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(17 pp)

SYLVICULTURAL NOTES ON SPECIES
Jarrah Euc.marginata Sm.

C. E. Lane-Poole

0. For botanical description see Von Mueller, Eucalyptographia. Dec.7 - Critical Revision. Vol.1 P.241.

1. Range: It occurs throughout that portion of the extreme south west of Western Australia which is approximately bounded by the 25" Isohyet. Area approximately 13,000,000 acres. Geographically 31°30 to 35° S. latitude.

II. Topographical Range: Its occurrence is not interfered with by the minor configuration which is a feature of W.A. Starting at sea level on the coast it is found growing up the scarp of the Darling fault to the top of the highest points which are only 1000 to 1200 feet above sea level, thence it extends eastward on the plateau till the rainfall drops to about 25".

12. Climatic Range: Lauretum region, mean temperature of 4 hottest months 70°. Mean annual temperature of 59° at Albany to 64° at Perth. The centre of the prime belt has a mean annual temperature of 60°. The accompanying graphs show data of Perth 197 feet and Collie 604 feet. They clearly show the winter rainfall climatic conditions. November, December, January, February and March each receive less than 1" of rain and October only 2.2"; the mean temperature is over 65° while the mean maxima are October 61° November 75°, December 82°, January 86°, February 85° and March 82°. The mean diurnal range is 17.8 at Perth - summer 21, winter 15, thanks to south westerly evening and night winds, and amounts to 26.2 at Collie where in winter it is 22 and in January 32. Rains during the summer arrive from the Tropics and take the form of storms; by April however the Southern cyclones set in and with the apparent march of the Sun north of the equator the rainfall increases and the temperature drops. April 1.4" and 65°, May 5" and 61°, June 7" and 56°, July 6½" and 55° (Collie 7.1" and 48°). The Sun now moving south from Cancer increases the temperature. So that in August 57° are registered, the rains too fall off to 5.8"; in September the spring shows itself by the blossoming of most of the plants forming the ground cover - rainfall 3-4" and temperature 58°. The mean minima for the year are Perth 55°.2, Collie 45°.6. The mean of the minima of the coldest month at Perth is 47.7 and Collie 37.6. The mean of the maxima for the hottest month in Perth is 84.9 and at Collie 85.9.

In the exteme south a mean annual rainfall of 50" is experienced.

The vegetative months are not definitely known. There appears to be no period of rest unless one occurs in midsummer through lack of moisture in the soil. The reliability of the rainfall is a characteristic of the climate - 10" had been the Perth variation from normal until 1928 when it increased to 14" owing to the phenomenal rains. The evaporation at Perth is very intense and reaches a maximum at the period of least rainfall. Total 68.85 inches with 1.7" in July and 10.4" in January.

To sum up the prime belt has a mean rainfall of 30" and over - lowest recorded 25" - a mean temperature of 60°, and 70° in four hottest months and mean maxima of 80 and up to 106° highest recorded temperature. Mean annual minima 50° with 39° for the 3 coldest months and lowest recorded 24°.8 at Collie.

13. Soil Range: Found in all soils except limestone. When drainage is bad either through pan or clay it fails. Individual trees reach their greatest development on rich diorite soils but here Jarrah is subsidiary to Marri and blackbutt. On the sand plains between the coastal limestone belt (Tuart country on West) and the Darling fault, it does not attain large dimensions; it thrives best wherever secondary ironstone gravel is found mixed with the sand. It grows however on the deep pure sand of this region and some of the most durable poles have been obtained from such trees. It assumes its best known habit on the laterite capped granite Darling Range and there occurs in almost pure stands Marri being represented however in very sparce numbers throughout. Further east on yellow clay subsoil it becomes subsidiary to Wandoo and as the rainfall diminishes even on good ironstone sites it assumes a small habit and is of little commercial interest at present. To the south of a line from Nannup to Manjimup it finds itself in competition with Karri as well as Marri which in that rainfall hold the better soil sites and it is again found in pure formation only on ironstone ridges. Further south again the same conditions occur only the climate is wetter - 50" and the two tinglies are added to karri and marri in the competition for good soils. The general poverty agriculturally speaking of the land in the S.W. of W.A. and particularly the Jarrah sites, is the only reason why so much land has remained Crown property and so large an area has been permanently dedicated to forestry.

14 & 15: Forest Types:

A. Prime Jarrah type. This consists of Jarrah with a sparse sprinkling of Marri in the topstorey and Sheoak (Cas.Fraseriana), bull banksia (Banksia grandis) Dryandra floribunda, Emu bushes (Persoonia spp) Christmas tree (Nuytsia floribunda) forming a very scattered lower storey. With the exception of sheoak it is doubtful whether any of the above form with each other a sylvicultural mixture. Rather do they occur in groups in direct competition with the main species. In the case of the Christmas Tree it is a parasite on the roots of several other species.

Below as an understory are to be found blackboys (Xanthorrhoea Preissii) and in poorer patches grass tree (Kingia australis). With these occur the common Zamia palm (Macrozamia Frazeri). The ground is covered with a wealth of xerophytic shrubs and woody plants of which legumes are in the majority, prickly moses (Mimosa pulchella) is the commonest low wattle. The epacridiae take the place of true heaths to be found along the Mediterranean or in Cape Colony in very similar climates. Proteaceous plants are very well

represented grevilleas and hakeas being in the majority. All this ground cover is of the thoroughly drought resisting type. Leaves are reduced to mere scales or thorns in some cases and every adaptation of nature is provided to enable them to live through the long hot rainless months. Mention should be made of the rutaceous woody plants of which Boronia in places forms pure thickets 3 to 4 feet high. The entire absence of graminae from this type is very remarkable. The hard prickly leaved woody plants are much better adapted than is grass to the locality and they hold the ground to the exclusion of most other plants.

A. Sub types - edaphic - within the prime Jarrah type:

Bullich (E.magacarpa) is to be found in pure or almost pure groups along water courses at the higher elevations.

Flooded gum (E.rudis) occurs in similar situations on large streams at lower levels.

Mountain marri, E. haematoxylon, occupies with Jarrah stony knolls in certain parts.

Swamp formations. Usually clothed with paper bark trees.

Sandy plain. Sheoak, Christmas Tree, Black boys, and grass trees. All these sub types are islands in the sea of Jarrah which occupies the rest of the zone irrespective of aspect merely improving its quality according to the nature of the soil.

B. Marri & Jarrah:

On the disintegrated diorite soils, that are derived from the intrusive dykes that here and there cut through the granite formation, and washed down into basins is to be found a distinct type in which marri predominates with or without blackbutt (E.patens). The Jarrah here reaches the greatest development (see photo) of all, but it is always in the minority. The soil cover is often bracken and black boys when present show a more vigorous development making 2, 3 and sometimes 5 heads. (see photo). Native grasses are here also found and such country is always good for agriculture and all but the smallest pockets were taken up by the first settlers.

Sub type - edaphic.

Along creeks. Banksia verticellata and Albizzia lophanta.

C. Sand plain type:

Between the lime stone fringe that skirts the sea coast and the Darling range the Jarrah woodland is very open and the trees are shorter and do not attain a large diameter. Mixed with it in varying properties is marri which here adopts a very grand wide crowned short

stout boled habit. E. Staerii is here found also. The number of other trees of what would be a second story if the dominant one were not so scattered is here much greater. To those already enumerated in the prime belt we must add Native pear (Xylomelum occidentale). Banksia Mongonii. Nut Christmas tree is much more prevalent as are the black boy and grass trees. In certain parts, notably between the tingle forests and the sea, grass trees growing to 28 feet in height are to be seen. It is undoubtedly still a Jarrah type but can no longer be called forest. It is open woodland. The ground cover is mainly woody but native grass is to be found and clearing and cultivation has in parts enabled the establishment of pasture formed of exotic graminae and subterranean clover. The Jarrah here is prone to forking and this is not due wholly to fire for it occurs in the experimental plots planted at Hamel 26 years ago and protected from fire.

Sub types:

Pan country. This is sand over ironstone pan as a rule and carries scrubby jarrah with grass trees needlewood (hakea sp.) Christmas tree.

Semi drained country. Jacksonia, needlewood the jarrah is still more dwarfed.

Swamp type. Metalensa spp. No jarrah.

Jarrah decipiens type. On the edge of the limestone country on the coast where rocky knolls occur E.decipiens occurs either pure or mixed with very stunted jarrah.

Jarrah tuart, Jarrah Karri and Jarrah Yate types.-

Jarrah does not enter the belt of limestone proper but Tuart intrudes into the jarrah and karri woodland and a poor mixture results which is to be found all along the western coastline. Where tuart ceases and the coast turns east jarrah and karri with an underwood of peppermint continues and mixes in with stunted karri. At the mouth of the Deep and Frankland Rivers the mingling is with the crimson flowering gum, E.ficifolia, and further east near Denmark yate (E.cornuta) occurs in the sand plain in all the damper soils

D. Wandoo type:

Jarrah and wandoo mix for some distance on each side of the line marked on the map. On the jarrah proper side wandoo is found in mixture on the stony granite sites; on the wandoo side jarrah is found on the well drained poor sandy cum. latenti sites and leaves the clayey sites to wandoo pure. Large areas of very inferior probably quite useless jarrah occurs in the tract lying between the main belt near Mt. Dale and Albany. It is chiefly pure Jarrah in scattered formation with tattered fringes of wandoo in the northern half. On the seaward side also a wandoo mixture is found and this continues along the foot of the Darling fault to well south of Pinjarrah.

In the first 30 miles also occurs a white gum (E.Lane Poolei). North of Perth the mixture of wandoo and jarrah continues till the progressive drop in the rainfall first stops Jarrah and then Wandoo. On the range itself and particularly in the neighborhood of Chidlow's Well occur wandoo and powder bark wandoo (E.accidens) in mixture with jarrah or in isolated groups.

Marri
E. Jarrah/Sheoak: Here and there on sand mixed with secondary laterite there occurs very distinctive formations in which jarrah and sheoak are equally represented. Such a type occurs immediately to the north of Albany. No-where is sheoak so prevalent as here; the jarrah is however poor and marri reaches no great size.

F. Karri country jarrah type: In this must be included the tingles as well. On ironstone ridges running between the better soil on which karri and marri are growing are to be found good stands of jarrah which carry a much heavier percentage of marri than in the prime belt. Great height development is attained here and 75' piles have been obtained. Here as in the diorite country bracken is often found as a ground cover on the slopes of the ridges. The ridge tops show the characteristic jarrah soil cover and the tree is usually pure.

16. Small trial plantations of jarrah have been made in many places notably in Cape Provence in S.Africa and in Mt.Lofty Range of South Australia. They have all given very poor results.

2. Sylvicultural Characters:

The forest is an open ugly type. Its saving grace is its remarkable purity. The prime belt is by far the least mixed eucalypt forest covering so wide an area in Australia. The canopy is very light so that no light demanding plants are suppressed except under the oaks. The angular branching with its elbows and almost vertical limbs carrying very often dead branchlets at the extremities gives the whole forest the appearance of being in dire need of something and shaking its nearly bare arms to an unrelenting heaven. The mature trees require wide space and the number of trees of 90" and over to the acre on an average would not exceed three merchantable trees.

There is always a large number of small size tree growing under and often quite close to the boles of the mature trees. These appear to grow vigorously up to a certain point and then to stagnate. Only when good openings occur between the mature trees do groups of poles or piles exist. The felling of mature trees is followed by the growth of the smaller trees if they have not been too long suppressed or too fire damaged. As is to be expected the number of groups of pole and pile wood in a virgin forest is small. Jarrah is a long lived tree and the period of its life beyond what we called maturity but what was really economic mill size 15 years ago is many times the 120 to 130 years it takes it to reach that girth.

The forest is open enough to ride through easily and the obstruction is not the trees but the boulders of ironstone. As in all forests of eucalypts the old hands report that the forest was still more open in the early days of the colony. There was less sapling growth say they. Here are figures kindly supplied by Stoate of 2 very good virgin stands of Jarrah each an acre in extent. Both are well above the average which is between 600 and 1000 cubic feet per acre. No.2 is lower than the highest yield I have measured which was 6000 cubic feet u.b. The largest tree has a girth of 21'5" and is 122' feet high with a 49' bole and a volume u.b. of 764 cub.feet.

Summarising the figures we find:

Sample Plot No.1 (one acre).

	No.	Basal Area O.B.	Basal Area U.B.	Vol. O.B.	Vol. U.B.
Merchantable Jarrah	16	166.28	148.2	4480	3880
Useless and suppressed jarrah over 12" g.b.h.	26	27.79	20.26	-	-
Useless and suppressed jarrah under 12" g.b.h.	50	1.39	-	-	-
Marri over 12" g.b.h.	10	36.03	29.35	-	-
Marri under 12" g.b.h.	4	0.16			
Totals:-	106	231.65			

Sample Plot No.2 (one acre).

Merchantable Jarrah	26	189.79	165.54	5905	5005
Useless & suppressed jarrah over 12" g.b.h.	36	47.07	34.03	-	-
Useless & suppressed jarrah under 12" g.b.h.	33	0.84	-	-	-
Marri over 12" g.b.h.	6	32.35	27.60	-	-
Marri under 12" g.b.h.	3	0.14		-	-
Totals:-	104	270.19			

The total number of trees and basal area in each plot are high for a eucalypt yet the forest is quite open. If the old hands are to be believed a large proportion of the smaller sizes, say under 3 feet g.b.h. have thickened up since the advent of the white man and his fires.

Like other eucalypts it is "crown shy" except in early youth and so requires wide spacing if it is to put on a good increment. I anticipate that under intensive sylviculture an average of 20 - 25 trees 6-7 feet g.b.h. will be attained per acre or say a mean b.a. of $3\frac{1}{2}$ sq.ft. or 80 sq.ft in all.

The crowns being thin and narrow the question of a surface feeding underwood must be considered. Of the present ones banksia and Persoonias etc. are of no economic value and their sylvicultural value is hard to see. Sheoak is in a different category, it reduces fire risk by suppressing the usual xerophytic soil cover and probably adds nitrate to the soil through the agency of root nodules. Its economic value is not high however. When these subsidiary species are absent young jarrahs hold the field coming up vigorously in between the larger stems and stagnating when they come strongly into root competition with the overwood. The appearance of this young jarrah is most depressing for it is all malformed owing to fires. No less than 69 and 76 of this type are represented in the two sample plots. When we come to the sylvicultural treatment you will see what is the technique adopted in connection with the small malformed stems.

The following figures of sand plain jarrah country are of interest. These have been supplied by stoate:

1. Applecross on the Swan near Perth. Counting all species, viz. jarrah, marri, banksia, down to 6" d.b.h. gave a basal area of 367 sq.feet on 5 acres or 73.4 sq.ft. per acre.

2. Myalup, 9 miles west of Harvey.
   Marri 36.94 sq.ft)
   Jarrah 376.14 sq.ft) on 5 acres or 107 sq.ft. per acre.
   Banksia 122.5 sq.ft.)

Unfortunately height and number of trees were not taken. The omission of the less than 6" class makes exact comparison of b.a. impossible. It will be seen however that the b.a. in the sand plain types is quite high without the under 6" d.b.h. class. As already stated under heading 14 this type of jarrah is small in size and is interesting only from a pole and fence post point of view.

21. Form above the ground: A tree attaining a height of 150 feet but averaging 70 to 100 feet with a bole of 30-55 feet. The appearance of the tree is that of a stringybark which it would undoubtedly have been called had it grown in Eastern instead of Western Australia. The bole is remarkably cylindrical in the pole pile and 90" mill log classes. These mill logs show a relation of mid girth to g.b.h. of between 85% and 90% or in other words a form factor of between 0.72 and 0.81. Many of the short logs give a 95% midgirth or a F.F. slightly over .9. As the trees grow older and the g.b.h. passes 10 feet root buttresses form and the g.b.h. increases to a greater extent than the mid girth. The crown girth also increases and the tree adopts a form which shows a distinct waist in the middle. This form becomes accentuated in very large trees and the loss to the department in calculating the volume of the log on mid girth area increases. Actually conversion is so wasteful that there is probably no increase in utilisation in these trees. The butt and crown are largely wasted. Here are examples. Unfortunately they only give the relationship of mid girth to g.b.h. I have no figures of crown girths:

G.B.H. ft. in.	Mid.G. ft. in.	Relation %	F.F.	Height feet.	Height Bole ft.	Vol. c.ft.
21 : 5	14 : 8	68.5	46	122	49	839
20 : 7	14 : 1	68	45	137	63	995

The average of the jarrah forest however shows a relationship of 90% on a form factor of 81 and in estimating volume by eye it was my custom to halve the breast height diameter squared and multiply by the bole length and to the result add one quarter of it. Thus for a 2½ foot g.b.h. log 30 feet long it works out at 3⅛ x 30 or 94 cubic feet + ¼ of 94, or 117 cubic feet in all. (Actual volume would run out at nearer 120 cubic feet). As the unit of measurement was loads one entered 2½ loads as near enough. Some of the larger logs would cause one to drop down to a F.F. of .72 and only ⅛th would be added or even .64 when half the diameter squared was near enough for estimation purposes. I counsel you all to practice occular estimation of volume on this system; nothing teaches you better the form of a tree than to visualise the space occupied by the bole in relation to an imaginary cylinder surrounding it - to see the factor of forms in fact.

The crown of jarrah is narrow but deep, the spring of the branches occurring generally at a point from the ground less than half the total height of the tree. The leaves are however clustered at the extremities and the total area of foliage always appears small. The actual spread of crown varies considerably but one may place it at between 40 and 50 feet for a well grown tree of a g.b.h. of around 90".

22. Tolerance: I use the word tolerance to cover the quality of bearing shade or root competition. With eucalypts it is my opinion that root competition is the important factor. Jarrah requires openings of at least 1½ to 2 chains but the department allows a regeneration blank to be as narrow as 1 chain from stem to stem at narrowest point leaving a minimum hole in the canopy between the crowns of the two nearest trees of 10 to 15 feet. In youth the trees tolerate the proximity of large trees and develop into saplings ~~and develop into saplings~~ and these stagnate until the competing trees are removed.

23. Root system: A strong deep system. It thrusts its tap down between the boulders and does not make very wide horizontal superficial roots. It is a wind firm species.

24. Flowering and seeding: No general seed years occur throughout the length and breadth of the jarrah belt. It flowers and seeds about every 4 years by district. Its buds form in January, it flowers in October and seeds in October to February of the following year and sometimes if a wet season occurs it may not seed till June and even be carried over to the third year. Seed dispersal is fair and reaches a distance approximately equal to the height of the tree. One would expect wider dispersal for while the seed is large for an eucalypt it is really quite small and should be carried further. It follows that unless seed trees are numerous that blanks in the regeneration occur.

25. Germination: Occurs in June and July and takes place everywhere even on ant heaps and old stumps, tops of dead blackboys and forks of trees (All recorded by Stoate). The green carpet that results is a very remarkable sight. The cotyledonary leaves are large and sometimes 3 in number. The development of the seedlings grown in the plant house of the A.F.S. was as follows:

1. 7. 29. Seed sown 19-6-29.
First seedlings appeared on 1-7-29, i.e. a germination period of 12 days.

12.7. 29. No leaves present. Cotyledons large, emarginate, petiolate, trinerved, bifacial. Specimen collected measured:

Cotyls.	12 m.m. by 8 m.m.
Petiole	12 m.m.
Stem	2 m.m.
Root	17 m.m. (tap root only developed).

19.7. 29: - 1 week later:
Primary leaves forming on stem between the 2 long petioles of the cotyls. Measurements:

1 week old.

Cotyls.	14 x 9 m.m.
Petioles	13 m.m. Leaves 3 x 1 m.m.
Stem:	3 m.m.
Root:	19 m.m. (lateral roots now developing well).

3.8.29: 2 weeks later:
Primary leaves much larger; cotyledons persisting; roots, both laterals and tap, developing quickly and well.

3 weeks old.

Measurements:

Cotyls	19 x 12 m.m.
Petioles.	15 m.m.
Leaves	7 x 3 m.m.
Stem	5 m.m.
Tap root:	26 m.m.

17.8. 29. Primary leaves growing quickly also length of
2 wks. later: stem increasing rapidly. Stem is dark red.

5 weeks old

Measurements:

Cotyls:	20 x 14 m.m.
Petioles	15 m.m.
Leaves.	12 x 5 m.m.
Stem.	15 m.m.
Tap root:	28 m.m.

21.8. 29: 2 weeks later:
Leaves are now opposite and decussate with very short petioles. Venation markedly distinct. Intra-marginal vein looped and prominent.

7 weeks old:

Measurements:

Cotyls:	20 x 14 m.m.
Petioles	15 m.m.
Leaves	28 x 12 m.m
Leaf stalk:	2 m.m.
Stem:	32 m.m.
Root	31 m.m.

Some specimens of this species appear above ground with 3 cotyledons in lieu of 2. Percentage of such in the box would be 1%. Few oil dots are visible in the largest and oldest leaves.

The seedlings a s a rule persist through the summer no matter on what soil they germinate and whether the ground is burnt or otherwise but if ash beds exist the effect is

1. More seedlings remain alive per sq. yard through the next summer. This is no advantage as there are too many.

2. They are a healthier colour and have a greater number of leaves per seedling.

3. They are somewhat faster growing but the addition is only an inch or so in height growth each year and so is of little consequence.

The result of the 1923 regeneration work at Mundaring was an excellent germination and the seedlings are now 4 inches high on an average except on heavy ash beds when they average eight to 10 inches.

The length of time that jarrah seedlings remain in the slow growing stage is not known. As much as 3 ft. growth has been obtained in the first three years and at Dwellingup 2" a year appear-s to be the average, while 1" a year is the average in the northern part of its range.

26. Ligno tubers: It develops large ligno tubers and its early slow height growth is probably due to much of the strength of the plant going to form ligno tubers.

27. Microrrhiza: Nothing known.

28. Post seedling development: Owing to the slowness of growth of seedlings on the one hand, and to the fact that until recently no part of the forest was protected from fire and all so called seedling stems are in reality coppice shoots, no information can be given on rate of the growth of saplings which have developed by this means.

3-311. Natural regeneration from seed: This is excellent but generally speaking unnecessary as only in rare cases e.g. an area at Mundaring where no seedling coppice existed, and one at Dwellingup where it had all been eaten out by goats. Repeated seeding and repeated fires have resulted in seedling coppice springing from the root tubers occurring everywhere.

312 to 315 and 32. : Sylvicultural methods employed in Treatment of canopy, undergrowth, soil and use of fire.

A description of the departmental method now employed will be found on pages 14 to 20 of the W.A. Manual. The sequence of operation is as follows:

1. Advance burn
2. Tree marking,
3. Trade cutting of all mature and overmature trees
4. Regeneration cleaning.

(A) Removal of useless trees and understorey on blocks where regeneration is desired with the retention of certain worthless trees where needed as seed trees.
(B) Final burn.
(C) Removal by complete ringbarking of worthless seed trees after regeneration is secured.

The whole technique is so well described in the Manual from which I have culled the above that I do not propose to extract any details. It is for you to make a very careful study of these pages and so make yourselves thoroughly familiar with a regeneration system which is giving excellent results in the Western State.

Coppice: Jarrah coppices very vigorously indeed and, while regeneration from seedlings will probably in the future be the main method, at present, thanks to the enormous number of coppice stems that have grown up owing to repeated fires, coppice may be regarded as the source of practically all the trees that will be grown and finally sawn as a result of the sylvicultural work in W.A.

Experiments have been carried out with a view to seeing whether the popular belief that jarrah seedlings require to be burnt before they would develop is correct. This apparently stupid idea might have had some foundation if the burning of the competing woody shrubs which come up so densely enable the coppice from the jarrah tubers to develop more rapidly. Seedlings between the ages of 6 and 18 months and some 30 months old were killed outright by fire. At 3 years and six months most of the seedlings were killed but the development of the remainder was no faster. Since then burnings were carried out in spring and autumn, at ages of 4 years and 3 months and 4 years and 9 months respectively, but it is too soon to report results. So far it does not appear that burning assists growth, nor that the seedlings after the first few years are much affected by fire since they coppice freely and quickly reach the original height growth. It follows that fire protection after 3½ years is not so necessary. Since a severe burn is put through after regeneration cleaning and fires won't run for two years after, fire protection is only important after the 2nd year for a year and a half. (Stcate).

4. Artificial Regeneration. Has only been practiced in a very small experimental way to fill up blanks - But see page 21 of the Manual.

41. Seed supply: Abundant. 29,000 seeds to the lb with chaff.

It stores well and no data are yet available as to the life of seed stored in sealed containers - the usual practice - or in bags.

42. Direct sowing has been the system adopted in the experimental work. No data available yet.

43. Nursery practice. None in W.A. I have never experienced any difficulty in raising jarrah seedlings in South Africa. The trouble came later when I tried to grow them. They transplant well. They were planted out at 9 months to a year old at the beginning of the wet season.

45. 46: Tools, Costs and Accounts: No data.

5. Tending after seedling stage:

It is not possible to define the limit in age or height of a seedling jarrah. A fire is not necessary to convert a seedling to a seedling coppice for in dry summers the seedling 4" high and say 5 years old will often die back and coppice in the autumn. Stoate calls a seedling one that still retains its withered seed leaves and if these are not present he calls it a seedling coppice. In considering this point compare young plants of white mahogany at Coopernook, also Bloodwood. A prostrate habit seems common to all these and their early development like jarrah is doubtless very slow. The proof of whether a young plant is a seedling or a coppice lies in examining the root tuber when the position of the shoot makes it clear which we are dealing with.

At 10 years jarrah starts its height growth and the protection from fire should then be complete until the young trees are at least 15 feet high - they are then 15 years old at most. In practice it is impossible to "control burn" over large areas and complete protection seems the only method. Actually since all the country carries advance growth older than 10 years the above is really merely theoretical. (Stoate)

Apart from fire protection the tending of jarrah in the sapling, pole and pile stages consist of improvement work and this is concentrated in the groups of trees that exist. On p.21 of the Manual will be found the short description. Actually the work is too young for any thinning to have been effected in areas regenerated since the start of sylviculture in W.A. and improvement work consists mainly in the removal of old trees (by means of trade cutting) which are suppressing younger ones. The thinning of the pole and pile groups has been delayed until the regeneration on the blanks has been established. In short restocking the area with sound stems is the first business and thinning must wait.

6. Sylvicultural Systems: From what has gone before it is clear that a clear felling system is not desirable for the seed years of jarrah are too far apart. There are already a number of middle and smaller trees growing more or less vigorously between the mature trees. As already stated Stoate, Shadly and Rodger schooled in the N.S.W. technique of "Selection by groups" introduced this method into the jarrah forests. Actually the forest is not on all fours with the coastal blackbutt, tallowwood, white stringy bloodwood, white mahogany stands of the east coast. Jarrah, as has been shown, regenerates and develops to a pole under a fair stand of big timber. Again there is no possibility of favouring one tree against another as is the case with tallow-wood and blackbutt for marri which is not wanted while making a much better crown does not come up in smaller holes than jarrah. Actually the elimination of marri is done in the regeneration work and in prime jarrah country there is no danger even without this precaution of marri becoming intrusive. When areas have been felled of all big sound timber and graziers have rung the stags the resulting regeneration from seed of the stags has been in the same proportion of jarrah and marri as in the original stand. The obvious system is clear felling with seed trees. This gets over the spaced seed years. It does not, however, get over the difficulty of vigorous younger trees already established. We can't afford to cut down 20, 30, 40 and 50 year old trees in order to attain an even aged stand over a whole compartment. So in virgin forest we must remove the mature timber and leave the vigorous trees to grow on and as these occur often in groups with blanks in between them the term selection by groups may be applied. This is the case shown in diagram. 2, p.19 of the Manual. There are three groups and the rest of the compartment is an economic blank though of course it carries useless trees. So the system is to provide conditions suitable for the development of the regrowth. All useless trees in the blanks are removed and the crooked coppice stems are cut back to recoppice. But this portion may contain insufficient advance coppice stems and trees are retained then as seed trees. So this part of the compartment is worked on clear felling with seed trees and the final result will be a compartment carrying an even aged stand over most of its area and three groups which will be felled when mature and be regenerated again on the group system. These are to all intents and purposes small areas of high forest worked on a clear felling system but the felling occurs at a different time than the remainder of the compartment.

If one accepted No.2 diagram as quite representative, all the group selection portion would be contained in the three groups. Actually the blank portion may be in any conditions of uneconomic stocking, indeed it may and does usually contain some vigorous middle aged trees which can't be regarded as useless and must be retained. These are retained in the place of stags as seed trees but they are kept till they are mature.

Regeneration in the form of advance growth in any case occurs in groups and unless it is all so malformed as to require cutting back to the ground the blank part of the compartment is regenerated rather on the lines of the group shelterwood system. Needless to say there is no necessity for a shelterwood yet I don't know what else to call a number of trees left in for 30 years or more while the compartment regenerates itself. There is no longer group selection proper but is really group shelterwood or the uniform shelterwood system according as the regeneration comes up in groups and these are expanded to fill the compartment or the regeneration is well distributed and the overwood - you see I try to avoid the term shelterwood for no shelter is necessary or desirable - is removed in trade cutting operations.

Clearly when these take the form of stags then it is a case of clear felling with seed trees, the latter are rung out as soon as they have done their work of casting seed, and never need stand longer than 8 years. Usually by half ringing the stags a copious seed fall is assured in the first season and they may be completely rung in two to three years after regeneration cleaning.

Diagram 2 becomes reversed when the 3 groups are mature. The portion now marked blank consists of a more or less even aged stand and the three groups are blanks once the trees on them are felled. Sooner or later "management" must face the situation and decide to sacrifice the groups for the sake of obtaining a uniform regeneration over the whole compartment. The portions marked blank will be worked on some system of clear felling with seed trees or the uniform system and when that time comes it would be well to sell the poles on the three groups even at a sacrifice and so start fair.

Taking now Diagram No. 1. Here the system is definitely group selection. The greater part of the compartment carries uneven aged groups, each one of which containing trees of even age. It also carries some blanks requiring regeneration. The latter are regenerated and the groups are improved. Such a compartment will remain a group selection area viz. a collection of small patches of even aged forest for all time and only by a very great sacrifice can the system be altered to anything approaching the unform system or the group shelterwood or the clear felling with seed tree system.

I have gone at length into the question of systems because I want it to be quite clear that while selection by groups is the officially accepted system it varies very much with the stocking and in fact clear felling with seed trees is far more usual than the selection by groups in its classic form.

7. External dangers: Man, his stock and his fire stick, are the only serious dangers that jarrah forests have to face.

71 - 73. Man in a wild effort to convert good forest into wretched grazing has acquired from the crown areas of land within the forest or along its edges. As a rule such holdings have 2 to 5 acres of marri or blackbutt flats and the remainder possibly 200, sometimes 1000 acres, is pure jarrah country. The holder acquires grazing rights over the forest adjoining his property and, since the xerophitic vegetation is only eaten by stock in the young leaf stage, he burns the forest. The Forests Department now controls the forests not the Lands Department and grazing is under very strict regulations. The habit of burning is so ingrained in the people that it will take a long time yet to educate them that fire does harm to forest.

The stock in the forests is very light and consists entirely of great stock - horses and cattle. There are no rabbits in the prime belt and no sheep can live in the forests. They are only found on private property on diorite soils.

Insects and fungi: Pine hole borer (Atractocerus Kreuserleri) enters wherever the bark is removed. The practice of sleeper hewers chipping trees to test straightness of grain has resulted in a large number of trees being rendered faulty at butt. The leaf miner Tinea sp. does some damage. Jarrah resists attacks of termites and of fungi but the heart while sounder than in most eucalypts is often attacked by both.

Cattle and horses do no harm to jarrah and their exclusion from regenerated areas is only necessary because of the fire risk they cause.

Fire has made the jarrah forest the ugliest and most deformed stand in Australia. Its extraordinary capacity of surviving has enabled this species to persist when a less hardy tree would long ago have been wiped out. An examination of a pole stand is quite the most depressing experience. The evidence of repeated fires - they came every 3 or 4 years - is written on the stems. No-one can say how old are the 10 foot saplings, they may have been burned back countless times, they show kinks at close distances up the stem. Between 10 and 20 feet the kinks are a little further apart for the height growth is quicker. The leading shoot is still killed and a new one is made which is never a prolongation of the old. Over 20 feet ordinary fires do not kill the leader but every now and then a big fire occurs and this will defoliate large trees and kill outright 20 - 25 foot small poles. After such a fire greedy branches break out over both the branches and the boles of the trees and while these fall off as soon as the main leaf canopy is renewed they leave little gum pockets in the timber of the bole which depreciates the value of the sawn product.

For fire control methods see W.A. Manual.

74. Plants: All the xerophytic soil cover is a danger because of its inflammability in summer. It will carry a fire in three years and in 4 fire runs fast. The tree underwood is some help in suppressing this growth and casuarina is best for the purpose. Unfortunately in the best jarrah areas tree undergrowth is very lacking. The question of introducing an understorey that will make use of the soil and fight factors used by the xerophytic soil cover and the unsaleable tree underwood has long exercised the minds of foresters. It is the same problem that confronts the forester in the Mediterranean forests and there Pinsapo and firs of Africa and Asia Minor have been suggested. I certainly am at a loss what to suggest for the jarrah country which is too far down in the lauretum climate to expect success from such trees as these.

75. Atmospheric agencies: Lightning annually causes the loss of a number of trees and fires have been recorded following a tree being struck; in no case however has such a fire spread for the summer thunderstorms are always accompanied by rain. Line cyclones have on rare occasions done damage.

76. Erosion. Owing to the very stony and gravelly nature of the country and the absence of precipitous slopes, no erosion has occurred in the jarrah forests. Destruction of 16,000 acres of jarrah by ringbarking around the Mundaring reservoir was not followed by erosion but by an increase in the salinity of the streams emptying into the reservoir.

77. Floods. No serious floods occur in the prime belt. On the coastal plains however the land is sometimes flooded during the winter and farmers always pay attention to drainage.

8. 85. Afforestation. Except for a limited amount of experimental work in blanks no afforestation has been done.

9. Statistical. For full details see Decennial Review of the operations of the Forests Department.

Forest Area.

State Forests. 2,423,600 acres. Compare this with the figures given on the W.A. Statement presented to the E.F.C. which gives the area of State owned but not dedicated forests.

State owned.

Virgin.		1, 291,700 acres.
Cut over with considerable mature timber remaining.		846,450
Cut over with only odd merchantable trees remaining		314,450
Low quality forest.		333,200
	Total.	2, 785,800
State Forests as in 1929		2, 423,600
	Remainder	362,200 acres.

From which it will be seen that the bulk of the jarrah forests have now been permanently dedicated to forestry. This dedication differs from that of several states in that it followed close enumeration or assessment and therefore only real forest country is included in the State forests.

Tree marking is now being carried out at 21 centres.

The area regenerated to date is 45,000 acres, while the programme is now 20,000 acres annually. 9,175 acres of good sapling growth have been thinned and at least 10,000 acres should receive treatment during the coming year. Top disposal in the logging areas is an important part of the work and 245,291 acres have been dealt with departmentally.
