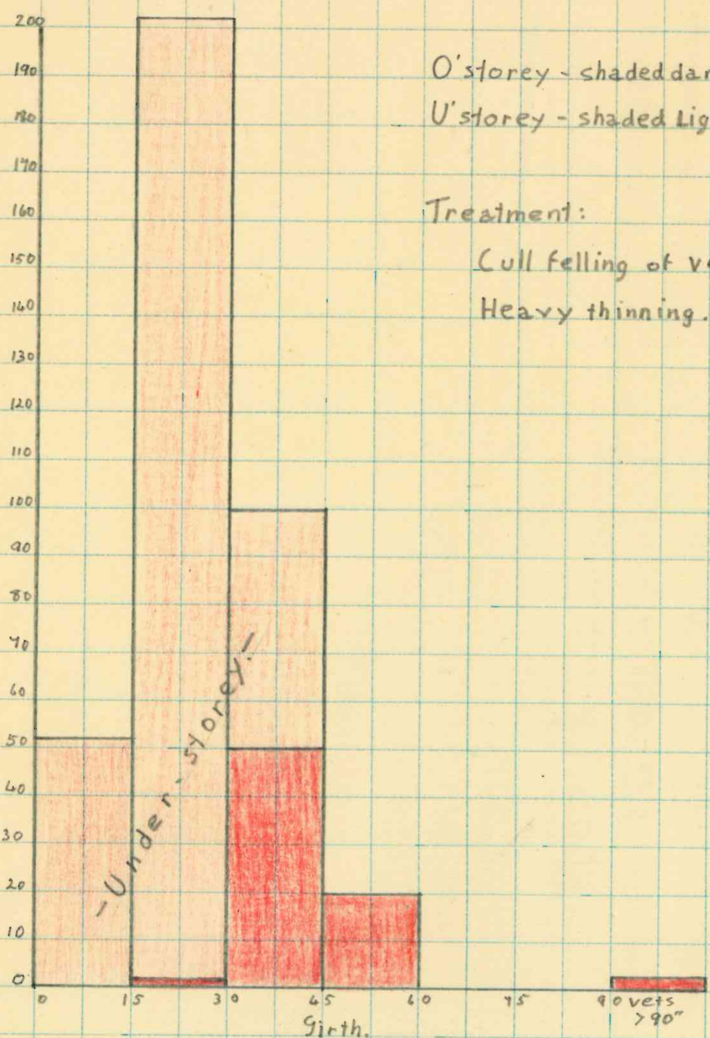
46 sq' removed every 15 years
31 as mill logs
15 as thinnings

Conversion of
to Uneven-age

1. Unthinned, even-aged stand 45 y.o.

O'storey - shaded dark.
U'storey - shaded Light.

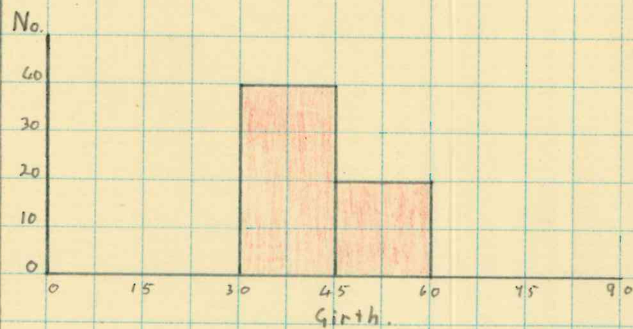
Treatment:
Cull felling of vets.
Heavy thinning.



Basal Area: Total 180 square feet.
O'storey 86 " "

2. Immediately after heavy thinning leaving the best 60 well spaced trees.

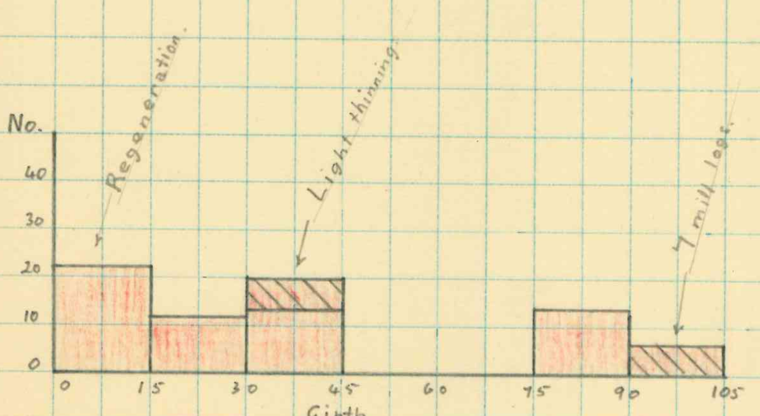
(A cleaning treatment 3 to 4 years after this will eradicate all unwanted coppice leaving approximately 40 well spaced coppice shoots.)



Basal Area = 61 sq'.

5. 45 years after 1st Thinning.

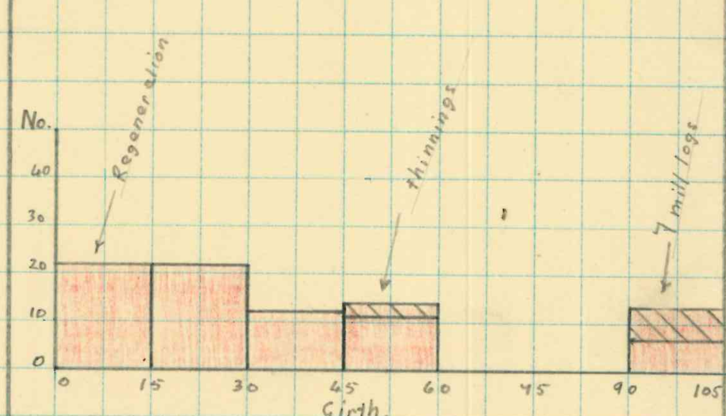
Treatment:
Removal 7 mill logs.
Light thinning in coppice
Stumps to be sprayed.
Slash regen. if necessary.



Basal Area Before Cut 110 sq'.
After Cut 68 sq'

6. 60 years after 1st Thinning.

Treatment:
Removal 7 mill logs.
Light thinning.
Stumps to be sprayed.
Slash regen. if necessary



Basal Area Before Cut 109 sq'.
After Cut 67 sq'.

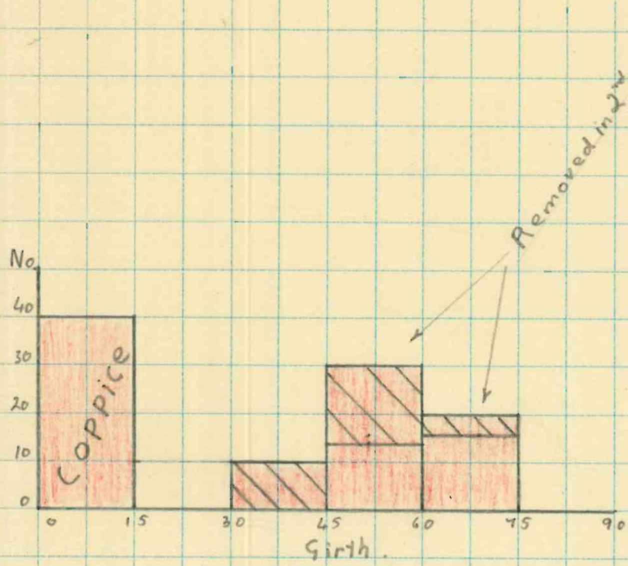
n of Even-aged Stands

-aged Selection Forest.

3. 15 years after 1st Thinning.

Treatment:

A 2nd Heavy Thinning leaving 30 best well spaced trees. Stumps to be sprayed to prevent coppice development.



Basal Area Before Thinning 103 sq'.
After Thinning 63 sq'.

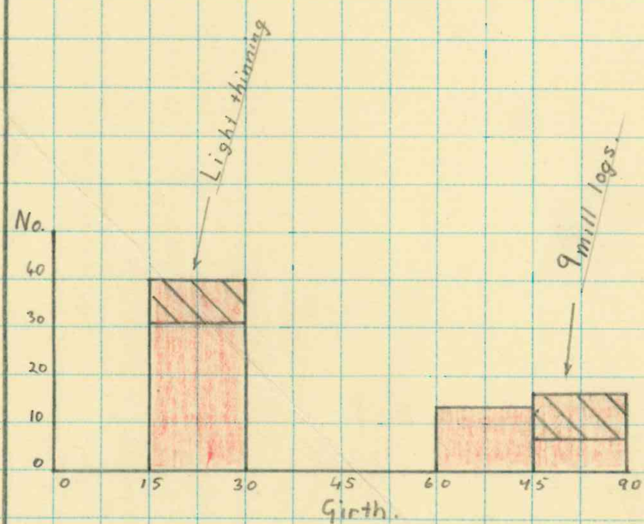
4. 30 years after 1st Thinning. ie. at 75 years of age.

Treatment:

Removal 9 mill logs 75"-90"

Light thinning in coppice.

Stumps to be sprayed.



Basal Area Before Cut 107 sq'.
After Cut 71 sq'.

7. 75 years after 1st Thinning.

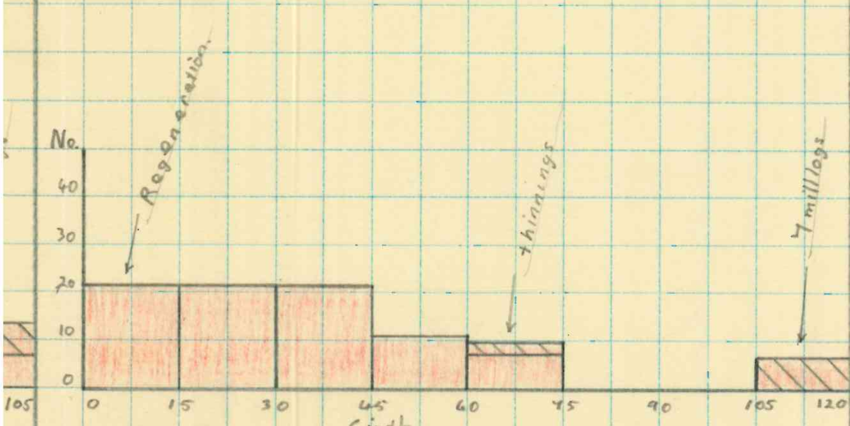
Treatment:

Removal 7 mill logs.

Light thinning.

Stumps to be sprayed.

Slash regen. if necessary.



Basal Area Before Cut 110 sq'.
After Cut 60 sq'.

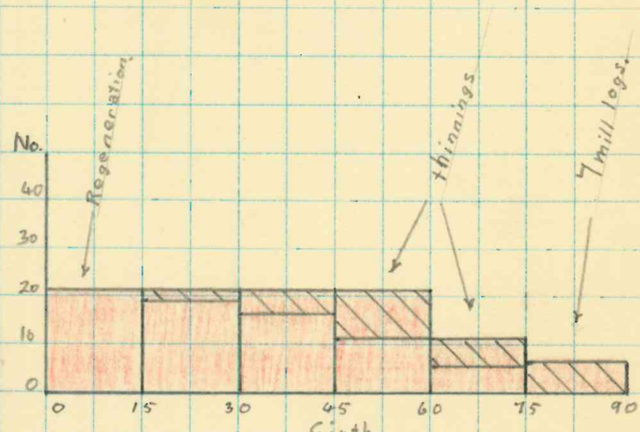
8. 90 years after 1st Thinning.

The stand is now at a stage where the "Ideal Distribution" can be maintained by thinning.

Treatment:

Removal of 7 mill logs

Thinning in all sizes.



Basal Area Before Cut 112 sq'.
After Cut 53 sq'.