C.O. Hamilton 1951.

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Copy for Tony Brand.

# THE DYING OF JARRAH (E.MARGINATA) IN WESTERN AUSTRALIAN FORESTS.

## PROGRESS OF WORK DONE TO JULY, 1948.

1.

### SUMMARY

A description of work done during the period November, 1947 to July, 1948 on the problem of the death of Jarrah in the Western Australian forests is given. A short general note is followed by a more detailed description of the progress achieved on the Teesdale Experimental area, Dwellingup Division.

2.

### INTRODUCTION.

Some years ago, forestry officers noticed that there were areas in the northern part of the Jarrah Forest Region, where there seemed to be an abnormal number of dead Jarrah trees. Later it was realised that the areas were becoming larger, more numerous, and the phenomenon began to assume economic proportions.

At the time of commencement of this research work, many areas were known, scattered through the western part of the forest from the Mundaring Division in the north to at least as far as the Kirup Division, some 150 miles further south. No accurate idea of the total acreage of country affected could be given, but it would not be overestimating to say that it exceeded a thousand acres by a good margin.

Several outstanding facts were noted at an early stage -

(1). the dying areas were associated with definite topographical features - being located in gully heads, saddles and along upper sections of drainage channels.

(2). two principal soil types were affected, the black heavy laterite gravels which are a feature of the poorer Jarrah forest close to the Darling Scarp and the yellow brown gravels occurring on slopes below heavy lateritic caps. The latter may be overlain by greyish sands.

(3). the extension of the deaths was occurring at a rapid rate.

(4). trees of all sizes and ages were affected, even young regrowth and coppice on stumps were no exceptions.

(5). the death of various species of lower vegetational layers (particularly Banksia grandis) was closely associated with the trouble and preceded the death of the Jarrah trees.

(6). whereas Jarrah was killed over quite large areas, Marri (E.calophylla) was not only able to live within the same locality, but was able to regenerate freely. No deaths of Marri on such forest land have been correlated with the trouble.

Thus it was realised that the problem had begun to reach serious proportions, and that some basic research work was re-

quired to ascertain the causes underlying the deaths, and to see if this was in any way linked to the general crown deterioration noted in the Jarrah Forest over much greater areas.

The following plan of attack was decided upon in 1947.

3. PLAN OF PROJECT.

A. GENERAL INVESTIGATION.

The first part of the work was aimed at finding out the exact location and extent of the forest suffering from the deaths. All officers in charge of Divisions and Districts were asked to mark on maps (usually on the scale of 80 chains to the inch the occurrences within the sphere of their activities. Several such maps were submitted and they showed that some of the worst areas were to be found in the Gleneagle District along the Albany Road.

Each occurrence noted in the Dwellingup Division was given a serial number, and, attached to the plan, was a short description of the main site and vegetational features of each patch.

Secondly, the plan aimed at finding out the site factors involved and the way in which the trouble was manifested in the vegetation. Many different dying areas were to be inspected in the rapid notes recorded of topography, soils, nature of the tree and other vegetation particularly with regard to their health. Quite a number of these investigations were made in the Dwellingup Division.

Next, it was intended to find out all that was possible of the history of the deaths.

The above three aims covered the early lines of investigations required to give facts about location and symptoms of the phenomenon over the whole of the range of the Jarrah forest.

B. DETAILED SURVEYS.

At the same time as the general investigation of a large number of sites was going on, the plan provided for the detailed study of a typical dying area, so that exact data could be obtained pertaining to all possible aspects of the problem. The area chosen was located beside the main road from Dwellingup to Pinjarra at a point close to the turn off to Marrinup siding. This was called the Teesdale Experimental plot, and it lies on the northerly aspect of the slope below the Teesdale Fire lookout.

Selection of Experimental Site.

The reasons for choosing the Teesdale site were several. Firstly the dying of Jarrah trees was noticed, possibly for the first time, on this very area so that symptoms and factors responsible should have been well developed. Secondly the location

was admirably suited for continuous study, being so accessible and close to the Dwellingup Office and Research Station. The various features of dying areas were well seen there, and on the southern side the boundary between the healthy and affected Jarrah forest was particularly well marked and suitable for comparative study. At the time of initiating the programme, the rapid extension of the area in a westerly direction was evident, and lastly within the badly affected portion of the plot, were several very good patches of Marri regeneration.

In all, the area chosen appeared to be a good one for detailed study and should furnish much information on the nature and cause of the changes seen in the vegetation.

4. DESCRIPTION OF TEESDALE PLOT.

Location. See locality plan in appendix.

Climate. Being located in the Jarrah Forest region, the area is characterised by a "Mediterranean" type climate with cool wet winters and hot dry summers. The average annual rainfall is 52.17 inches which is mainly received in the months of June, July and August. During the long summer, the main rain is brought by tropical low pressure systems and is scanty and uncertain. The six months period from mid October to mid April is dry and a running fire can be started at practically any time in three year old leaf litter. Rainfall figures are appended, and they show the month of greatest rainfall is July with 10.93 inches; and the lowest monthly averages are registered in January and February with 42 and 46 points respectively. The driest period on record, extended from December 1949 to April 1950, when only 49 points were recorded in those five months.

The fire season is always long and severe Temperatures are high in summer, exceeding 100°F several times a year and maximum averages from 79.6°F to 84.2°F during the three hottest months.

Some frosts are experienced in winter but days are not cold. The average maximum from June to August varies from 58.60 to 60.9°F. Average minimum from same months varies from 41.9° to 42.8°F.

| | | |
|---|---|---|
| Absolute Maximum temperature | - | 107.7°F |
| Absolute Minimum " | - | 26.4°F |
| Lowest Terrestrial Minimum | - | 20.2°F (21.7.51) |

Physiography. The study area is located on the "Darling Range" at an altitude of approximately 860' above sea level, a short distance below the site of the Teesdale fire lookout tower (990') which is on a high point a few miles East of the Darling Scarp. It takes in portion of middle and lower slopes of Teesdale hill on the North and North Eastern aspects adjacent to a small saddle-like shoulder through which the Pinjarra-Dwellingup Road

is routed. It was noted that a similar "Dying patch" is located on the other side of the shoulder, a half mile or so further to the West. The total range in altitude of the dying patch is from 820' to 925' A.S.L.

The dying area is centred around a shallow "gully-head" or upper drainage basin which opens to the North towards Marrinup Brook. No definite water channel is developed, the moisture from above percolates laterally down the slope in the soil layers and only for a short period during the height of the winter-wet-period does actual free water flow over the surface of the ground.

Slopes are not steep, except high on Teesdale Hill, just above the actual area plotted. For the most part slopes do not exceed five or six degrees. The main slopes being to the North they expose the higher parts of the area to the midday heat in summer.

Geology and Soils.

Beneath the mantle of present day soils, lies the old Precambrian granites and younger intrusive epidiorites. The rocks do not show in the area, except for an occasional small boulder of epidiorite here and there; but a few miles to the west, along the eroded edge of the Darling Scarp, the "country rocks" are exposed by the removal of the overlying soils and lateritic remnants.

The present soils are almost exclusively sands and sandy gravels resulting from the truncation, destruction and transportation of previous lateritic soils of a past climatic age. Only in very small areas do soils approach a loamy texture.

Sands and sandy gravels overly cemented lateritic gravelly material or massive laterite at various depths, the massive rock-like formations may actually outcrop at the surface or be found at very few inches below the surface in some cases. On the slopes, gravels attain their greatest thicknesses, something in the neighbourhood of four feet.

Because of the original composition of the parent laterites, and the subsequent history of the soil material, the fertility of the area is extremely low and, no doubt, was always approaching conditions marginal for the growth of good Jarrah.

Vegetation.

The original forest consisted of a mixture of Jarrah and Marri and was of rather low quality. Jarrah comprised the greater part of the stand which was rather open in the lower lying parts of the study area. Thus, as compared with the forest on higher levels of surrounding country, the forest which clothed the portions which first developed the symptoms of "die-back" was of

inferior type and stocking was low.

Beneath the main storey of trees was a cover of Banksia grandis with an odd small tree of Persoonia elliptica. The Banksia, prior to the commencement of the study, had at some time or other been present over most of the area. However, much of the small tree layer had died and in places very few remains of it can be found.

The small shrub layer was well developed, a large variety of species typical of the Jarrah belt being seen on higher parts of the landscape. The association of shrubs noted on the gravels at lower elevations was very largely composed of a number of sedges - Loxocarya spp. which appear to be spreading rather rapidly on parts of the affected forest. At the lowest points in the area, the vegetation is quite different to that of high levels. It is composed largely of Baeckia Camphorosmae, Conostylis aculeata Hakea bipinnatifida, and Loxocarya flexuosa also in evidence.

Species characteristic of better drained sites and massive Laterite areas include Bossiaea eriocarpa, Dryandra nivea, Xanthorrhoea Priessii, Hibbertia spp. Leucopogon spp.

The undergrowth in the study area has shown the effects of adverse environment along with the Jarrah in certain parts, and considerable changes in the density and composition of the minor species have been and are being wrought.

Trade Operations and Log Removal.

The first logging for sleepers was done about 1910, and a heavy cutting of Jarrah for milling was made about 1919. Since then some sporadic cuttings of a minor nature have taken place.

The next important removal of tree crowns was effected when regeneration work was undertaken by the Forests Department in 1931 and 1934. In this work all malformed Jarrah and most Marri trees were ring-barked. This resulted in a further significant reduction of the original crown cover. The ring barking was not done on the fireline on the south side of the Marradong Road. A coppice cleaning was carried out in 1939 and 1940 - affecting the regeneration resulting from the earlier treatment.

? raised watertable in valley bottom?

When the Teesdale Tower was erected on the hill to the south of the area (1934), a large part of the hill top was cleared of timber and the regrowth has been cut down regularly ever since. It is interesting to note that the "suckering" of Jarrah around the tower site is particularly healthy in spite of such treatment and its position at the hill top. Below the cleared area of the hill top, regeneration of Jarrah and Marri has been sufficient to restock the heavily depleted stand, but on lower slopes and in the drainage basin, regeneration of Jarrah has been very poor and

has since died over much of these parts. On the other hand, in dying areas, Marri has shown that it can regenerate and several very fine little patches have resulted.

Protection and Fires.

RF
1940 755mm
41 1378
42 1609
43 1109
44 955
45 1889
46 1572
47 1308
48 1341
49 1147
50 1209
average 1288mm

From time to time parts of the study area have been subjected to fires, the firebreak south of the main road being burnt regularly. The compartment higher on the slope has been protected for a number of years and leaf litter is heavy beneath areas of more or less closed canopy. To the north of the road, fires have not been excluded and parts was burnt in a severe fire during the late summer of 1946. This burn undoubtedly adversely affected the forest, and the dying of Jarrah was much accelerated during the 1947-48 summer and autumn.

Summary of condition of Teesdale Plot at November 1947.

The portion of forest covered by preliminary investigations described in this report, was, in short, in the following condition when the study was begun in November 1947.

It occupies the mid and lower slopes to the N.E. of Teesdale fire lookout, and the soils are lateritic residual gravels and sands with occasional out-croppings of boulders or massive, vesicular and cemented laterite cap material. The original Jarrah-Marri forest had been heavily cut for the mills some 28 years before and the remaining canopy had been further reduced by ring-barking and minor cutting. Fires had been experienced over the greater part of the area and a recent severe fire had occurred in the N.W. corner. In the lower part the Jarrah had failed to regenerate or if scattered regeneration had been effected, it was in the process of dying. The same areas showed death of Jarrah trees of all sizes and these deaths were still occurring, the affected area increasing each year, but a rather stable line (above which Jarrah appeared healthy) had developed along the mid slope to the south of the project area. The undergrowth had undergone great changes, becoming very sparse with the death of many species, and subsequently invaded in places by Loxocarya spp.

5. METHOD OF WORK.

In November 1947 the writer commenced detailed study of the plot some thirty (30) acres in extent, taking in the main part of the affected area and stretching into green healthy forest on the south and south western corners.

First of all a base line was laid in a convenient position, and from it the strip lines were run off at approximately two (2) chain intervals; the strip lines running across the features at right angles, or nearly so, over the lower part of the plot. Higher up, the lines necessarily ran along the slopes above the

head of the drainage channel.

Field notes were then made along the strips, working one chain each side of the strip lines; details of present living trees, small tree layer; ground vegetation (species, cover and health) and surface soils being recorded for the whole area of about thirty (30) acres. A soil survey was begun.

From this data the following plans were constructed on a scale of two (2) inches to one (1) chain.

6. RESULTS OF WORK.

(1). Key map of all trees. A plan was prepared showing the location of all trees on the area, and a key number was allotted to each tree for future reference.

(2). Canopy at November, 1947. A second plan showed the total living tree canopy at the time of the commencement of the survey each species being shown distinctly and the health of the trees shown by symbols.

(3). Canopy of trees, died and ringbarked. This plan showed the reconstructed canopy of trees which had died for any reason other than cutting.

(4). Canopy removed. The fourth plan depicted reconstructed canopy of all trees removed during trade operations or otherwise cut down and removed. Details of all the log measurements were recorded in the field books for calculations of loadages removed.

(5). Total canopy. From the above plans a composite plan of total canopy was prepared. This showed the grand total tree cover which had existed at any time since the virgin stand was constituted, and includes larger regeneration since cutting first began. This therefore represented all ground covered, at any time, by some canopy of the tall tree layer.

(6). Small Tree Layer. A further plan depicted the location of areas covered by living Banksia grandis, and those areas over which the Banksia had died at different periods. The location of other species affected by "die-back" (such as Persoonia longifolia) were also noted.

(7). Ground Cover. The shrub layer was mapped in detail, the areas covered by various species and associations being shown by different colours and hatching.

(8). Soils. A preliminary map of the soils of the area was made from soil pits which were put down at two chain intervals over the area, and at intermediate places where soil changes occurred.

## 7. DISCUSSION OF RESULTS.

Up to the time of making this report, the work done on the Teesdale area and other localities, had been purely of a preliminary nature. For this reason it isnot possible to give an account of the causes of the phenomenon of "dying-Jarrah." However, a short discussion of various aspects of the problem as demonstrated on the Teesdale Plot, will serve as a basis for further investigation.

### Changes in the Vegetation.

The initial significant change in vegetation was seen when the majority of the merchantable timber was removed for milling about thirty years ago. What effect this operation had is not known, but it was probably followed by an intense burn when the resulting slash was fired. Canopy was further reduced some years later by silvicultural work and soon after this, the deterioration in the remaining Jarrah was sufficiently serious to be noticed. 1910-1919. 1931-1934.

In other areas, and on the edge of the Teesdale plot, the actual death of the Jarrah is preceded by mass death of the Banksia grandis understorey and other species such as Persoonia longifolia; species which are considered rather sensitive to environmental conditions. Jarrah crowns become thin and unhealthy-looking along the edge of dying Banksia and some of the ground flora are killed or become unhealthy - including Bossiaea eriocarpa, Dryandra nivea, Xanthorrhoea Priesii, Hibbertia hypericoides, Leucopogon capitellatus, L.verticillata, Macrozamia Fraseri, Acacia pulchella, Scaevola striata, S.platyphylla and others.

The next belt shows the Jarrahs commencing to die back. Many become stagheaded and die in several years. Others succumb more quickly, the entire crown dying in one year. In general, the crown dies first at the top, some crown is replaced by a secondary epicormic growth, the whole crown dies and a few epicormics are seen on the trunks. Finally, these wither and the tree is dead. Deaths occur predominantly in the late summer and autumn after protracted periods of dry conditions. On the other hand, the death of the Banksia commences before the onset of summer.

There is no size or age of tree which is immune to the trouble, seedlings and old trees alike are affected. Vigorous saplings within the area eventually succumb.

At this stage, on the mid and lower slopes, the ground cover is much depleted; the only overhead canopy consists of the Marri trees which are not affected and an odd remaining Jarrah. Large areas of bare gravelly soil are seen, and the shrubby type of perennial vegetation has given way, largely, to a crop of small annuals and xerophytic species with underground creeping stems

such as Loxocarya spp. and Lepidosperma spp. The bare patches are particularly unfavourable sites for seedling survival. In many cases seedlings of Jarrah and other associated smaller species germinate, but cannot survive the adverse conditions.

Along with such drastic alterations in the vegetation, a parallel series of changes are being wrought in the soil.

Changes in the Soil.

The most obvious changes in the soil occur in the uppermost layer of the mineral soil and in the litter immediately overlying it; changes which are strikingly accelerated by either severe or frequent burning of the forest.

With such large scale reduction of tree canopy and shrubby understorey, the amount of litter available to the forest floor is tremendously reduced. On areas unburnt for many years and situated in the centre of the "die back" patches, virtually no litter is present at all over as much as seventy per cent or more of the ground. The remaining area is protected by a few leaves and thin wiry vegetation. Litter protects the soil, supplies the nutrients necessary for the welfare of the vegetation growing upon it and supports the desirable microflora and fauna of the living soil. In areas so poor in soil nutrients as are the Jarrah soils, any upset of these conditions must be serious for the climax species, and it is probable that only invading species can survive. This is a reason for the presence of Marri on even the worst affected country. So it is that the soil fertility must be greatly depleted by the sequence of events outlined above.

Another aspect of soil deterioration is seen in the disappearance of the fine friable organo-mineral $A^1$, which is a feature of the better class protected Jarrah soils. With the exposure of the soil surface by depletion of litter and vegetation, the organic matter and fine soil material is rapidly removed from the topmost layers and there is no way of replacing this most valuable horizon without first re-introducing a more or less continuous vegetative cover.

Soil moisture relationships are adversely affected simultaneously, and this aspect may well be of high importance in the death of the vegetation.

Summary of possible causes.

As I see it at this stage, the sites on which Jarrah is dying, are definitely not good quality sites. They are more or less marginal for the growth of Jarrah in spite of a considerable quantity of merchantable timber being produced there in the past. The Jarrah forest was built up as a climax association through the work done by earlier hardier pioneer species such as Marri and

various undergrowth species. The poor lateritic derivatives were enriched by the vegetation until the soils could support the Jarrah forest of the type seen prior to the original milling.

With the depletion of canopy and general disturbance of the forest composition brought about by cutting, ringbarking and burning, the forest site has inevitably deteriorated to a point when not only does Jarrah fail to regenerate, but continued growth of existing trees is not possible.

The factors of great importance can be listed:-

1. The reduction of canopy and protective vegetation exposing the site to increasingly adverse conditions, increasing insolation, evaporation and surface rain-wash effects.

2. The reduction of litter, resulting in an unprotected soil, lacking the cyclic return of organic matter so essential for the maintenance of soil fertility in extremely poor laterite soils of gravelly or coarse sandy nature.

3. The changed moisture relationships which are manifested in much more rapid movement of water through the soil particularly laterally; a reduction in water holding capacity and heavy leaching of such soluble and finely divided materials that are present. Drought conditions are greatly intensified.

4. Reduction in beneficial microflora and microfauna in the soil by depriving them of necessary food material and alteration of environment in the surface layers of soil.

Conclusions.

As stated before, the work is far from complete. The paragraph above on possible causes is inserted here to suggest various fields available for investigation, and likely to prove helpful in solving the problem.

Although it has been noted in one or two instances that Jarrah has died in virgin bush areas, it cannot be disputed that the greatest effects are seen in heavily cut areas, in areas of poor soil-site, in more northerly longer cut-over and less favourable (climatically) parts of the Jarrah regions, and there are at present signs that the trouble is gradually spreading into Jarrah country in the far south west. There is every reason to believe it will increase, wherever heavy removal of canopy and continued burning or destruction of undergrowth is practised on sites which have marginal characteristics for the growth of Jarrah.

In June 1948, the author handed over the work to A.D.F.O. P.H. Barrett at Dwellingup.

The notebooks, field book and all maps mentioned in this report, have been deposited in the Forest Research Laboratory at Dwellingup, from where the investigation is being continued.

(Sgd.) C.D. HAMILTON.