KARRI REGROWTH PROGRAMME

INVENTORY AND PLANNING SOUTHERN REGION

KARRI REGROWTH PROGRAMME

The Karri Regrowth Programme has been developed in the Southern Region to systematically determine the nature of regrowth karri.

Regrowth Karri is identified as the second growth (or rotation) forest, occurring naturally as a result of wildfires and by means of logging, and subsequent regeneration activities.

The programme is designed to determine regrowth occurrence, growth rates, response to silvicultural treatments, identification of site influence on growth (site quality/index), influence of Karri veterans, result of defect on timber quality, and volume of timber produced.

There is no single discrete growth factor. The attached Appendix I illustrates the interwoven characteristics, and highlights our lack of knowledge of the second growth karri forest.

It is well known that there is "plenty" of regrowth in the Southern Region, but where is it, what area is there and how old is it? Much of the even aged regrowth has been recorded on the Hardwood Operations Control System. This mostly identifies regrowth resulting from logging activities. What of regrowth resulting from wildfires such as in Maringup and lower Gardner and past clearing practises (Group Settlement).

A project to resurvey the existing regrowth was initiated. (Appendix II outlines the project objectives and its purposes). The survey was conducted over the entire karri range in the Southern Region (Appendix III) and involved recording of both known and previously unrecorded stands. The unrecorded stands which resulted from selection cutting, group selection logging and fire damage, had to be identified using existing API Type maps and aerial photographs with numerous field checks.

The regrowth resource covers the following area (to December 1981)

DATE	AREA (hectares)	AGE (years)
Pre 1928	200	over 50
*1928-1960	6500	20 - 50
1960-1970	3300	10 - 20
Post 1970	16800	Under 10

(See Appendix IV)

*This includes the Big Brook/Treen Brook regrowth which is currently being commercially thinned.

The reinterpretation of aerial photographs (Black and White 1:40000 and 1:15840 scales) located an additional 1400 hectares of regrowth of which about 1000 hectares was of unknown age. The Karri regrowth resource now totals 29,000 ha and is increasing by about 2400 hectares annually through hand planting/seeding or from seed trees following logging.

The approximate areas of Karri regrowth in Big Brook and Treen Brook have been identified, however the exact boundaries are yet to be mapped. This arises due to the need for more detailed stratification of the forest which will isolate even aged regrowth from the existing mature forest and show differing degrees of overstorey. Existing photographs do not provide sufficient detail and completion of the regrowth assessment is now dependent upon a new series of 1:25000 aerial photographs scheduled to be taken during February-March 1982.

The question of age initiated the next phase of the project. For all unknown age stands, Karri aging by growth ring counting had to be carried out.

Also at this stage, as the regrowth to be aged was located across the range of karri occurrence, it was decided to incorporate stem analysis to provide an insight into the possible effects of geographic and rainfall variation on growth patterns of the second growth stands.

The procedures for aging by ring counting and stem analysis are outlined in Appendixes IV and VI respectively. A sample of the results from stem analysis is illustrated in Appendix VII.

Regrowth aging is in its final stage with only Maringup Block and part of the Big Brook/Treen Brook forest remaining.

With the conclusion of the regrowth survey (including aging), all data will be incorporated into HOCS and FMIS.

Determining growth rates of the even aged karri forest requires the establishment and remeasurement of a new series of increment plots. This project (Appendix VIII) created the tasks of identifying:-

1) a strategy which would provide for a distribution of regrowth plots across its natural range;
2) the number of regrowth plots required;
3) the type of plot required and its method of establishment;
4) the type of data required from the plots;
5) the type of input form on which to record the data for processing and;
6) the output format which would present meaningful and useable growth data.

1. Stratification of the Southern Region

Stratification using rainfall isohyet information and river catchment boundaries was used as the basis for locating the permanent increment plots. Appendix IX illustrates how this was achieved and how each "macrosite" was identified.

The distribution of regrowth is wide and varied, with concentrations of younger regrowth in logging priority areas, and this determined the distribution by ages.

2. Number of Plots Required

The dispersion and patch distribution of regrowth more or less determined the number of plots able to be established.

By stratifying regrowth by macrosite and age (classes were 0-10, 10-20, and twenty plus years) and by using approximate areas of each occurrence (from regrowth survey maps), the required number of plots was calculated to be 200 (Appendix X).*

3. Type of Plot and Method of Establishment

After field trials of various plot layouts, a square plot with four circular subplots was chosen. The size of the plot and subplots varies with age, as do the parameters measured. This was to provide a balanced representation in sampling upto age 30 years. The design is a 30 x 30 metre plot with subplots of different radii, depending on age. (i.e. 10% of plot at ages 0 - 5 years, increases to 20% at age 5 years, increases to 50% at age 10 years and the whole plot (30 x 30 metres at age 15 years). Refer Appendix XI.

A detailed procedure of plot establishment was produced (Appendix XII) and the first forty plots were established. In the procedures, definitions of tree and stand parameters relative to the regrowth forest are given plus detailed remeasurement procedures.

4. Type of Data Required

The type of data measured varies with age due to rapid changes in the regrowth stand structure.

For stands aged less than fifteen years information is required on the development of stand structure, changing dominance and mortality. All tree and stand parameter have been recorded for twenty four paired plots to obtain this data.

The additional plots in stands of this age group less data is gathered. In regrowth less than ten years old the trees are tallied by species only and between eleven and fifteen years they are tallied by species and diameter.

As the stand reaches fifteen years of age more tree characteristics are recorded. (See Appendix XIII).

5. Type of Input Form

A survey of existing Forests Department Increment/Inventory forms found that there was no one form to meet the data requirements.

A new form, F.D. 750 (see Appendix XIV) was developed which will enable recording of data as required for the different regrowth age categories.

*Also at this stage a selection of regrowth areas across the Southern Region was made in which the first forty plots were to be established. Following their establishment by October 1981, a review of progress was carried out. The results are discussed later in the report.

6. Output Format

The output format is being developed to give as much flexibility as possible for manipulating data. (Appendix XV).

There is provision for two output types.

i) Stand Statement - where stocking, basal area and volume (all by diameter classes) will be standard. The option will also exist to break down the output by other attributes which have been recorded for each tree i.e. species, defect class,height classes etc. Provision will also be made to divide the stand into rated portions i.e. top 10% basal area per hectare by diameter classes.

ii) Increment Statement - where basal area per hectare per annum and volume per hectare per annum by diameter classes is standard. Ingrowth and outgrowth for diameter classes will also be standard.

Provision will also be made to simulate thinning.

A review of this programme in October 1981 checked progress, suitability of procedures and data recording, methods and means for data manipulation and included a discussion on Stem Analysis and Site Quality progress and procedures.

A copy of the review is attached (Appendix XVI). The findings were that:-

1. Short term distribution of plots should be concentrated within two catchments (Donnelly and Shannon) and along an east-west belt between two isohyets (See Appendix XVII). This will hopefully provide an early indication of rainfall and geographic influence on Karri regrowth.

2. The number of plots remain at the proposed level of two hundred, as the resource is sufficient to enable their establishment.

3. The optimum number of trees per plot be in the vicinity of thirty. This provides sufficient data per plot for representative basic data for a growth model.

4. The size of plots remain as per the original schedule except that plots ages 30 - 50 are 40 x 40m's, 50 - 70 are 50 x 50m's and 70+ are 60 x 60m's.

5. Some modification be made to plot establishment procedures to meet varying objectives (see Appendix XVI page 3).

6. Output format be developed further.

7. Existing procedures and programme for Stem Analysis and Site Quality be continued, with a review at the completion of the Karri Aging Programme.

Current knowledge of the productive capability of different sites for Karri is limited, being based on the experience, of many years of forest management.

At present, the project of determining a set of site index curves for Karri regrowth is beginning to develop. The purpose of this work is to obtain an objective, scientifically based measure of site quality to direct protection and silvicultural effort.

It may be possible to relate differing production potentials to some other index, such as soil type or vegetation indicator species. This has already been contemplated as a future project (see Appendix I).

Site index curves can be derived in two ways:

(i) from measurements that indicates height and age of selected trees at different time or,

(ii) from measurements of height and age at any one point in time on a large number of trees across the age range.

The first method was stem analysis data or recurrent measurements of selected trees on permanent sample plots and is the procedure adopted for karri regrowth.

A wide range of data has been recorded to date. Appendix XVIII shows the distribution of data as derived from stem analysis of trees forty-plus years, and permanent regrowth plots.

The influence of veteran trees on the development of regrowth is known to be one of suppression. To quantify the effects of veterans two projects have been initiated.

The first project (Appendix XIX) was to determine the effect that single overstorey veterans have on the development of regrowth. This effect supports the practise of clear felling in Karri.

Sampling was restricted to forty to fifty year old regrowth in Treen Brook and Big Brook forest Blocks where regrowth is the result of clear felling in the early 1930's leaving seed trees for regeneration.

The study was completed and written up by mid 1981. The findings were:-

1. Height is affected to 1.25 R (R = Veteran Crown Radius)
   BA/ha is affected to 1.75 R
   Stocking/ha is affected to 1.75 R
   Volume is affected to 2.00 R
   Crown Depth is affected to 1.25 R
   Crown Development is affected to 1.25 R

2. Full stocking of crop tree regrowth is not achieved until 1.5R. That is, a 10% veteran crown cover allows about 75% of the area to achieve full regrowth stocking.

3. For every 1% of veteran crown cover there is a 2% loss of regrowth volume.

4. At 22% crown cover, the effects of individual trees begin to interact and are likely to be greater beyond this point.

   This supports the current practise of choosing a 15% veteran crown cover as the maximum acceptable for management as an even aged regrowth stand.

   This project has been extended to establish the effect of more than one veteran on the surrounding regrowth but is still in the design stage. (See Appendix XX).

An ongoing project is the study of Karri Stand Deterioration. The purpose is to determine whether or not small islands of uncut forest deteriorate with time due to exposure after cutting (See Appendix XXI).

The second of a series of photographs has been taken, however, the results have not been analysed as yet. Immediate impressions are that during the first few years epicormic growth develops on the external trees. This may have resulted from exposure or be an effect of the regeneration burn. Continued monitoring of reaction to cutting will determine the overall influence.

A project nearing completion is the Regrowth Volume Table for Karri. (See Appendix XXII). The base data has been collected and a tree volume model computed. The design of the volume table format has been completed and the final version of the printout produced. To complete the project a mock-up of the table is to be prepared and printed and a final report compiled.

Periodic updating will be required due to silvicultural and site changes which may affect the original sample's representativeness.

Several projects have been undertaken in the area of Silvicultural treatments.

The Karri Chip Yield plot trial was established in 1972 to provide thinning data in proportion for the thinning of extensive areas of forty to fifty year old regrowth forest. The size and extent of the plots were considered inadequate, however, they comprised the only thinning plots at that time (See Appendix XXIII).

Several reports have been written since the project began and remeasurements will continue until a review after the December 1984 remeasurement. Extensive thinning trials need to be initiated to cover the range of thinning options likely to be used.

The Karri Pole Taper versus Stand Density study set out to record the effect of thinning on taper, which could lead to an overestimate of volume if the diameter at breast height and height are the only measures used to predict volume. (refer Appendix XXIV).

The outcome of the study revealed that there exists significant differences in taper for heavily thinned stands (after twenty five years). More details will be made available if requested.

A further study, in liaison with Research Branch and C.S.I.R.O., involved the determination of effects of various machinery operating under adverse weather conditions on retained Karri stems in thinned areas.

This is a long term project, established in 1980, and will involve many remeasurements before results will be available. To date one measurement of the established plot has been recorded and a photographic series of upper stems has been taken. The photography is to record the affects of thinning on the remaining canopy.

Additional areas of study, particularly long term yield, need to be initiated as soon as possible.

Appendices

INVENTORY & PLANNING KARRI REGROWTH RESOURCE

LEGEND

- √√ KNOWN
- √ UNDER PROGRESS
- X TO BE INITIATED
- P10/79 I&P PROJECT NUMBER

MANAGEMENT OF REGROWTH KARRI AS A TIMBER PRODUCING RESOURCE

P 14/79 √ SURVEY OF EXISTING REGROWTH
MAINTENANCE OF √√ H.O.C.S. REGEN. RECORDS

- What % overstorey is too great for a stand to be managed as a regrowth stand?
- Where is regrowth with a high protection priority?
- Where is the regrowth? How much area? How old?

P 12/79 I, P12/79 II INFLUENCE OF VETERANS ON REGROWTH DEVELOPMENT
P12/79 I COMPLETE √√
P12/79 II TO BE DONE √

- How to manage mixed aged stands?
- Influence of surrounding trees in a small clearfell area

P 9/79 VOLUME FORMULAE √√ FOR REGROWTH STEMS - VARIATION WITH SITE AND DOMINANCE CLASS WEIGHT DATA FOR CHIP √√

- Volume of a stand or part stand?
- Long term information on effects of site and dominance class on tree form

PROTECTION MANAGEMENT

- What growth parameters do I wish to measure in the long term?
- Where are the most valuable sites?

MAINTENANCE OF OLD PERMANENT GROWTH PLOTS √√
P 10/79 √ Establishment of permanent growth plots on a range of macrosites and ages.

- How do volume & height growth relate to each other & site?
- Long term improvement of Site Index Classification.

√ SITE INDEX DETERMINATION BY STEM ANALYSIS

Is there a strong link?

X VEGETATIVE CLASSIFICATION OF SITE QUALITY CLASSES (SITE INDICATORS)

- What is the range of productive capacities?
- How can the site quality classes be mapped best?
- Which are the sites on which to concentrate silvicultural management?

X QUALITY OF TIMBER PRODUCED FROM REGROWTH STANDS

- Is the quality of regrowth timber different from old growth timber?
- What effect has thinning on timber quality?

P13/79 √ SILVICULTURAL TENDING OF STANDS

- Can I manage the stand to improve yield?

APPENDIX 1

RA

File copy

FOR PROJECT REGISTER

1.1 Regrowth survey - Karri

1.2 Reference no. :- 14/79

1.3 Files :-

2. OBJECTIVES

To locate areas of evenaged karri regrowth, to map the boundaries and assess its suitability for two purposes.

(i) for growth plot studies.

(ii) for management as a regrowth resource rather than allowing it to be cut as the mature forest is cut.

The two have different criteria.

3. PURPOSES

For objective (i) the purpose is to gather information on the growth of even aged karri stands with time over a range of sites. For objective (ii) the purpose is to extend the life of the timber industry until regeneration being established now becomes merchantable. Location of the areas is vital for planning of logging.

4. LOCATION

The karri occurrence belt of the Southern Region from the Donnelly Catchment in the west to the Frankland in the east.

5. INFORMATION REQUIRED

As stated in the objectives, two different set of criteria are applied, one for the growth plot objective, the other for the management objective.

(i) growth plot objective.

(a) minimum area 1 ha.

(b) no overstorey.

(c) minimum regrowth cover 50 - 60%.

(ii) management objective.

(a) minimum area 2 ha, to be reviewed following field checking of areas of this size.

(b) maximum overstorey 10 - 15%

(c) minimum regrowth cover 50%

5.1 Initial work

5.1.1 Mark possible areas from A.P.I. plans. These include areas that meet the above specifications and areas of severe fire damage that may have developed regrowth since.

5.1.2 Check these areas with 1:40,000 aerial photos. Different years photos will be used; summer photos to check species, winter photos to check stratification. The original 1:15,840 A.P.I. photos can be used, particularly to check for 1 ha areas free of overstorey.

5.1.3 Devise a coding system to code an area's suitability for one or other of the objectives.

5.1.4 Use spotter aircraft to check on doubtful areas and 35mm black and white oblique photos if necessary.

5.1.5 Ground checks will also he possible where areas are readily accessible.

5.2 Subsequent Work

5.2.1 Map areas onto H.O.C.S. 1:50,000 block plans and 1:25,000 coupe plans. Record areas in the H.O.C.S. system as evenaged regeneration.

5.2.2 Areas suitable for the growth plot objective will be a subset of the areas suitable for the management objective. These need to be mapped, rated for suitability and aged by stem analysis. They shall be mapped onto 1:50,000 block plans and arranged by river catchments.

5.3 Staff Required

T/A time to assist in interpreting photos and field work. Training of suitable staff in airphoto interpretation will be necessary.

6. REPORTS AND CONCLUSIONS

The project will be completed for the Shannon catchment and then re-appraised in a report.

7. FUTURE ACTION

Regeneration from present logging operations is already being mapped onto H.O.C.S. sheets. Once the project is completed no further work is envisaged unless selection criteria change.

3/12 5/12 5/12

MAP 3

KARRI ON CROWN LAND

SCALE 1:500 000

LEGEND

- Main Karri Belt
- Private Property
- State Forest, Timber Reserve (Forest Act) and C. of F. Land
- National Park and Proposed National Park
- Other Crown Land
- Karri Occurrence on Crown Land

Greenbushes
Boyup Brook
Mayanup
Bridgetown
Nannup
Yornup
Palgarup
Deanmill
Manjimup
Southern Region and Division Office
Jardee
Nyamup
Pemberton
Quinninup
Northcliffe
Pt. d'Entrecasteaux
Windy Harbour
West Cliff Pt.
Broke Inlet
Cliffy Head
Pt. Nuyts
Pt. Irwin
Foul Bay
Irwin Inlet
Nornalup Inlet
Nornalup
Walpole
Bow Bridge
Rocky Gully
Unicup Lake
Little Unicup Lake
Lake Muir
Byenup Lagoon
Tordit Gutrup Lagoon
Lake Jasper
Pt.

St. John
RIVER
Brook
HIGHWAY
BLACKWOOD
SEARS ROAD
River
KINGSTON ROAD
Yarraminup R
VASSE
Brook
DAWSON ROAD
Wilgarup
PERUP
STEWART
Barlee ROAD
GRAPHITE RD
Donnelly
ROAD
DAY
SEVEN
Brook
Lefroy Brook
WESTERN
ROAD
RIVER
Carey HIGHWAY
COAST
WARREN
Dombakup
Brook
WHEATLEY
COAST
ROAD
River
BEVAN
ROAD
THOMPSON
NORNALUP
Deep
Shannon
DEESIDE
HIGHWAY
West
River
Meerup River
ROAD
HARBOUR
CHESAPEAKE River
WINDY
Gardner
ROAD
ROAD
FRANKLAND
ROAD
River
Bow R
SOUTH
MORDALUP
RD
Tone
RIVER
Inlet Bk
ROAD

SOUTHERN OCEAN

APPENDIX IV

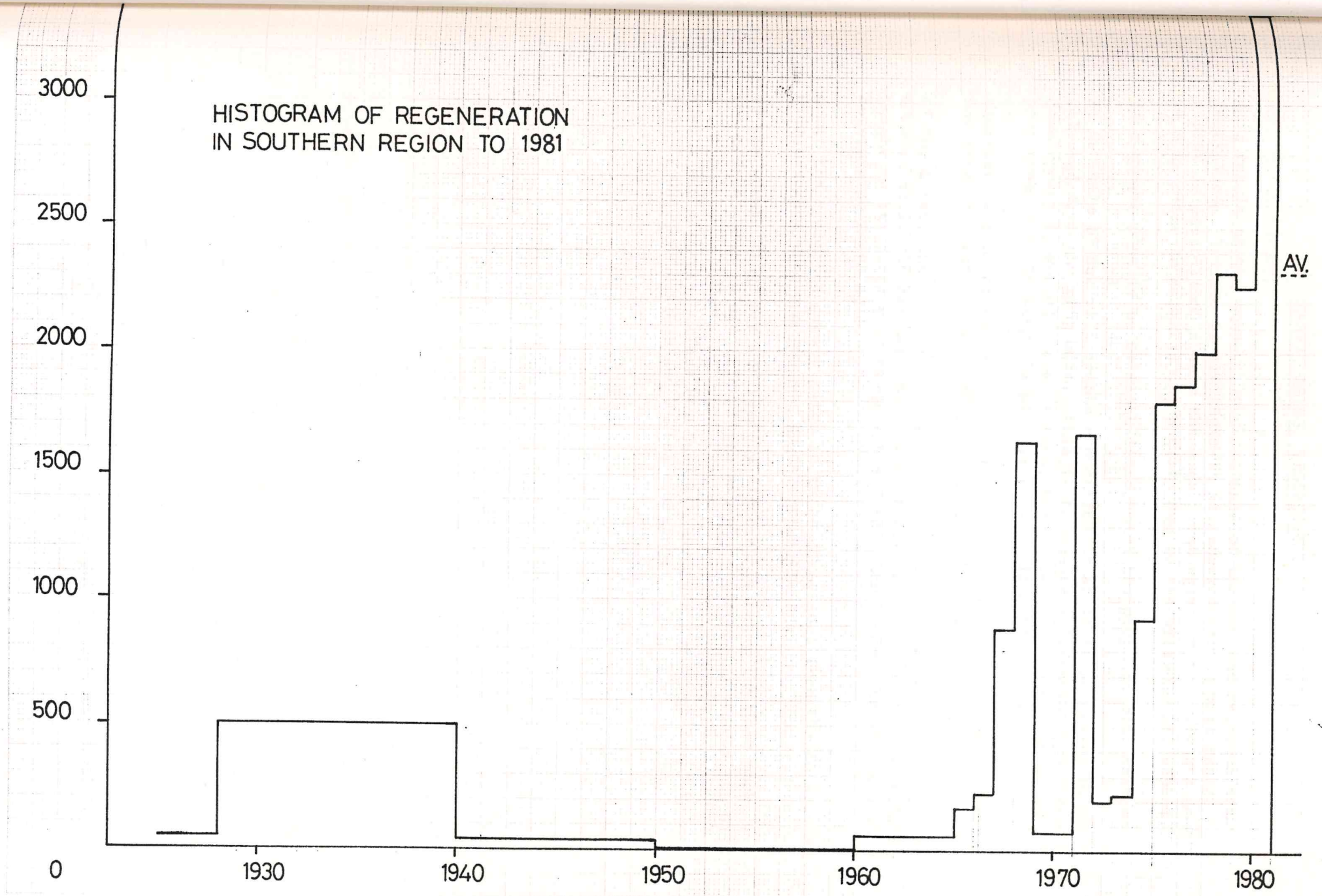
1. DATA EX H.O.C.S.

Age	Hectares	
Pre 1928	184	184
1928 - 1940	6033	
1941 - 1950	370	6553
1951 - 1960	150	
1961 - 1965	252	
1966	178	
1967	237	
1968	896	3279
1969	1640	
1970	76	
1971	76	
1972	1670	
1973	203	
1974	230	
1975	936	
1976	1813	16744
1977	1878	
1978	2005	
1979	2325	
1980	2260	
1981	3348	
	26760	

Average establishment over last 5 years is 2360ha/annum.

2. ROTHERAM'S REGENERATION SURVEY

Located a further 1420 ha
of this 1160 ha of unknown age.


HISTOGRAM OF REGENERATION
IN SOUTHERN REGION TO 1981
3000
2500
2000
1500
1000
500
0
1930
1940
1950
1960
1970
1980
AV.

KARRI AGING PROCEDURE

As a result of the survey, 1000 hectares of unknown age regrowth was identified. The age of the regrowth is required and in most cases, a plot is established within the area. The aging of the regrowth must be done prior to establishing a plot, due to the variable procedures.

If a growth plot is to be established, mark the proposed plot centre.

An estimate of age will enable a position of at least 50 metres to be selected from the plot edge. This is to ensure influencing plot tree development by reducing competition, to ensure there is no damage to plot trees and, to keep the plot free of inflammable debris.

Demarcate a plot of radius 15.96m (0.08ha) and measure the heights of the three tallest trees to obtain local top height.

Of the three, the tallest is felled and a disc removed at 0.5m above mineral soil. (It has been found that Karri can achieve at least 0.5m's height in its first year of growth and this has become the standard of determining Karri age).

Count the number of growth rings in three directions from the centre, at 0.5m, average then and add one to determine the age.

If the growth rings are not readily discernible bring the disc back to the office. Use an electric planer and plane diagonally across the disc.

When a satisfactory surface has been achieved use the "Magi-lamp" to magnify the growth rings and assist counting.

APPENDIX VI

S.M ANALYSIS - FIELD PROCEDURE

1. You will be given a plot location, plot size and the number of trees within that plot to be felled. Find all the trees and decide the order in which they are to be felled. Fell no dangerous trees.

2. Record the tree's dominance class. Fell tree.

3. Place marks at 0.5m, 1.3m, 3m, 6m, 9m, etc. to 4cm D.U.B. (i.e. 3m intervals). Where a bulge or branch exists at these points change the mark up or down but note the changed height. Record these heights on the field sheet next to disc numbers (note heights above ground level).

4. Measure and record total tree height.

5. Calculate 0.6 x total height and place a mark at this point on the stem also.

6. Measure and record height of crown break.

7. Cut discs of 10 - 15cm thickness at each of the marks on the stem. The mark is to be the top of the disc.

8. For the disc at 0.6 x total height measure and record D.U.B. then throw disc away.

9. Clearly mark on each disc the tree number and disc number. Use paintstick and/or Artline 70 felt pens.

10. Return to Manjimup with the discs.

11. Check all the discs of the tree are present, lay them out in order on a bench.

12. Measure and record bark thickness for each disc (an average of three measures).

13. Remove the bark then measure and record D.U.B. of each disc.

14. Plane the disc surface to allow rings to be counted along two radii.

15. Count the rings to get good agreement between counts in two directions. Record the average on field sheet.

16. Check all information on the field sheet is completed before discarding discs.

17. For trees too dangerous to fell, fill in a field sheet with as much information as possible. Accurate height measures.

Equipment Needed

Chainsaw + accessories
Axe
Branding Hammer
Paintsticks
Red Tape
30m Tape
Diameter Tape
Clinometer
Booking Board
Field Sheets
Scribble sheets
Trailer for Vehicle

Safe Working Advice

1. Standard safety procedure when felling. Watch for hung up limbs. Wear safety boots when operating chainsaw.

2. Discs will get wedged, to remove them first try cutting the stem at other places. If levering of the stem is necessary, select a sound branch for the purpose and lever using your legs. Both operators to help. Always get into a good position for any lifting and pushing and use your legs not your back.

STEM ANALYSIS - FIELD SHEET

Forest Type ..... Plot No. ..... Date ..... Assessor .....

Age of Regrowth ..... Plot Location .....

Tree Species ..... D.B.H.O.B. ..... 0.6 x total ht. .....

Tree No. ..... Total Height..... DUB at 0.6 tot. ht. .....

Dominance class ..... Total Age ..... Crown Break Height. .....

Disc	Height	D.U.B	Bark Thickness	Growth Rings	Age	Disc	Height	D.U.B	Bark Thickness	Growth Rings	Age
1						10					
2						11					
3						12					
4						13					
5						14					
6						15					
7						16					
8						17					
9						18					

Tree Species ..... D.B.H.O.B. ..... 0.6 x total ht. .....

Tree No. ..... Total Height ..... DUB at 0.6 tot. ht. .....

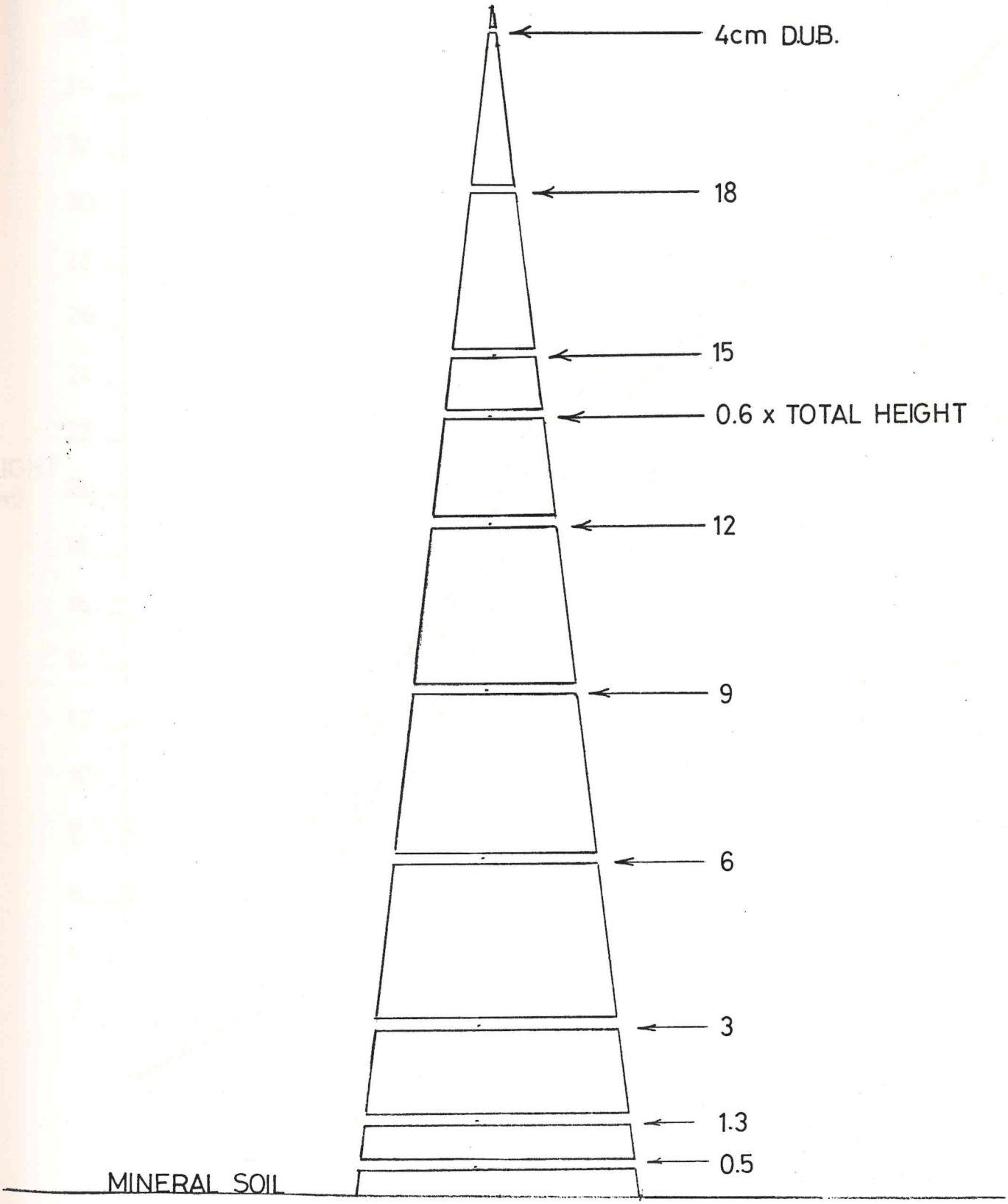
Dominance Class ..... Total Age ..... Crown Break Height .....

Disc	Height	D.U.B.	Bark Thickness	Growth Rings	Age	Disc	Height	D.U.B.	Bark Thickness	Growth Rings	Age
1						10					
2						11					
3						12					
4						13					
5						14					
6						15					
7						16					
8						17					
9						18					

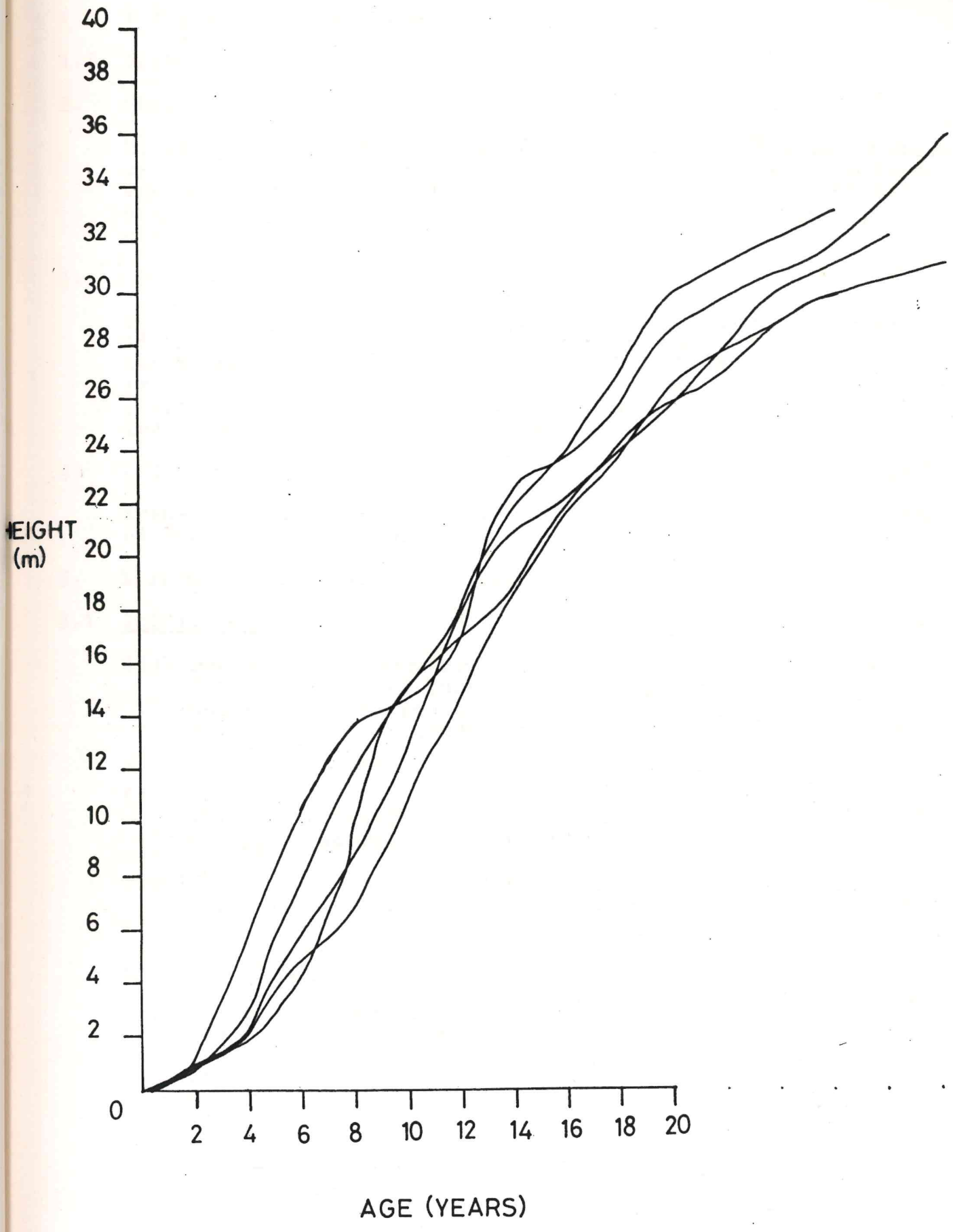
Accuracy of measurement - height to nearest 0.1m

- diameter and bark thickness to nearest 0.1cm

SCHEMATIC DIAGRAM OF STEM ANALYSIS



EUCALYPTUS DIVERSICOLOR



APPENDIX VIII

FOR PROJECT REGISTER

1.1 ESTABLISHMENT OF PERMANENT GROWTH PLOTS WITHIN EVEN-AGED KARRI STANDS.

1.2 10/79 A Revised 3-1981

1.3 B2.10

2. OBJECTIVES:

To establish growth plots in karri regrowth to give information on the development of stand parameters with time and how these vary with macro and microsites. Stand parameters of interest are species, stocking, basal area, total height, dominance class, crown size.

3. PURPOSE:

To expand knowledge on the growth of even-aged karri stands. It will be used to refine site index procedures, monitor development of stands to help silvicultural decisions, provide information on basal area and volume increment overtime and relate all these to the site on which the stand develops.

4. LOCATION:

Even-aged karri stands within the Southern Region and outliers at Boranup and near Denmark.

5. INFORMATION REQUIRED:

5.1 Initial Work

(i) Determine the occurrence and ages of well stocked (50% cover), even aged karri with freedom from overstorey competition, minimum area 1ha for growth plot establishment of a compact shape. (60m x 60m plot plus 20m buffer).

(ii) Stratify areas of karri occurrence by major river valleys to ensure good geographical representation of the plots across the karri range.

(iii) Within these river valleys the rainfall range shall be split into about 4 zones and plots established in these rainfall zones.

(iv) Within a river valley/rainfall strata the range of landscapes and soil types will be identified and plots established across this range. Reference will be to the soil types identified by McArthur and Clifton (1975). These river valley/rainfall/soil type locations will from hereon be called macrosites. Variation in stand top height will also be used to identify different macrosites.

(v) Where more than one age of even-aged stand occurs within a macrosite information is desirable in stands of approximately 5 years age difference in 0-20 year stands and 10 year age difference in 20-100 year stands.

Stands younger than 15 years old are very numerous but the number of plots in these stands will be no more than 30% of the total.

5.2 Subsequent Work

(i) The establishment procedure will differ with stand age, as will the stand parameters measured, but every plot established in a young stand must be capable of being expanded into a full sized plot with appropriate buffer.

(ii) Establishment procedures will be developed from the standard hardwood plot procedures, with appropriate attention paid to tie points to the plot and relocation of plot boundaries after fire.

(iii) The plots will be placed on H.C.C.S. Print 2. Close co-operation with Divisions is necessary when burning or trade operations are nearby.

(iv) Plots in 0-5 years stands will be remeasured every 2 years, plots in 5-15 year stands every 3-4 years and plots in 15 years + year stands every 5 years.

(v) Appropriate procedures and field sheets for measurement in each type of plot are to be developed. Computer worksheets are to be used in the field.

5.3 Staff Required

T/A's to assist with all this work. T/O Supervision and A.D.F.C. to revise procedures periodically.

6. REPORTS AND CONCLUSIONS:

Reports to summarize significant phases of the work are necessary. These will deal with:

(i) the macrosites defined in 5.1

(ii) the even-aged stands within which we can establish growth plots.

(iii) procedures for establishment, maintenance and measurement of the plots in the different aged stands.

(iv) After 40 plots have been established the procedures should be reconsidered.

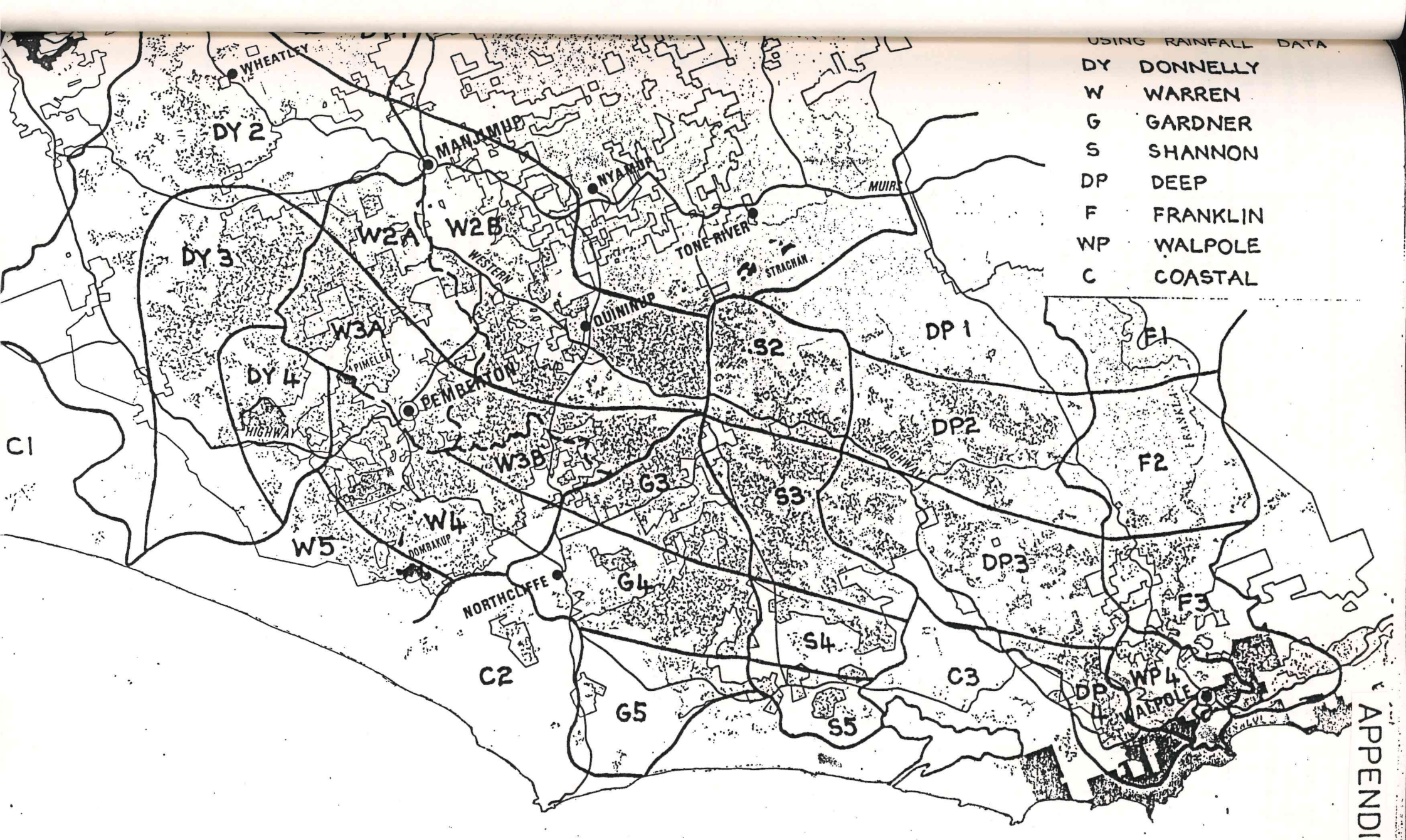
7. FUTURE ACTION:

After the first wave of growth plots (i.e. 200) have all been established and remeasured several times there should be a reconsideration of the needs before a second wave of plots.

Check annually for newly regenerated stands in microsites otherwise unsampled.

References:

McArthur, W.M. & Clifton, A.J. (1975) "Forestry and Agriculture in Relation to Soils in the Pemberton Area of Western Australia" C.S.I.R.O., Soils and Land Use Series No. 54.


USING RAINFALL DATA
DY DONNELLY
W WARREN
G GARDNER
S SHANNON
DP DEEP
F FRANKLIN
WP WALPOLE
C COASTAL
WHEATLEY
DY 2
MANJIMUP
NYAMUP
MUIR
DY 3
W2A
W2B
WESTERN
TONE RIVER
STRACHAN
QUININUP
W3A
S2
DP 1
F1
SPIMELEA
DY 4
PEMBERTON
HIGHWAY
DP2
F2
C1
W3B
G3
S3
W4
W5
DOMBAKUP
DP3
NORTHCLIFFE
G4
F3
S4
C2
C3
WP 4
WALPOLE
G5
S5
SCALE 1:500 000

APPENDIX IX

APPENDIX X

CATCHMENT & RAINFALL ZONE (Refer pp) B.2.10.B		Age of Stand	No. of Plots/ Stand	
DONNELLY 4	Flybrook 12	1972	2	
	Flybrook 3	1978	2	
	Beedlup Falls National Park (near Bunns dam)	?	1	
	Carey 9	1866		Perm. inc plot 819
	Beedlup N.P. (northern part)	?	1	
	Carey 6	?	1	First 40
DONNELLY 3	Lindsay Block (scattered areas)	1938	3	First 40
	Gordon 4 (One Tree Bridge MPA)	1953	2	First 40
	Graphite 7	?	1	— " —
	Graphite 4	1972	2	— " —
	Gray 1	1967	2	— " —
	Iffley 2	1977	2	— " —
	Iffley 2	?	1	— " —
DONNELLY 2	Andrew 4 and 6	1972	2	
	Andrew 1 and 2	?	2	
	Donnelly River (Wheatley, Gordon, Mack)	?	3	
	Willow Springs	?	2	
	Yanmah G562/61	?	1	
	Yanmah (Fatty Damper Gully)	?	1	
WARREN 5	Callcup Road	1940	2	
WARREN 4	Hawke 4	1939	3	
	Warren 2	1950	2	
	Warren and Dombakup 1969 & 1972 regen	1969/72	3	
	Warren 6	1887	1	First 40
	East of Dombakup plantation	?	1	
	Dombakup (south of Rifle Range Road)	?	2	
	Crowea 69 and 67 regen	1969/67	3	
	Brockman 10	?	1	
WARREN 3A	Brockman 12	1928	1	First 40
	Brockman 6	1924	1	— " —
	Brockman 6	1911	1	— " —
	Brockman (1967)	?	1	
	Brockman 6	1971	2	
	Solai 3 and surrounds	1937	2	First 40
WARREN 3B	Poole 1968 regen.	1968	2	
	Poole 1965 regen.	1965	2	
	Nairn 1963 and 64 regen.	1963/64	3	
	Brockman 13 planted	1964	2	
	Crowea 9	1942		Perm. inc plot 829
WARREN 2A	Deanmill surrounds	?	2	
	Diamond 1 coupe 18	1922	2	First 40
WARREN 2B	Diamond 2	1945	2	
	Quininup 6	1938	2	
	Sutton 2	?	2	
	Sutton 11, 19 and 22	1969	2	
	Sutton 1978-80 Regen.	1978-80	2	
	F 158/25 HC 70	?	1	

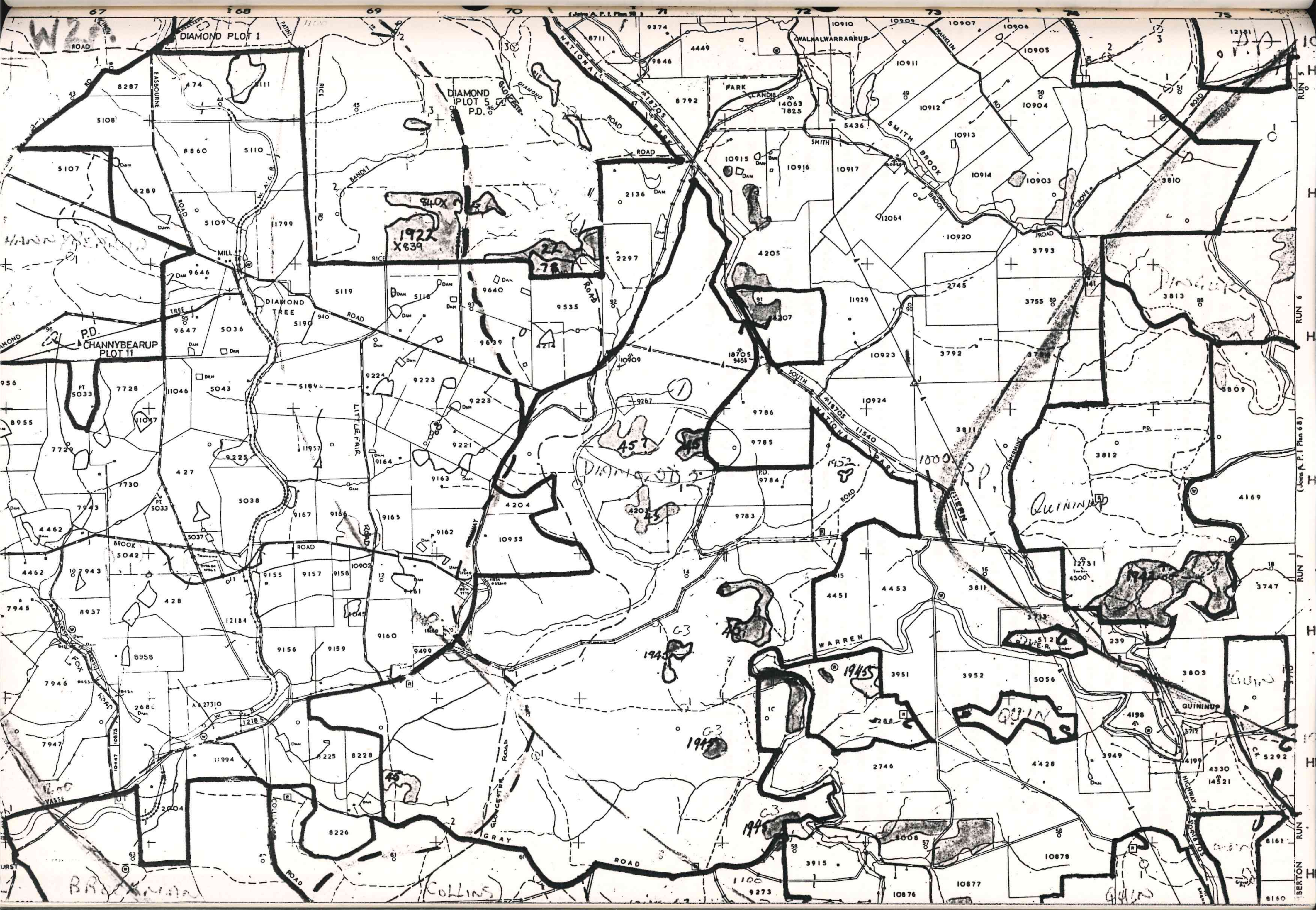
CATCHMENT & RAINFALL ZONE (refer pp 9-10) B.2.10.B		Age of Stand	No. of Plots/ Stand	
WARREN 1	Diamond 2 (east of SW Highway)	1942	2	
	Dingup 6	?	2	
GARDNER 5	Junction Chesapeake Rd & Gardner River Road, North of Lake Maringup In proposed South Coast N.P.	?	3	
GARDNER 4	Babbington, Muirillup, Boorara 1969 regen.	1969	3	
	Babbington 4 (KTC Road)	1980	2	
	Boorara 14	1949	1	
	Boorara 9	1950	1	
	Boorara 1 and 2	1969	2	
	Boorara 9	1967	1	
	Northcliffe Block JB 72	?	1	
GARDNER 3	Muirillup Block and adjacent Northcliffe Block.	?	2	
	Muirillup (east part of block)	1945	3	
SHANNON 5	Chesapeake Block JP82	?	3	First 40
SHANNON 4	Dixie 3	?	2	
	Trafalgar 1/Babbington 3	1972	4	
SHANNON 3	Weld 2	1966	2	First 40
	Weld 9	1972	2	— " —
	Westcliffe 10 and 11	1977	2	— " —
	O'Sullivan 6 and 7	1944	2	— " —
SHANNON 2	Gobblecannup 1	1972	2	— " —
	Curtin 1	1979	2	— " —
DEEP 4	Burnett Block (Railway Road)	1942	1	
	Keystone, Yellow Tingle and Karri	?	3	
	Keystone 1975 and 76 Regen.	1975/6	3	
DEEP 3	Mossop 75-79 regen	1975-79	2	
	Dawson 75-78 regen	1975-78	3	
	Dawson, S.E. part	?	1	
	Ordnance, Karri/Tingle	?	3	
DEEP 2	Challar (West part of Block)	?	1	
	Challar 9	1979	2	
	Mattaband 3	1964	2	First 40
WALPOLE 4	Swarbrick 1973-79 regen	1973-6	3	
	Walpole 2	?	2	

CATCHMENT & RAINFALL ZONE (refer pp) B.2.10.B		Age of Stand	No. of Plots/ Stand	
FRANKLAND 2	Walpole N.P. Karri/Red Tingle	?	2	
	Giants 72 regen.	1972	3	
	Walpole	?	2	
	P.P. (J.V. 108/9)	?	2	
	Frankland 1975-79	1975-79	3	
EAST OF FRANKLAND	P.P. 666 south of Giants Block	?	1	
	Red Tingle/Karri - Giants Block	1906(?)		perm. inc plots 639 and 64
	P.P. JV 127, JX 129, JZ 132, JZ 134	?	4	
	Karri Regen and Timber reserves & NP around Denmark.	?	6	
COASTAL 3	Burnett Block (72 regen) Centre Road	1972	1	
COASTAL 2	P.P. 9017 (JA 63), 12221 (JD62), 8886 (JD66)	?	3	
BIG BROOK, TREEN BROOK AND SURROUNDS 1930's regen.	Select the 20 plots across the range of sites in this forest.	1930's	20	

SUMMARY OF GROWTH PLOTS - MACROSITE AVAILABILITY

CATCHMENT /RAINFALL		AGES 1975-80	1970-75	1960-70	PRE 1960
NNELLY	1		UNLIKELY ●		
	2		✓		✓
	3	✓	✓	✓	✓
	4	✓	✓		✓
ARREN	1		UNLIKELY ●		✓
	2A		●		✓
	2B	✓		✓	✓
	3A		✓		✓
	3B		●	✓	✓
	4		✓	✓	✓
	5		●		✓
RDNER	3		●		✓
	4	✓		✓	✓
	5		●		✓
ANNON	1		✓		
	2	✓			
	3	✓			✓
	4		✓		✓
	5		●		✓
EP	1		UNLIKELY ●		
	2	✓		✓	✓
	3	✓	✓	✓	✓
	4	✓			✓
NKLAND	2	✓	✓		✓
	3		●		
POLE	4		✓		✓
STAL	1		UNLIKELY ●		
	2		●		✓
	3		✓		
T OF FRANKLAND			●		✓

● STRATA WHICH HAVE NO PLOTS IN 1970-80 DECADE i.e. REVIEW EACH YEAR THE REGEN WHICH FALLS IN THESE STRATA



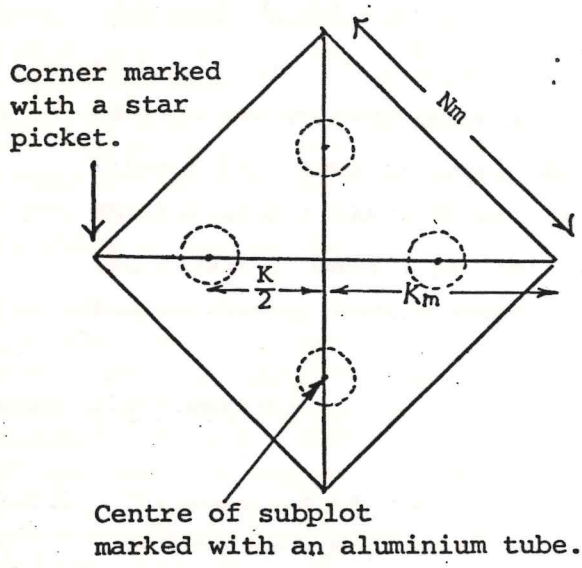
DIAMOND PLOT 1
DIAMOND PLOT 5 P.D.
P.D. CHANNYBEARUP PLOT 11
DIAMOND TREE
WALHALWARRARRUP
SMITH BROOK
PARK LANDS
NATIONAL PARK
SOUTH WESTERN
QUININUP
WARREN
GRAY ROAD
GLOUCESTER ROAD
BANDIT
RICE RD
EASBOURNE
LITTLE FAIR
BROOK ROAD
FRANKLIN RD
GROVE ROAD
PEPPERMINT
MILL
HIGHWAY
VASSE
FOX
RUN 5
RUN 6
RUN 7
(Join A.P.I. Plan 68)
(Join A.P.I. Plan 58)
67
68
69
70
71
72
73
74
75

APPENDIX XI

I have chosen to have a square plot of 30 x 30 metres (0.09ha), this being easy to establish in the field. Within each quadrat of this square we will locate 4 points as centres of circular subplots. Depending on the proportion of the plot we wish the subplots to comprise we can change the radius of these subplots ie. radius 2.676m gives a total of 10% of the plot with the 4 subplots, radius 3.785m gives 20% of the plot etc. My intention is to increase the size of these subplots from age 0 until at age 15 we measure the whole plot. We either specify the ages at which the radius of the subplots increases by certain amounts or specify the approximate number of trees to be included in each subplot and then record the radius (each of the 4 subplots should be the same size at any measurement). At this stage I have suggested subplots to be 10% of the plot from age 0 - 5, increase to 20% at age 5, increase to 50% at age 10 and then to the whole plot at age 15. If the principle of this plot arrangement is approved I will do some field trials to test these numbers. Another possibility is that at age 10 all the trees down to a diameter limit on the whole 30 x 30m plot can be tagged and measured, in addition to measuring all trees on the subplots.

With this plot set up the measurements at successive ages will be consecutive. Plot size increases as the stand sorts itself out. The same input sheet will be used at each stage but until age 15 not all the columns will be used. In age 0 - 5 stands, species, height, crown radius and crown depth will be measured. At age 5 DBHOB will be added and at age 15 defect, dominance class and epicormic rating will be added.

Each measurement more trees will be added and the numbers will eventually be hard to follow but I don't see any way around this. With tree deaths numbers will become scattered anyway.



AGE	N(m)	K(m)
≤30	30	21.21
30 - 50	40	28.28
50 - 70	50	35.36
70+	60	42.43

SUBPLOTS

AGE	$\frac{K}{2}$(m)	RADIUS(m)
0 - 5	10.6	2.10
6 - 15	10.6	4.32
16 - 25	10.6	5.63

AGE 0 - 5	Species Total Height Tree Position
AGE 5 - 15	Species Total Height DBHOB Crown Radius Crown Break Height Mean Bark Thickness on North Subplot only Tree Position
AGE 15+	Species Defect Dominance Epicormics DBHOB Bark Thickness on North Subplot only Total Height Height to Crown Break Crown Radius Tree Position

HARDWOOD INCREMENT PLOTS IN EVEN-AGED STANDS

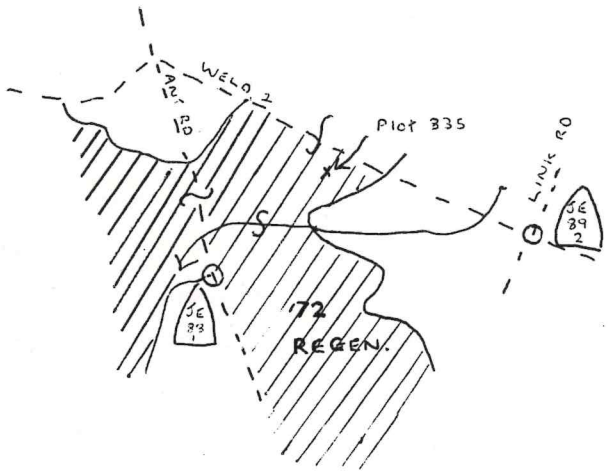
1. ESTABLISHMENT

1.1 Equipment Needed

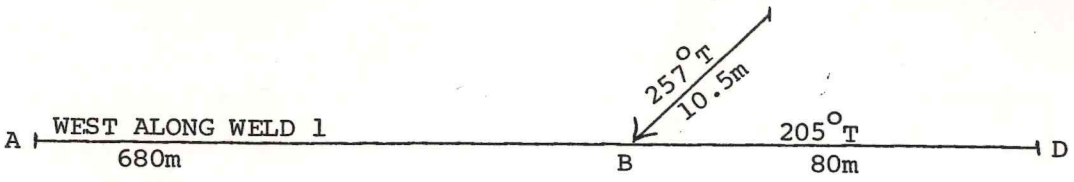
Booking board, plot sheets, maps, scale rule, protractor, pencils and rubber, compass, 100m survey band, 30m fibre-glass tape, diameter tape, bark guage, clinometer, height sticks, star pickets (5 per plot), aluminium tubes, numbered tags, nails, hammer, paintsticks, white paint, brush, soil auger, plastic bags, labels.

1.2 Plot Location

1.2.1 The position of the plot will be on either a 1:25,000 scale plan supported by a B&W airphoto. Work out the tie to the plot centre using a protractor and scale rule. Where possible use a reference tree as the tie point, failing that, a well defined road junction or creek crossing. For other than a ref. tree give a 6 figure map reference also.



1.2.2 Tie from tie point to intermediate point using the vehicle "trip meter". Near to the intermediate point establish either a shield tree or marked stump and tie from it to the intermediate point. Tie from intermediate point to plot centre using chain and compass. Do a tie sketch on F.D. 586 as follows.



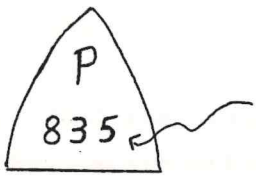
A) JE-89-2 Junction Weld 1 and Link Road.

B) Intermediate pt. on south side Weld 1.

C) Painted stump

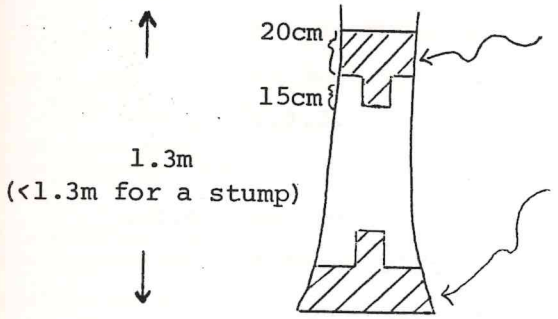
D) Centre of plot 835

1.2.3 A shield tree is preferred but may not be possible in young regrowth, in which case a stump should be painted as per marked trees (softwood procedures). If neither is available use a 10 x 10cm jarrah post painted white with the letters cut into it.



Plot number

Cut the letters deeply and use large, neat lettering.



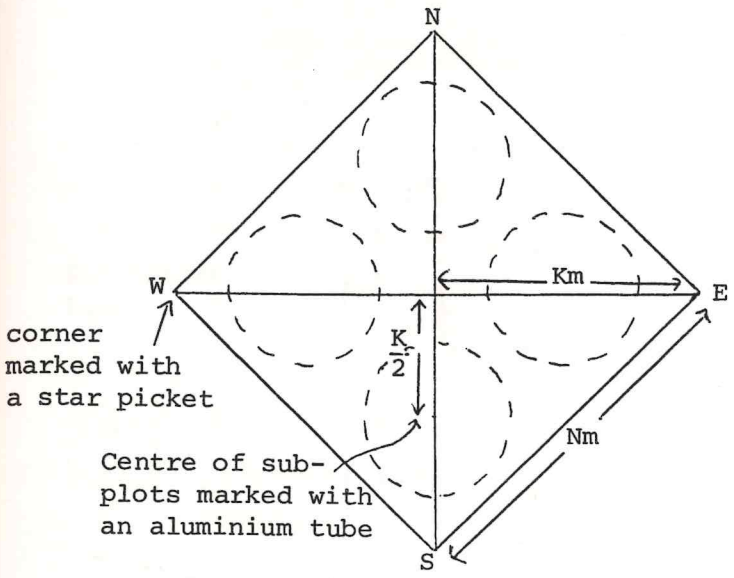
Top painted band 20cm wide, 1.3m above ground. Vertical lines 15cm long, facing intermediate point.

Lower painted band 20cm from mineral soil, clear away litter.

1.3 Plot Establishment

1.3.1 Mark plot centre and four corners with star pickets painted white. Pickets should be driven in 45cm where possible. Tie a tag, with the plot number on, to the centre picket. Where there is an obstacle at the point which prevents putting the picket in, then place the stake as near as possible to the point and note the bearing and distance from the pocket to the true point. If the obstacle is a sound log put a nail and tag in at the exact point.

1.3.2 Plot corners are established by fibreglass tape and compass from the centre point. Take both a forward sight and a back sight, trampling scrub where necessary. Corners are K metres from the plot centre at the four points of the compass (north, east, south and west).



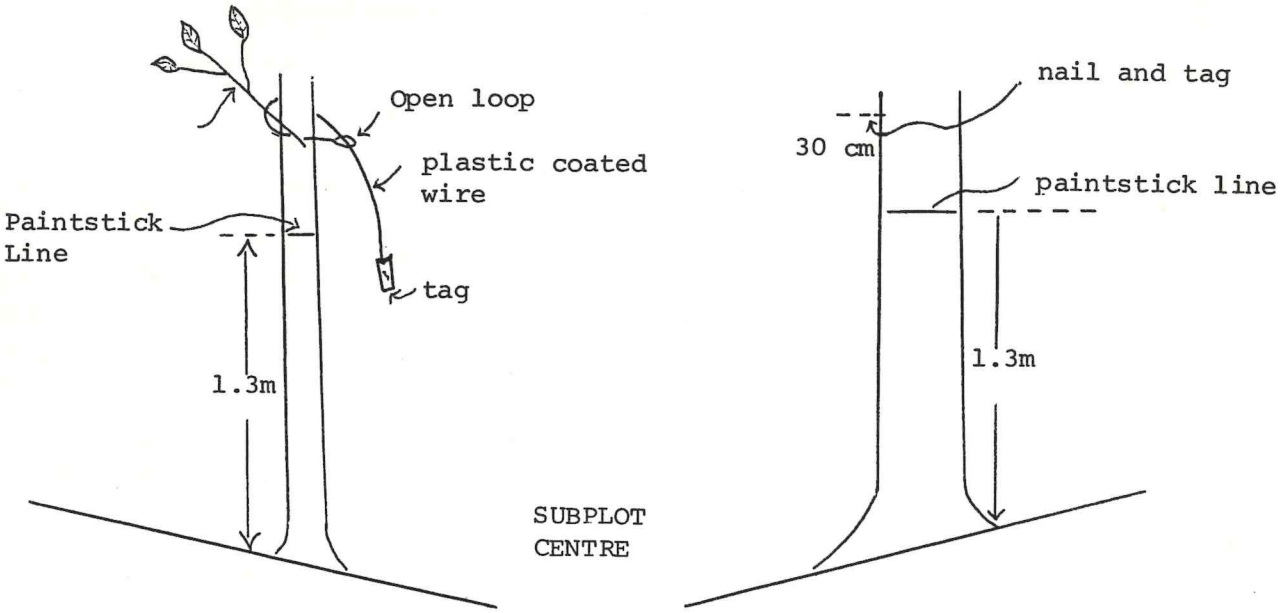
AGE	N(m)	K(m)	$\frac{K}{2}$
≤ 30	30	21.21	10.61
31 - 42	35	24.75	
43 - 56	40	28.28	
57 - 70	50	35.36	
71 - 82	60	42.43	
83 -100	70	59.50	
≥101	80	56.57	

1.3.3 Check that the sides of the plot are Nm. Maximum error is ± 10cm. Start off with your most reliable corner and chain around the plot. Adjust the positions of the pickets if necessary. When completed, drive in pickets. NB If 1.3.2 is done very precisely step 1.3.3 is easy, so take time on 1.3.2.

1.3.4 Subplots are established along the north, east, south and west diagonals at $\frac{K}{2}$ metres from the plot centre. They are marked by an aluminium tube with 3cm showing above soil level (see diagram in 1.3.2).

1.4 Tree Measurement - Are subplots to be established, if yes go to 1.4.1, if no go to 1.4.12.

1.4.1 Subplot radius is 2.10m from 0-5 years, 4.32m from 6-15 years and 5.63m from 15 - 25 years. Start at north subplot. Mark all trees in the subplot, checking particularly borderline trees. Number trees in a clockwise direction starting from north of subplot centre. Mark breast height with a paintstick using a 1.3m stick on the high side of the tree. Place a numbered tag on the tree. For trees up to 13cm DBHOB suspend tag from plastic covered wire. Use a branch to hold wire well off ground. For trees >13cm use a nail 30cm above breast height with tags to face subplot centre.



1.4.2 Measure all trees in subplot. The parameters to be measured change with tree age.

Species Codes are:
1 - Jarrah
2 - Karri
3 - Wandoo
4 - Blackbutt
5 - Marri
6 - Yellow Tingle
7 - Red Tingle
8 - Tuart
9 - Other - Specify

AGE 0 - 5	Species Total Height Tree Position
AGE 5 - 15	Species Total Height DBHOB Crown Radius Crown Break Height Mean Bark Thickness on North Subplot only Tree Position

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AGE 15+	Species
	Defect
	Dominance
	Epicormics
	DBHOB
	Bark Thickness on North Subplot only
	Total Height
	Height to Crown Break
	Crown Radius
	Tree Position

1.4.3 Defect is as it affects growth. Code as follows:-

0: - Nil Defect.

Defect \ Severity	Slight	Moderate	Severe
Butt	1	2	3
Bole	4	5	6
Crown	7	8	9

Note: slight is affecting < ¼ of tree, moderate between ¼ & ½ & severe > ½ tree.

Note: defect is not to be confused with the effects of suppression by more dominant trees. Where two parts of a tree are defect affected, score the more severe of the two.

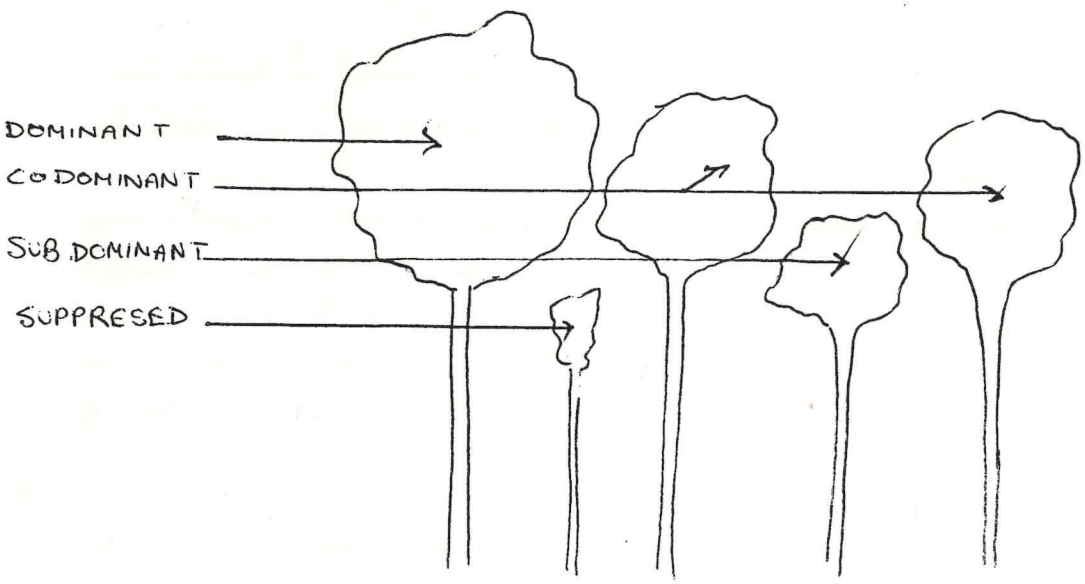
1.4.4 Dominance is based on the crown position and vigour.

1: Dominant crown with access to light from above and sides.

2: Codominant crown with access to light from above.

3: Subdominant crown with restricted access to light from above.

4: Suppressed crown well below competitive level with no access to direct sunlight.



1.4.5 Epicormic rating, is as follows:-

0: - nil
1: - mild epicormic development in crown.
2: - heavy epicormic development in crown.
3: - mild epicormic development on bole.
4: - heavy epicormic development on bole.

In case of crown and bole epicormics the largest number is booked.

1.4.6 Bark thickness is the mean of at least 2 bark thicknesses at breast height.

1.4.7 Crown break, total height and crown radius can be either estimated or measured. At least three well spaced trees per subplot must be measured. Heights are measured using either height sticks or accurately with a clinometer if too high for height sticks. Crown radius is measured at three points around the stem and the mean taken. A clinometer is used to get the vertical projection of edge of the crown to the ground.

Where trees are estimated, the measured trees are used as the reference.

E,M,D means estimated, measured or dendrometered. Dendrometer measurement of selected trees will be used at a later stage.

Crown break is defined by "active" branches. Active branches are ones with a healthy end region and few epicormic shoots along the branch. The eye moves up the tree to the first active branch. The distance from it to the second active branch is measured (or estimated). If it is less than X metres the first active branch is crown break. If greater than X metres repeat for the second and third active branch and so on (X is 5 x DBHOB, Eg. DBHOB = 40cm, X = 2 metres).

1.4.8 Tree position is a bearing and a distance from the subplot centre. Don't take a bearing on each tree. At 0^{o}, 45^{o}, 90^{o}, 135^{o}..... 315^{o} select the nearest tree to that bearing and record its bearing. All the trees will be in clockwise order.

1.4.9 Repeat 1.4.2 - 1.4.8 for all subplots. Numbering should be consecutive. e.g last number North subplot 17, first in East subplot is 18.

1.4.10 At age 10 and older all unmeasured trees down to 10cm DBHOB will be tagged and measured on the whole 30 x 30m plot. All trees outside subplots will be assigned subplot X and the position given from the plot centre. Accurate positions must be given for trees 5m from centre picket. Measurement as per the trees in N,E,S and W, subplots.

1.4.11 At the end of tagging the remainder of the bundle of tags will be stored for use at remeasurement when new trees may be added. The bundle will be marked with the plot number.

GO TO 1.5

1.4.12 No subplots are used. All trees on the plot $\geq$ 10cm DBHOB are tagged and measured. All tree species are included. Trees are numbered in a clockwise direction, starting from north of the plot centre. Mark breast height with a paintstick using a 1.3m stick on the high side of the tree. The tag is placed on a nail 30cm above breast height facing the plot centre.

1.4.13 Parameters to be measured for each tree are:

Species (Codes 1 - Jarrah, 2 - Karri, 3 - Wandoo, 4 - Blackbutt,
5 - Marri, 6 - Yellow Tingle, 7 - Red Tingle,
8 - Tuart, 9 - Other species, specify)

DBHOB

Crown Radius

Crown Bark Height

Mean Bark Thickness (north subplot only)

Defect

Dominance

Epicormics

Tree Position

1.4.14 Defect is as it affects growth. Code as follows:

0: - Nil Defect

Defect \ Severity	Slight	Moderate	Severe
Butt	1	2	3
Bole	4	5	6
Crown	7	8	9

Note: defect is not to be confused with the effects of suppression by more dominant trees. Where two parts of a tree are defect affected, score the more severe of the two.

1.4.15 Dominance is based on the crown position and vigour.

1: Dominant crown with access to light from above and sides.

2: Codominant crown with access to light from above.

3: Subdominant crown with restricted access to light from above.

4: Suppressed crown well below competitive level with no access to direct sunlight.

1.4.16 Epicormic rating, is as follows:-

0: - nil
1: - mild epicormic development in crown
2: - heavy epicormic development in crown
3: - mild epicormic development on bole.
4: - heavy epicormic development on bole.

In case of crown and bole epicormics the largest number is booked.

1.4.17 Bark thickness is the mean of at least 2 bark thicknesses at breast height.

1.4.18 Crown break, total height and crown radius can be either estimated or measured. At least 10 well spaced trees per plot must be measured. Heights are measured using either height sticks or accurately with a clinometer if too high for height sticks. Crown radius is measured at three points around the stem and the mean taken. A clinometer is used to get the vertical projection of edge of the crown to the ground.

Where trees are estimated the measured trees are used as the reference.

E,M,D, means estimated, measured or dendrometered. Dendrometer measurement of selected trees will be used at a later stage.

Crown break is defined by "active" branches. Active branches are ones with a healthy end region and few epicormic shoots along the branch. The eye moves up the tree to the first active branch. The distance from it to the second active branch is measured (or estimated). If it is less than X metres the first active branch is crown break. If greater than X metres repeat for the second and third active branch and so on (X is 5 x DBHOB, Eg. DBHOB = 40cm, X = 2 metres).

1.4.19 Tree position is a bearing and a distance from the subplot centre.

1.4.20 At the end of tagging the remainder of the bundle of tags will be stored for use at remeasurement when new trees may be added. The bundle will be marked with the plot number.

1.5 Stand and Site Measurements

1.5.1 Fill in all sections of the plot sheet.

1.5.2 Note Land-form which refers to topography e.g. ridge top, slope, next to creek stream or river.

1.5.3 Soil phosphorous analysis will be done at establishment. Sample 3 points per plot. One will be the centre, another the corner most upslope from centre and the third the opposite corner to the second. These will be labelled U - upslope, M - midslope and D - downslope.

Around each point 5 subsamples will be taken within 2 metres of the point. Soil will be augered to 5cm and the 5 subsamples combined and sent to Como for analysis.

1.5.4 List the 3 predominant understorey species.

1.5.5 Microsite refers to ashbed condition. More microsite factors may be identified in future.

1.5.6 Top height is based on 25 trees per hectare or two trees within 15.96 metres of the plot centre. The total height of the two tallest trees in that circle will be measured accurately and recorded. Coppice off stumps should be excluded.

2. REMEASUREMENT

2.1 Remeasurement interval is 2 years for age 0-5, 3 - 4 years in ages 5 - 15 and 5 years from age 15 onwards.

2.2 At remeasurement a new subplot size may be required.

Extra trees should be added systematically i.e. do all extra trees in North subplot, then E, then S, then W, then X.

Within a subplot start at true north and work clockwise. Record bearings of the trees nearest to 0^{o}, 45^{o}, 90^{o}, 135^{o}, ,....., 315^{o}. Numbering starts from where the numbering was finished at the previous measurement.

2.3 Alternatively, some or all the subplots will be discarded after remeasurement. In such a case do the remeasurement then for the subplots that are to be discarded remove the tags on all the trees < 10cm DBHOB. Remove the aluminium tube. All trees ≥ 10cm DBHOB now become part of the whole plot at next remeasurement and at that time their position will be recorded as Subplot X and the appropriate bearing and distance from the plot centre recorded.

2.4 At remeasurement a new plot size may be required. Before doing this tag ingrowth trees on the original plot starting from north of plot centre and going clockwise. Then reposition the corner pegs at appropriate distances from the plot centre (see 1.3.2). The new trees are then tagged and measured starting from north of plot centre and going clockwise.

3. PROGRAMME OF MEASUREMENT

Age of Stand at Time of Measurement (YEARS)

	0 - 5	6 - 10	11 - 15	16 - 25	26+
SUBPLOTS					
Initial measurement	Establish 4 subplots Radius 2.10m	Establish 4 subplots Radius 4.32m	Establish N&S subplots Radius 4.32m	Establish N subplot Radius 5.63m	Don't Establish Subplots
Remeasurement	Remeasure all subplots	Expand subplots to radius 4.32m, measure all 4 subplots.	Remeasure all 4 subplots, then dismantle E&W subplots.	If N&S subplot remaining re-measure both then dismantle S subplot. If N only remaining expand to 5.63m and then measure.	Remeasure north subplot then dismantle it.
Different measurements to be introduced at different ages.					
Total Height Species Position	YES →				
D.B.H.O.B. Crown Radius Crown Depth Mean Bark Thickness (North Subplot Only)	NO	YES →			
Defect Dominance Epicormics	NO	NO	YES →		

INPUT DRAFT

1. TITLE: Even aged hardwood growth plot

2. PLOT INFORMATION:

Date
Assessor
Tie Information
Soil/Site Description
Vegetation Type (Understorey)

Plot Number
Division, Block, Coupe
Year of Establishment of Crop
Type of Establishment (Seed Trees, Planted etc.)
Date of Measurement - Previous
- Current

Block Name
Radius of Subplots
All trees down to ..... cms tagged and measured

Height of six largest diameter trees per plot (62.5 per ha).

3. TREE INFORMATION :

Subplot Letter :- N, S, E, W, or X for outside of subplots
Tree Number
Species
Suitability for Remeasurement
Defect:- 0 - 9
Crown Dominance Class:- 1 - 3
Epicormic Rating :- 0 - 3
D.B.H.O.B.
Estimated, Measured or Dendrometer:- E,M, or D, refers to Subsequent Measurements

Height to Crown Break
Total Height
Crown Radius

Tree Position:- (Bearing and Distance, not to be punched)

F.D. 750

FORESTS DEPT. OF W.A. HARDWOOD INVENTORY

INCREMENT PLOTS IN EVEN AGED STANDS

Sheet ___ of ___

ASSESSOR:	LANDFORM:	SOIL	UNDERSTOREY
DATE:	MICROSITE:		
6 FIG. REF.:			

PLOT Nº	DIV	BLK	CPT	YEAR of REGEN	PLOT MEASURED PREVIOUS MTH	PREVIOUS YEAR	CURRENT MTH	CURRENT YEAR	ASST. TYPE CODE	S'PLOT RADIUS (m)	D LIMIT (cm)

PLOT SIDE (m)	SUBPLOTS MEASURED N E S W	BLOCK NAME	TOP HEIGHT 15·96m RADIUS 1	TOP HEIGHT 15·96m RADIUS 2

SUBP	TREE Nº	SP	DEF	DOM	EPIC	D.B.H.O.B. (cm)	B.T. (cm)	EMD	CROWN BK (m)	TOTAL HT (m)	CROWN RADIUS (m)		POSITION DEGREES	POSITION DIST. (m)	COMMENTS
1	2 3 4	5	6	7	8	9 10 11 12	13 14	15	16 17 18	19 20 21	22 23 24	25 26 27	28 29 30	31 32 33	

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33

OUTPUT DRAFT

The output should be divided into a stand statement at a measurement date and an increment between two measurements. It should also be possible to aggregate plots and or subplots with like specifications. In this respect the output is similar to the hardwood increment plot printouts H1A, 1B, 2A, 2B. However, the rest of the even aged hardwood output must be an improvement on these old outputs.

The output should print general information about the plot. As an option the listing of the input data should be available.

1. Stand Statement

A stand composition diagram similar to the one produced by the Victorian F.C. would be very useful.

Numbers, Basal Area, and Volume all by diameter class (suggest 2cm classes) should be standard output. It should also be an option to break down those numbers, basal areas and volumes by an attribute that has been inputed for each tree such as species, defect class etc.

eg.

DIAM. CLASS	NUMBERS/HA			BASAL AREA/HA		
	KARRI	MARRI	OTHER	KARRI	MARRI	OTHER
3	5	0	0	.4	0	0
5	9	2	0	.6	.2	0
7	16	5	1	.9	.3	.1
9	15	3	0	.9	.1	0
11	23	8	0	1.5	.5	0
etc.						

. It may also be possible to divide by derived attributes such as crown depth (total height - height to crown break).

Another option for dividing the data is to divide the stand into the top x per ha, the second x per ha, third x per ha etc., based on diameter and also to add these to get the top x, top 2x, 3x etc. The type of information divided in this way would be basal area per ha, mean diameters, volumes per ha.

2. Increment Statement

Increment of basal area per ha/year and volume per ha/year by 2cm diameter classes should be standard. Again it should be possible to have these broken down by a specified tree attribute.

The increment data should also divide into top x per ha, second x per ha etc. and top x, 2x, 3x etc. x should ideally be a variable.

The change in numbers of trees from measurement A to measurement B should be divided by diameter classes and into growth into the d class, growth out of the d class and death from time A to time B. With shrinkage of suppressed individuals it may be useful to know if growth in or out of a d class was by expansion or shrinkage of D.B.H.O.B.

3. Thinning

The output should be designed to incorporate thinning aswell.

4. Miscellaneous

Greg Strelein suggested that bole lengths by diameter class and volumes by log assortments may be desired output.

by 2cm classes is too detailed - have facility to divide into whatever classes are of interest.

APPENDIX XVI

KARRI REGROWTH PLOT PROGRAMME REVIEW

INTRODUCTION:

A review of the Karri Regrowth Programme was held at the Inventory and Planning Office in Manjimup on the 12th and 13th of November, 1981. The following report outlines the results arising from discussion of most aspects associated with obtaining data to provide information pertaining to the growth of the even aged karri regrowth stands in the Southern Region.

AIM OF THE REVIEW:

The aim was to review the Karri Regrowth plot establishment progress; to review the procedures for plot establishment and data recording; to review and discuss methods and means for data manipulation; and to review and discuss Stem Analysis and Site Quality progress and procedures.

OUTLINE OF NEED FOR THE KARRI REGROWTH PROGRAMME:

The progress report identified the need for the Karri Regrowth Programme by outlining the amount of regrowth in the Southern Region (approximately 29,000ha). The progress to date was outlined covering field surveys and plot establishment, and office preliminary analysis of data.

Having established the need for a Karri Regrowth Programme and accepted the progress to date, it was decided that there were two interim objectives for which data was required. The objectives were identified as mensurational and silvicultural, with the detail of data required varying between them.

The most satisfactory time from which to begin collecting data for mensurational objectives was determined to be at age fifteen years. At this age, karri begins to show a clearly defined stand structure, the dynamics of the stand have begun to stabilise (in comparison with the earlier ages) and reliable indicators of site begin to express themselves (i.e. Total Height, Crown Radius). From this age, data suitable for the development of a growth model can be collected.

Data for silvicultural objectives is required for stands less than fifteen years old. This will provide information on changing stand dynamics, stand composition (species), mortality, height development, effects of silvicultural treatment (thinning, fertilizer) and indicate differences between seeded and planted stands.

It is the acknowledgement of the above separate objectives which creates the need to change the existing procedures and recording of details. The resulting changes are discussed later in the report. The following points list the various aspects pertaining to the Karri Regrowth Programme and the reviews of each.

1. PLOT DISTRIBUTION

The original proposal to establish 200 plots within available regrowth within the Southern Region, accommodating a broad geographic distribution was found to remain acceptable. The location of further plots will be determined by the Projects Officer with a view to obtaining the best possible data covering a wide range of sites and meeting the requirements for the development of a Karri Regrowth Model.

In the short term however, it is proposed to concentrate establishment of plots within two river catchments (Donnelly and Shannon Rivers) and between the catchments along a rainfall isohyet. This will effectively produce an east-west and two north-south distributions which will provide early data from which indications of the effects of rainfall gradient and geographic location of the karri may be obtained.

2. NUMBER OF PLOTS

The existing proposal to establish 200 plots was based on the current availability of even aged karri regrowth. The Southern Region was stratified to enable an even distribution of plots to obtain balanced information on the karri regrowth resource.

An attempt was made to provide a statistical back up to the proposed number of plots. Using data available and methods to hand, it was found that at least twice the number of plots proposed was required to provide a statistically based plot establishment programme.

It was pointed out that there was a problem with the method used to obtain the statistically based information and also that it was not necessary to have an excessive number of plots, provided the extremes of ranges for the different parameters were sampled.

The original proposal was accepted as being soundly based and is to be implemented with the continued programme.

3. NUMBER OF TREES PER PLOT

Data available from established plots in even aged karri regeneration (regrowth) indicates that in some cases there are too many trees being recorded. The number of trees varies with different sites and some compromise appears to be required to achieve a satisfactory solution.

An analysis of data with a view to determining the statistically required sample which would provide sound resource information was attempted. Various parameters were used initially, with tree Total Height being selected by its variability as being the most suitable parameter to use. This method of deciding the number of trees required per plot produced unweildy results, requiring more trees than were already being recorded.

From past experience it was decided that the optimum number of trees on any plot should be in the vicinity of 30, as this provides a sufficient number of samples to produce representative basic data for a growth model.

4. SIZE OF PLOTS

The use of variable plot sizes has resulted in satisfactory levels of data being recorded from plots within stands of different ages. The younger the stand, the smaller the plot size.

For stands less than 25 years of age, 4 subplots are used to avoid anomalies of microsite i.e. ashbed effects. The subplots are circular and of variable radii. The radius depending on the particular age of the stand involved.

Using figures previously obtained in deriving the statistically correct number of trees required per plot, an attempt was made to determine the statistically correct plot size. This resulted in exceptionally large plot sizes being required and it was decided that this was not operationally or economically justifiable.

It was decided to retain the existing schedule of plot sizes for stand ages less than 30 years and adopt the following rationalised plot sizes for use in the future plot establishment programme.

30 - 50 years	40m x 40m
50 - 70 years	50m x 50m
70+	60m x 60m

5. PLOT ESTABLISHMENT PROCEDURES

The review of establishment procedures indicated that to a large extent they remain satisfactory. However, some modifications were seen to be necessary to meet the diverse needs of the mensurational and silvicultural objectives.

MENSURATIONAL

It was suggested at the review that plot size be related to stand parameters such as stocking and basal area as they are direct indicators of site quality, rather than using stand age as is the current practice. The variable plot radii would enable the suggested optimum number of trees per plot (thirty) to be measured for growth model data.

This method presents a problem of having to implement a variety of plot sizes within stands of the same age, resulting from a range of site qualities.

To overcome the problem mentioned, it was decided to utilize the rationalised sizes indicated in the review of plot sizes as this will provide a standard procedural operation which can be readily applied and controlled in the field. The rationalised plot sizes are based on data obtained from plots established prior to the review.

For the recording of data for mensurational objectives (initially the development of a growth model) in stands of 15 years and older, it was decided to continue as outlined in the original regrowth assessment procedures. All tree parameters recorded on the assessment form, F.D. 750 were seen to be required for mensurational objectives and it was proposed to continue the use of the form in its present format.

SILVICULTURAL

Plot sizes and establishment procedures were seen to be suitable to continue as stated in the assessment procedures, with some changes to the data being recorded.

In stands of regrowth under 15 years there is a requirement to obtain basic information of gross stand parameters and to maintain an overall view of the stands. Information relating Karri regrowth response to thinning and fertilizer regimes was also seen to be required.

To obtain this detail it was decided to establish up to 20 plots within areas of even aged hand planted and seeded regrowth, selected to cover the middle and extremes of site quality. On these plots, subplots would still be employed to monitor and provide for microsite variation.

It was also decided that as there are extremely high mortality rates in regrowth, aged less than 10 years, no tagging of individuals is to be attempted. Data recorded in this age range is to be restricted to a tally by species and local top height (local top height being the average height of the three tallest trees within a 15.96 metre radius of the plot centre).

For stands aged between 10 and 15 years, diameter class tallies are to be recorded.

6. OUTPUT FORMAT

Required output data was defined at the outset of the Karri Regrowth plot Programme. This provided the background for discussion and the existing ideas were accepted. A need was seen to develop an output format and further work is to be carried out by the Projects Officer.

This will require an investigation of all possible output modes from the data available, specifications of exactly what is required and checking existing programme packages to obtain the desired output format.

SITE QUALITY - STEM ANALYSIS

The initial age determination of Karri Regrowth 'found' by Rotheram's survey, provided the basis for work towards determining Site Quality.

Direct information by felling selected trees for aging (ring counting) and measuring tree height has been obtained over a wide range in the Southern Region. The selection of trees was based on a 0.08 hectare plot. On this plot the three tallest trees (local top height) were measured and for stands under the age of forty years, the tallest was fallen and ring counting was carried out. For stands over forty years stem analysis was carried out on the tallest two trees. (NB. This upper age was later changed to over sixty years as data accumulated for the lower aged stands.)

The results of ring counting for age and stem analysis have been individually plotted . A Master Chart has also been plotted and is being used as a guide to direct further data gathering to specific areas requiring investigation.

The existing procedure and programme was accepted and will continue to completion of the regrowth aging programme. Further areas to be investigated will be determined by reviewing data at the completion of the aging programme.

FIELD TRIP

The review concluded with a field trip to various even aged stands in which regrowth plots had been established.

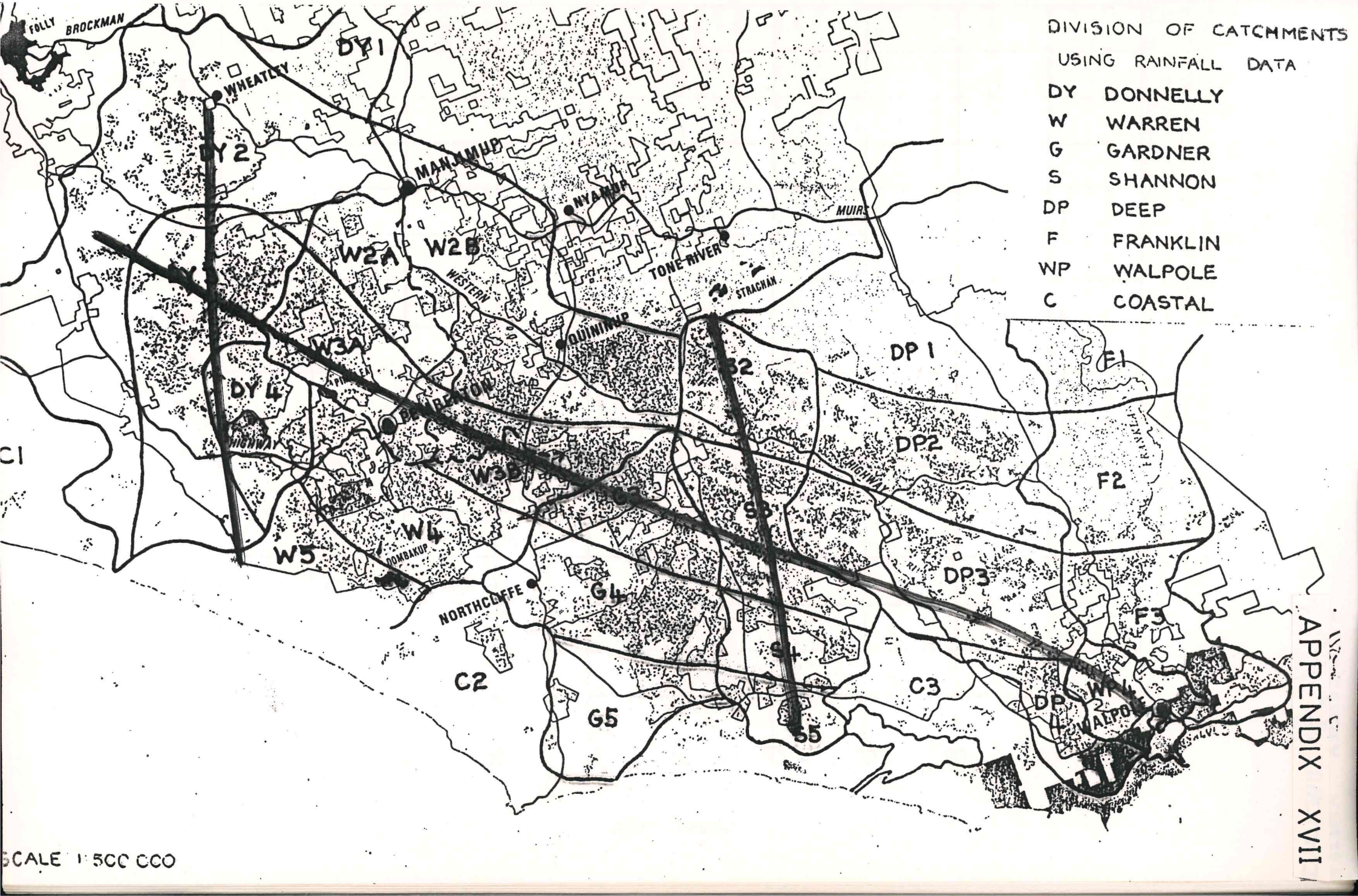
The Agenda indicates the age range of regrowth inspected and highlights some of the different types of problems encountered with the stands.

The need for different types of data for the two objectives of mensuration and silviculture was confirmed, as was the age at which data should begin to be collected for mensurational purposes (regrowth age 15 years).

Scale diagrams for the proposed plot sizes had been developed earlier, however, at the review and discussion stage existing plot sizes had been regarded as satisfactory for the young aged karri regrowth (less than 30 years) and rationalised plot sizes had been accepted for stands over 30 years.

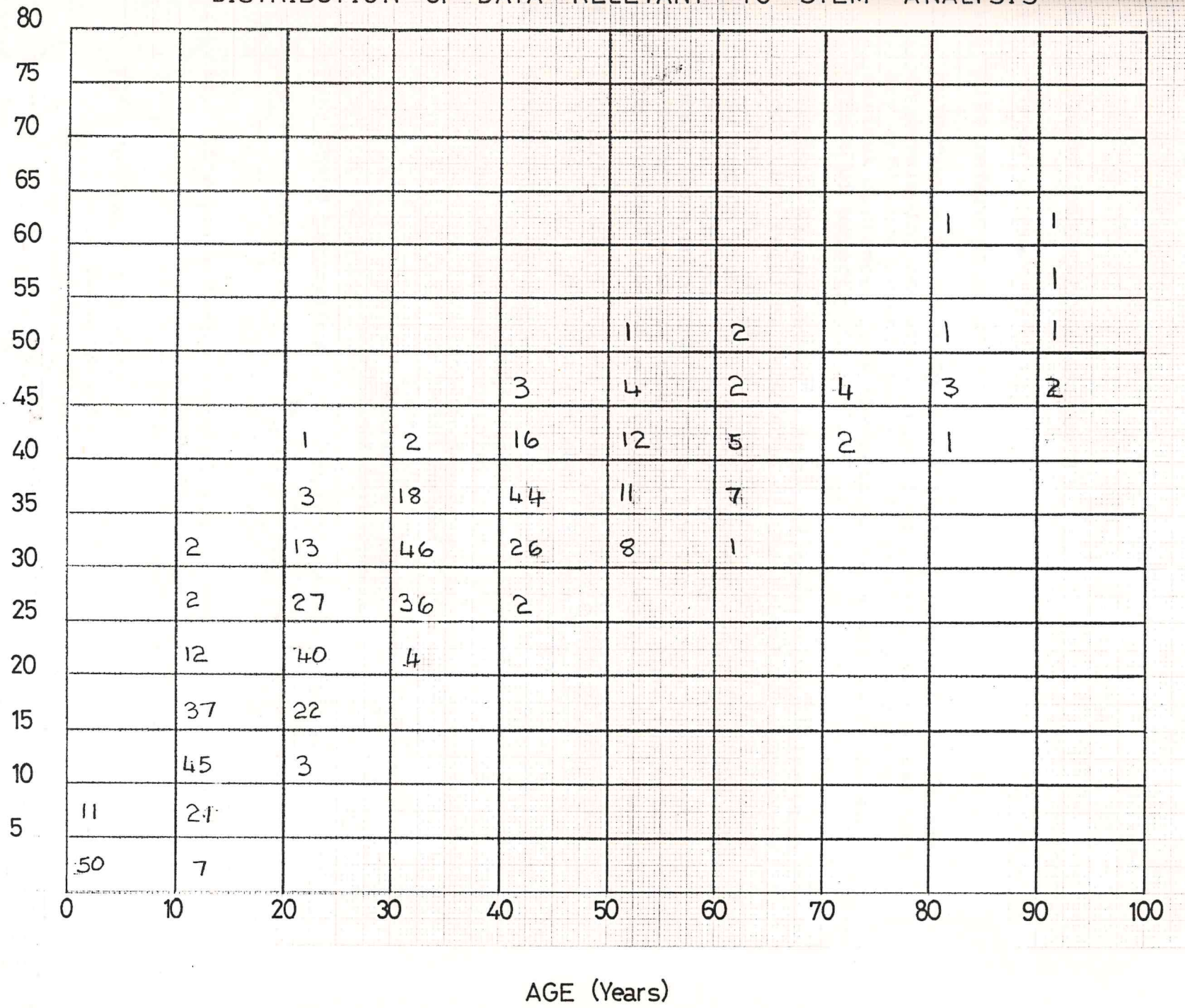
A.D. BRIGGS
O.I.C. I&PS

ADB:SG



APPENDIX XVII

DISTRIBUTION OF DATA RELEVANT TO STEM ANALYSIS



APPENDIX XVIII

FOR PROJECT REGISTER

1.1 VETERAN INFLUENCE ON REGROWTH - II

1.2 *Project ref no. 12/79 A*

1.3 File reference D5.21.

2. OBJECTIVE - To quantify the effect of overstorey veterans on developing regrowth. Questions asked are, how far does any influence extend, how much is growth depressed at various distances from the veteran bole and is there an effect of aspect.

3. PURPOSE - Management of a stand of trees to optimise wood production requires knowledge of the growth of components of that stand and their interaction. We have as a legacy many stands with a mixture of regrowth and old, often poor quality, veterans. There are also possibilities that future management could create similar though not identical situations, it would then be necessary to know the effect the retained trees are having on the regrowth developments.

4. LOCATION - Karri stands where there is a mix of veterans and regrowth. Minimum age about 15 years.

5. INFORMATION REQUIRED.

(a) Tree parameters - Species
- D.B.H.O.B.
- Total height
- Crown depth
- Dominance class
- Crown development.

(b) Stand parameters - Co-dominant height (define)
- basal area (m^2/ha.)
- stocking (trees/ha.)
- volume (m^3/ha.).

(c) Site parameters - General soil type
- aspect and slope
- topographic features, if any.

(d) Veteran - D.B.H.O.B.
- total height
- crown condition.

We wish to measure the tree and stand parameters along a line from the veteran bole until there is no influence by the veteran. Collection of information should allow it to be combined and analysed statistically.

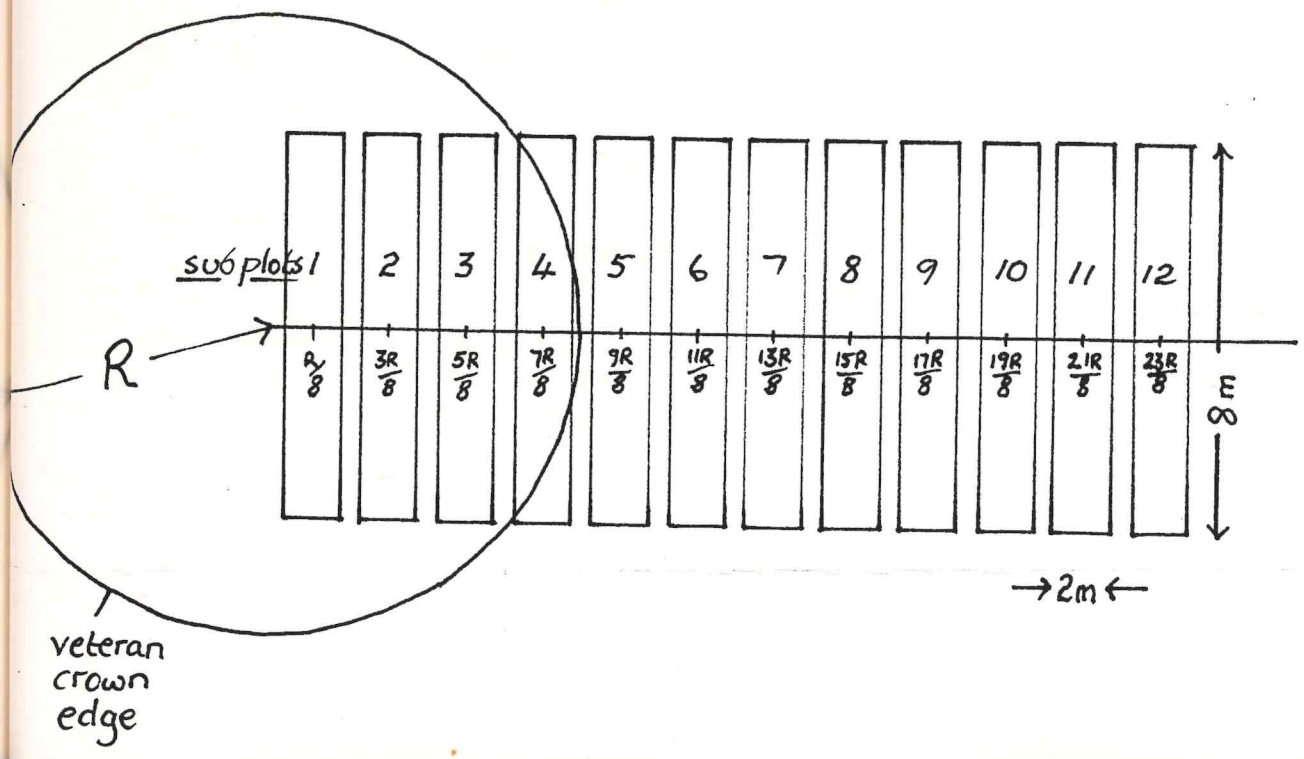
5.1 Initial Work.

5.1.1 Project I identified that in karri forest the veteran has an influence on regrowth beneath its crown, any influence beyond there was not evident from the sample, which was quite small.

5.1.2 This project should aim to select initially 40 veteran trees of the same age from which one can go both north and south through regrowth stems for a distance of 3R from the veteran bole, where R is the crown radius. At any point on this line no other veteran should be closer to the point than the original (1°) veteran. The crown of the 1° veteran should be healthy and even, the tree should have no appreciable lean.

5.1.3 The survey chain should be laid upon one of these lines and marks made on the ground at distances r/8, 3R/8, 5R/8, 7R/8 etc, up to 23R/8, from the veteran. A table will be drawn up to indicate these distances for a range of crown radii.

5.1.4 A subplot is now defined as goind one metre either side of each of these points along the direction of the chain and four metres either side of the chain. Subplots will be numbered 1 - 12 from bole outwards.



5.1.5 From the veteran bole the assessor measures each subplot, recording a line of information for each tree in that subplot on the field sheet.

5.2 Subsequent Work.

5.2.1 The data will be combined. All subplots 1 may be combined or all north subplots one, or subplots 1 & 2 may be combined. For a group of subplots the mean value for each parameter can be complied, plus the standard error of estimate to enable confidence limits to be determined.

5.2.2 Statistical tests on the significance of difference between mean values will be carried out these include:

(a) Plotting of mean value and 90% confidence limits.
(b) Using the test for significance of difference between two means for paired data.
(c) Other statistical tests in which values are ranked and the significance of a particular value being consistently low-ranked or high-ranked tested.

5.2.3 The results will be presented to clearly illustrate data.

6. REPORTS AND CONCLUSIONS

As mentioned in 5.2.3 above.

7. FUTURE ACTION

Possible extension of the project to answer more detailed questions relating to veteran influence on regrowth.

VETERAN INFLUENCE PART III

OBJECTIVE: To extend the present level of knowledge of the effect of overstorey veterans on developing regrowth (see D.5.21)

Past work indicates that a solitary veteran tree will influence regrowth up to twice the radius of the veteran crown. The question posed here is how does more than one veteran, influence the surrounding regrowth. Is the effect simply additive or is it some other geometric relationship.

PURPOSE: To quantify the effects of veterans on regrowth stands, so as to enable more effective management techniques to be developed and used to optimise wood production from these stands in future.

LOCATION: Karri regrowth stands where there are two veterans with overlapping influence zones (See Text). Regeneration should be at least 15 years old.

INFORMATION REQUIRED:

(a) Veterans:
- DBHOB
- Total Height
- Crown Condition (Define)
- Crown Radius
- Distance between Veteran Boles (Between Centres)
- Age
- Position

(b) Tree Parameters:
- Species
- DBHOB
- Total Height
- Crown Depth (Total height - Crown Break)
- Dominance Class
- Crown Development

(c) Stand Parameters:
- Co-dominant Height
- Basal Area m^2/ha
- Stocking stems/ha
- Volume m^3/ha
- Age

(d) Site Parameters:
- General Soil Type
- Aspect and Slope
- Topographic Features
- Points of interest - general observations.
  eg. understorey - evidence of fire or insect damage.

INITIAL WORK:

1. Select 'n' (not sure how many as yet) plots containing the configuration of veterans shown in Figures 1,2 and 3. Try to select veterans with a roughly equal age, crown radius and crown condition. No other veteran should be closer than three times its own crown radius to the two veterans in question.

2. The healthier of the two veterans shall be designated the subject tree (ST). A chain line is to be placed between the veteran boles. Using the crown radius (R), of the ST, points will be marked on the ground at distances of $\frac{R}{8}$, $\frac{3R}{8}$, $\frac{5R}{8}$, $\frac{7R}{8}$ etc. until the bole of the other veteran is reached.

3. A subplot is now defined as going one metre either side of each of these points along the direction of the chain and four metres either side of the chain. Subplots will be numbered 1 - n, from the bole of the ST outwards.

4. 2R is to be calculated for the ST and the other veteran and marked with a painted stake along the chain from their respective boles and recorded on the field sheet diagram provided.

5. From the ST bole the assessor measures each subplot, recording a line of information for each tree in that subplot on the field sheet.

SUBSEQUENT WORK:

1. For each separate arrangement, as shown in figures 1,2 and 3, the data for all subplots 1 will be combined and subsequently subplots 2,3,4 etc. The data to be combined will consist of BA/ha, mean total height, vol/ha, mean crown depth and stocking sts/ha and shall be plotted and statistically tested in a similar manner to Vets II data.

2. The data represented in Vet I can now be directly compared to the Vet II data. Both graphically and statistically (using t test for diff in means) i.e. Compare the effect of one vet. as opposed to 2 vets with varying degrees of overlaps.

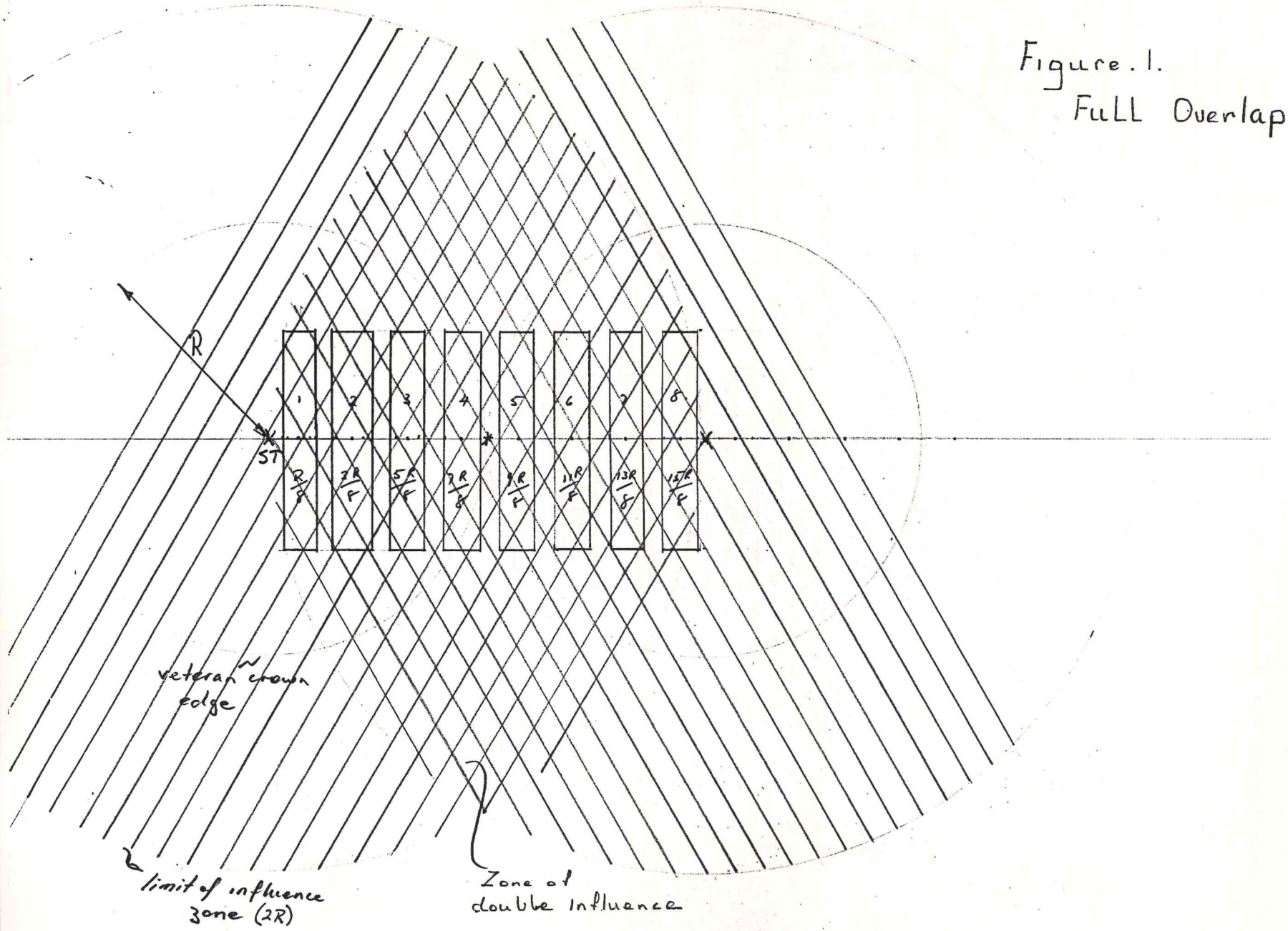


Figure. 1.
FuLL Overlap

Figure . 2.
½ Overlap

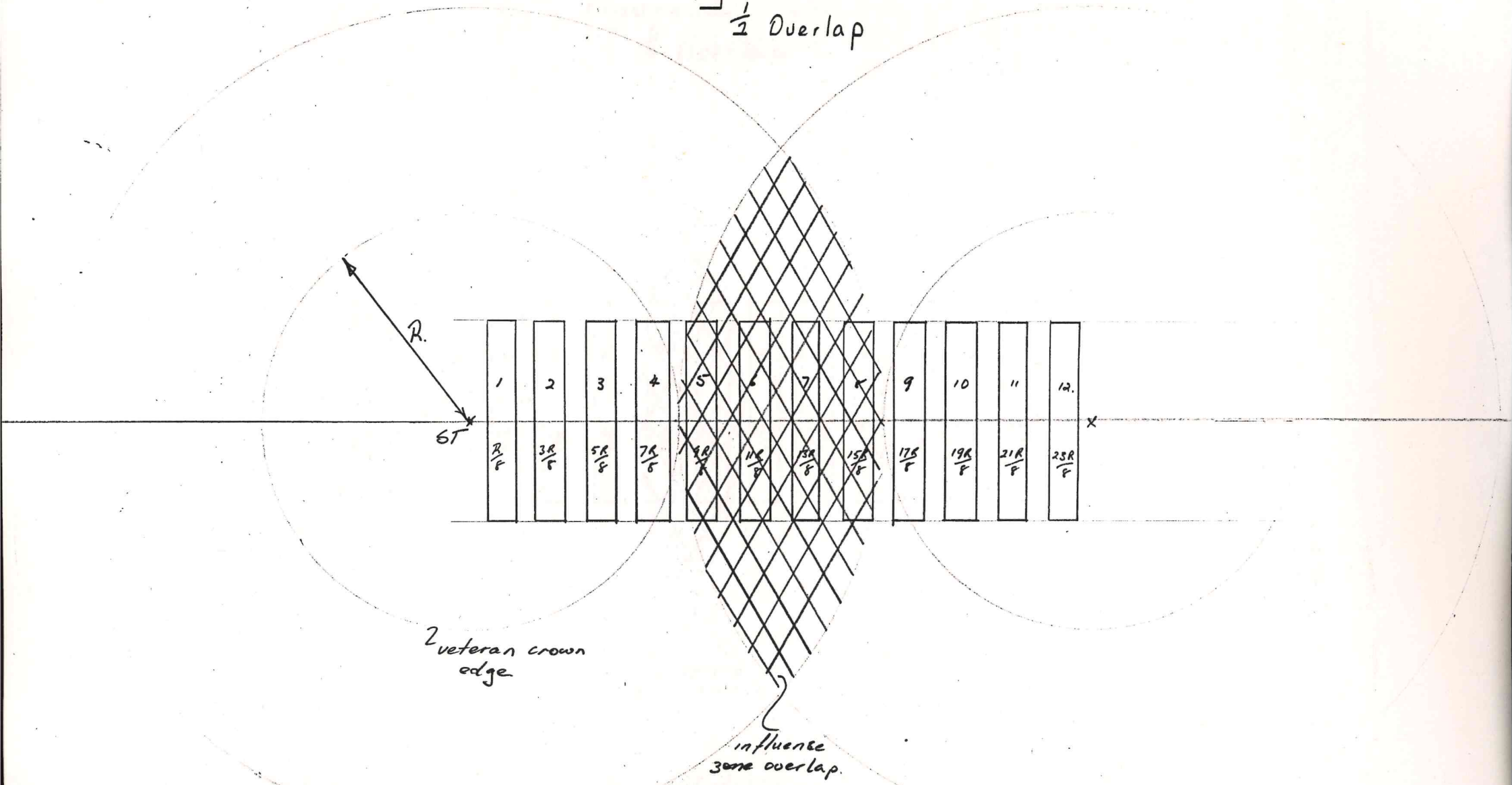
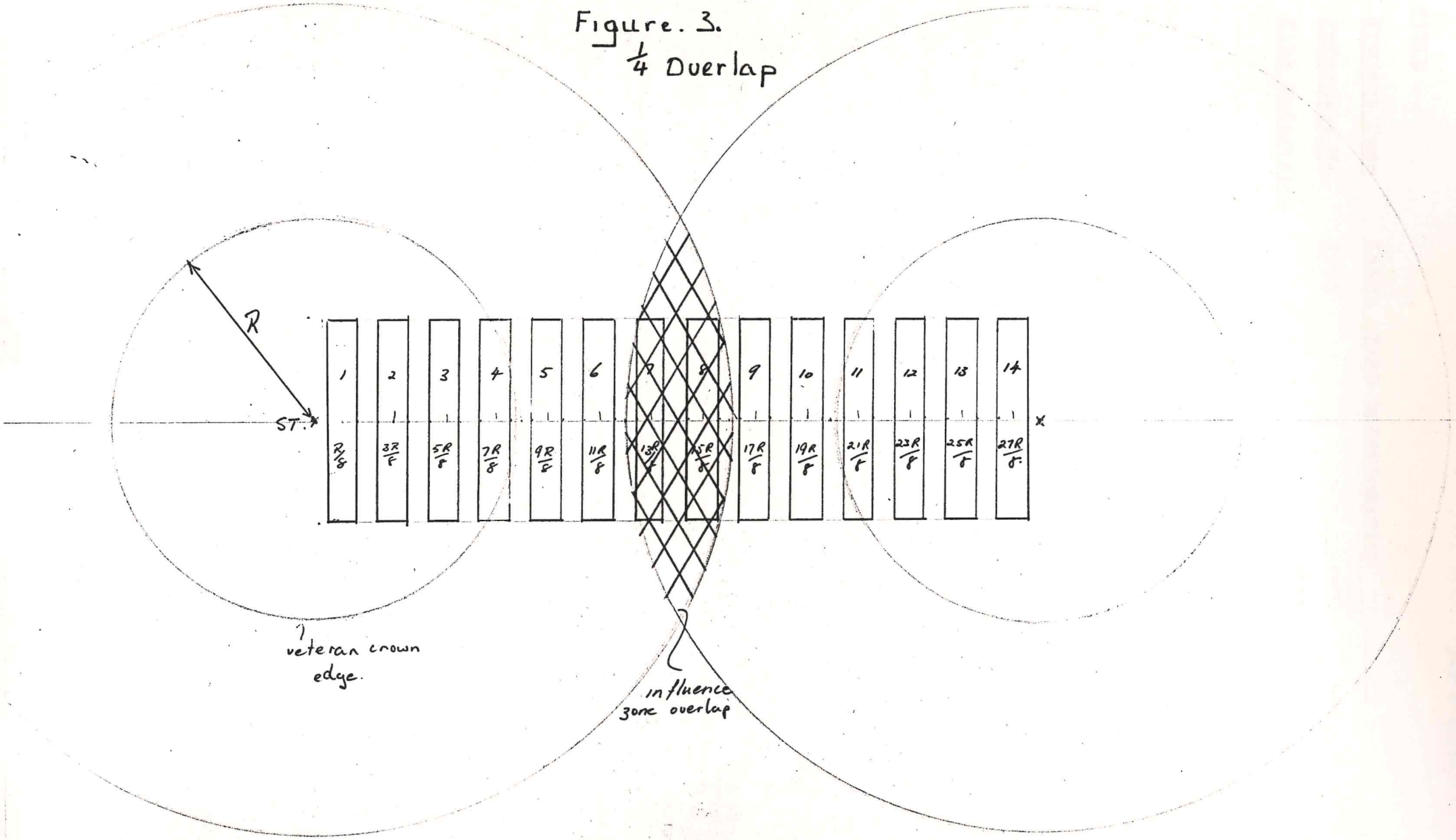


Figure. 3.
1/4 Overlap



APPENDIX XXI

1. TITLE

1.1 Project Name KARRI STAND DETERIORATION

1.2 Reference No. 8/79

1.3 File References D.5.19

2. OBJECTIVES

To establish a photographic record of the island of karri left after logging in Graphite coupe 8 to determine whether or not there is any degrade in stand condition due to exposure following cutting.

3. PURPOSE

To determine whether or not small islands of uncut forest deteriorate with time due to exposure after cutting. This will be significant when the accumulated area of narrow stream and road reserves is large and should be detected early.

4. LOCATION

Graphite coupe 8 M.R. HC 56

See attached plan

5. INFORMATION REQUIRED

5.1 Initial Work

To locate positions from which black and white photographs can be taken to record general stand appearance, from all aspects, and to record individual tree condition for several fringe trees.

Photograph stand and individual trees from the various positions. Record film and exposure settings, lens and filters used, time of day and general weather conditions.

Record the positions from which the photographs are taken and mark in the field with 75 x 75 mm jarrah pegs.

Record the direction of the photograph.

5.2 Subsequent Work

Re-photograph from each position after 1,2,3,5,7 and 10 years.

5.3 Staff Required

T/A Phillips-Jones

6. REPORTS AND CONCLUSIONS

- Required after 3 years

7. FUTURE ACTION

Re-assess project after 3 years in view of further programmed cutting and/or changes in stand condition if any evident.

PROJECT 8/79

GRAPHITE BLOCK - coupe 8

CUTTING

SMP 1543

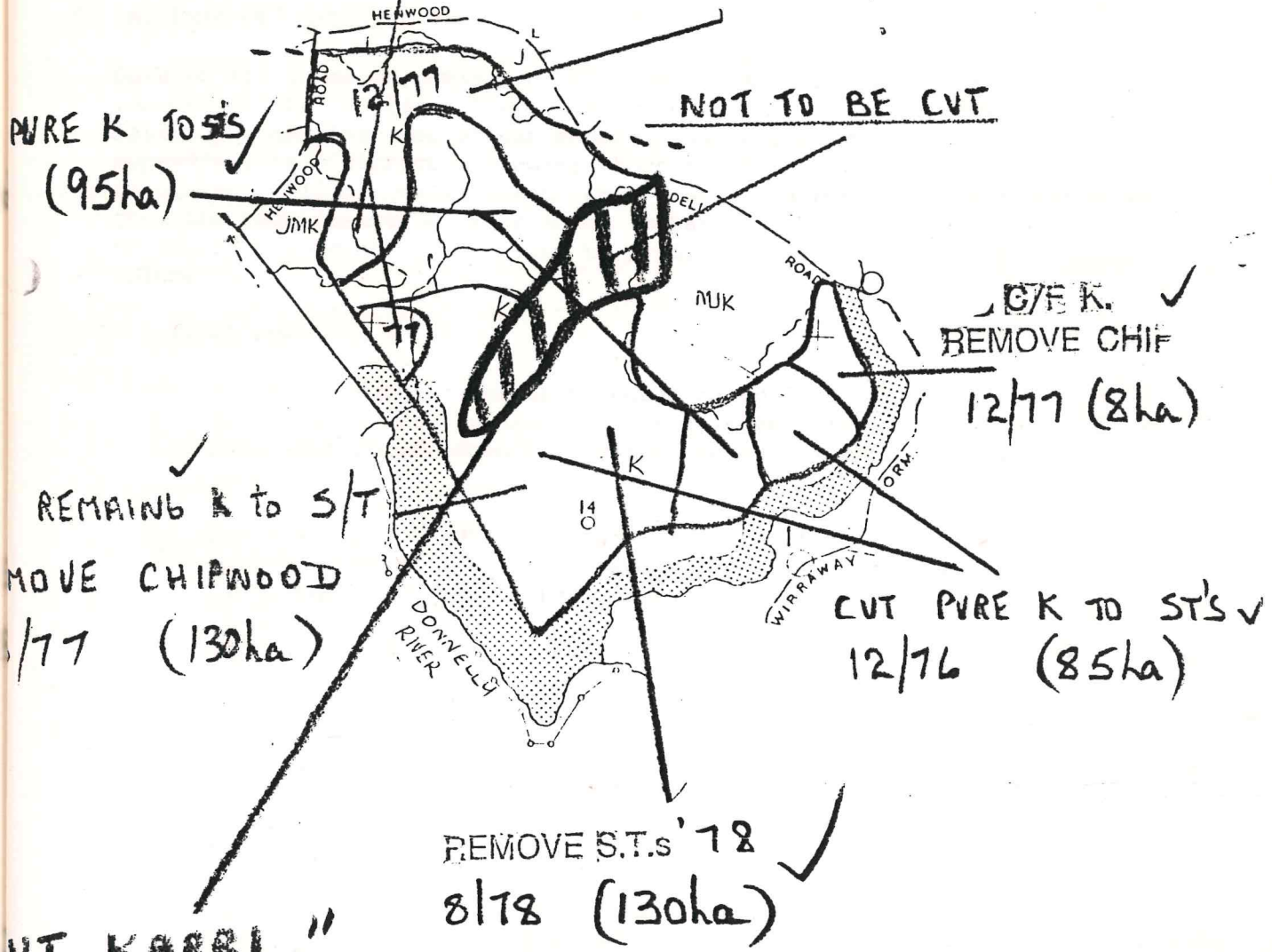
+ SEED TREE REMOVALS

SYMBOLS USED

J • jarrah
K • karri
S • summer logging
W • winter logging
C/F • clear fallen
ST.S. • seed trees standing
REGEN • regeneration
G/S • group selection cut
M • marri
X—X • boundary between S & W
•—•—• boundary between S.M.P.'s
N F • non forest
Cl • cleared
K.S.T. • karri seed trees
stream reserve
amenity reserve
D/B • dieback
P.P. • private property
• pine plot

REMOVE S.T.s '77 ✓
12/77 (50ha)

REMOVE CHIP
(50ha) 12/76 ✓



PURE K TO S/S ✓
(95ha)

C/F K. ✓
REMOVE CHIP
12/77 (8ha)

REMAINS K to S/T ✓

MOVE CHIPWOOD
/77 (130ha)

CUT PURE K TO ST's ✓
12/76 (85ha)

REMOVE S.T.s '78 ✓
8/78 (130ha)

UT KARRI "

APPENDIX XXII

FOR PROJECT REGISTER

1.1 Regrowth Volume Table - Karri

1.2 9/79

1.3 File D.5.10.3

2 OBJECTIVES :-

To produce a reliable volume table for karri regrowth poles from 10 to 50 metres in height.

3 PURPOSES:-

To accurately predict volumes of regrowth trees from a measure of D.B.H.O.B. and total height. Individual volumes can be added together to give stand volumes or part stand volumes for such purposes as thinning or permanent growth plot measurement.

4 LOCATION :-

Mainly in Treen Brook and Big Brook forest blocks where thinning operations are taking place, but also where regrowth poles are being felled for ageing or stem analysis purposes.

5 INFORMATION REQUIRED :-

Data on 112 trees in nominated height and diameter classes is required to complement the 73 trees already measured and to provide an adequate data base for computing tree volume models. (See p 186-191, file D.5.10.3). Appendix I is a histogram showing those trees we have collected and need to collect. If our measurements show that trees outside this range exist then the requirements will be added to. Bark thickness is also measured to obtain a good bark regression to predict underbark volume from overbark volume.

5.1 Initial Work

(a) S.D.F.O. Campbell has been requested to find out whether or not A.D.P. Como has the data for the 73 trees already measured. If not, what format does he require the data in, for input to the computer.

(b) Specify the form of collecting data from 112 additional trees. S.D.F.O. Campbell will be asked to approve this. Prepare a field sheet and associated instructions.

(c) Standardise the form of collecting stem analysis data to bring it into line with the format in (6) above, as far as is practical.

5.2 Subsequent Work

(a) Collect the data for 112 trees, when this is completed reassess whether the data base is adequate.

(b) Transfer the data to computer worksheets and send them to Como A.D.P, together with the 73 trees originally measured. Note, the 73 trees were measured in imperial units.

(c) Liaise with A.D.P. Como during the modelling phase, if certain trees are rejected for some reason others may need to be collected.

(d) Decide whether or not you wish to test the derived tree model before it is finally accepted. If so, devise the test on a range of tree sizes and work out a way of comparing measured volumes with those predicted using the model.

(e) If the model is acceptable it will be converted to a form in which it can be used by field staff. The bark regression will have to be incorporated at this stage to predict underbark volumes.

5.3 Staff Required

(a) T/A time to measure 112 trees and summarize data into a form for A.D.P. Como to work with.

(b) T/A time to test the model once it has been devised. This includes field measurement plus statistical testing.

6 REPORTS AND CONCLUSIONS

A report will be written when the format for collecting data has been formalised, it will briefly summarize the project's progress to that date. Another report is necessary when the data base for modelling is complete for sending to Como. Any changes made in the number of trees collected will be detailed. A final report will be made on the testing of the model and production of a finalised model plus volume table.

7 FUTURE ACTION

A volume table based on measurement of 185 trees is only as accurate as the representativeness of those 185 trees of the whole population. Ways of improving the data base should always be sought.

I. ROTHERAM
ASSISTANT DIVISIONAL FOREST OFFICER

IR:SG

APPENDIX XXIII

FOR PROJECT REGISTER 6th November 1979

1.1 Karri Chipyield Plots

1.2 Project ref. no. 13/79

1.3 Files D5.10. November 1972 to present.

2. Objectives

To measure the effect of thinning on stands of regrowth karri in Treen Brook. Stand parameters of mean diameter, mean height, basal area per hectare and volume per hectare will be charted with time.

3. Purpose

To answer questions in relation to the thinning of extensive areas of the Big Brook/Treen Brook regrowth karri forest. The size and extent of the plots are inadequate to answer the questions asked, however they comprise the only thinning plots to date and need to be maintained.

4. Location

Treen Brook block, see File D.5.10. and permanent hardwood plot tie sketches for exact details.

5. Information Required

5.1 Initial Work.

5.1.1 The sites of ten plots were selected after examination of 30 plots over a range of stockings. Pairs were selected to be initially similar then one plot of each pair was thinned to a residual basal area of 12m^2/ha. (50 ft^2/acre). A surrounding buffer was also thinned to the same prescription. For each tree in a thinned plot a counterpart tree of similar size was selected in its paired control plot. The remaining trees in control plots are termed surplus trees. Surplus trees plus counterpart trees = total trees in control plot.

5.1.2 Measurement of the stand has occured annually from December 1972 to December 1978, except for December 1976. Each tree is numbered and diameter and height measures are recorded. Height to green crown was measured to December 1975 and will be re-introduced at six-yearly intervals from 1981. Bark thickness has been recorded though it is not used at present.

5.1.3 Various extractions have occurred from the data for years December 1972 to December 1977 and these are summarized in graphs (pp 222-234, file D.5.10.1)

5.1.4 Cyclone Alby in April 1978 broke ten trees in the plots, two of which were thinned trees in plots 1, and 7. No counterpart trees were broken and only one tree of any significant size was lost in control plots (plot 6). The cyclone has caused the data to be re-assessed in a different form (see pp 104-5 file D.5.10).

5.2 Subsequent Work.

5.2.1 The data shows that to December 1977 the total basal area increment of the thinned plots was approaching the basal area increment of the control plots, indicating the site potential for basal area increment was being transferred to the fewer thinned stems. It is important to monitor this very closely if such a trend is occuring.

5.2.2 Proposed Program of Measurement

Parameter	Interval of measure	December 19..									
		79	80	81	82	83	84	85	86	87	88
Diameter	~~1~~ 3 year	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Height	3 years	-	-	✓	-	-	✓	-	-	✓	-
Bark thickness	3 years	-	-	✓	-	-	✓	-	-	✓	-
Crown break	6 years	-	-	✓	-	-	-	-	-	✓	-

Enough measurements now to note any response. Only requires monitoring.

5.2.3 At each year of measurement the data can be summarized for that year and paired with the data for the year in which it was previously measured, e.g. in 1981 diameter will be paired with 1980 data, height with 1978 etc. This provides a gross check on accuracy although other checks must also be made on increments of individual trees.

5.2.4 After the December 1979 measurement of diameter, graphs will be drawn to display the re-worked data 1972-79. Graphs of mean diameter, b.a.o.b., height and volume to 10cm d.u.b. vs. time will be drawn. Graphs of average annual increment of these parameters vs. time will also be drawn. The increment value is plotted against the mid point of the relevant time period. In addition the graphs will be divided into cyclone damaged and undamaged plots or they will become too confusing.

5.3 Staff Required.

For measurement and computing data, diameter (basal areas) annually and other parameters tri-annually.

6. Reports and Conclusions

6.1 Report by ADFO Harvey, describing initial establishment aims (file D.5.10 pp 7-10).

6.2 Report by ADFO Bright summarizing growth trends three years after thinning (file D.5.10 pp 96-99).

6.3 Report by ADFO Rotheram on cyclone damage and reworking of data to account for this (file D.5.10 pp 103-106).

6.4 Other reports/comments throught file D.5.10.

7. Future Action

7.1 Remeasurements as scheduled in 5.2.2

7.2 Review of frequency of remeasurement after December 1984 remeasurement.

Plots taken to monitor crown development following thinning

For consideration as an I&P project possibly using student labour

1.1 Karri pole taper vs stand density

1.2 1/81

1.3 M.3.5

2. OBJECTIVES:

2.1 To study the effect of heavy thinning on stem taper i.e. the increased taper of open grown trees.

2.2 To demonstrate use and capacity of telerelaskop.

2.3 To collect additional sectional data for the karri pole volume table.

3. PURPOSE:

If thinned stands have trees of greater taper than the norm, then we are likely to over-estimate the volume of those stands if we use DBHOB and height as the only measures. This study is to find if this problem exists and to gain some idea of its magnitude.

4. LOCATION:

Big Brook thinning plots (HL 62)

5. INFORMATION REQUIRED:

5.1 Initial Work

5.1.1 Select 15 codominant trees in each of the following:-

a) unthinned
b) thinned to 80 stems per acre in 1956
c) thinned to 20 stems per acre in 1956

5.1.2 Using the Telerelaskop measure the trees in 2 metre intervals as high as is practical. Measure DOB from N/S and E/W aspect.

5.2 Subsequent Work

5.2.1 Compare the shape of the trees in each thinning group with the karri pole model which predicts DOB at any height from DBHOB and total height.

5.2.2 Present any differences in shape of the three groups (graphically if possible) and compute the significance of these results in terms of volume estimates using the accepted karri pole model.

5.3 Staff Required

5.3.1 One team of two to do the field work.

5.3.2 Office backup to devise field sheets and check data,

5.3.3 either ADP staff to do the comparison between the data and the karri pole model, or

I&P staff to do the same manually with the aid of the programmable calculator.

6. REPORTS AND CONCLUSIONS

Results should be written up in an available form and conclusions drawn. Recommendations for further investigation may be made but on no account must the data collection be extended and the whole thing dragged out.

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