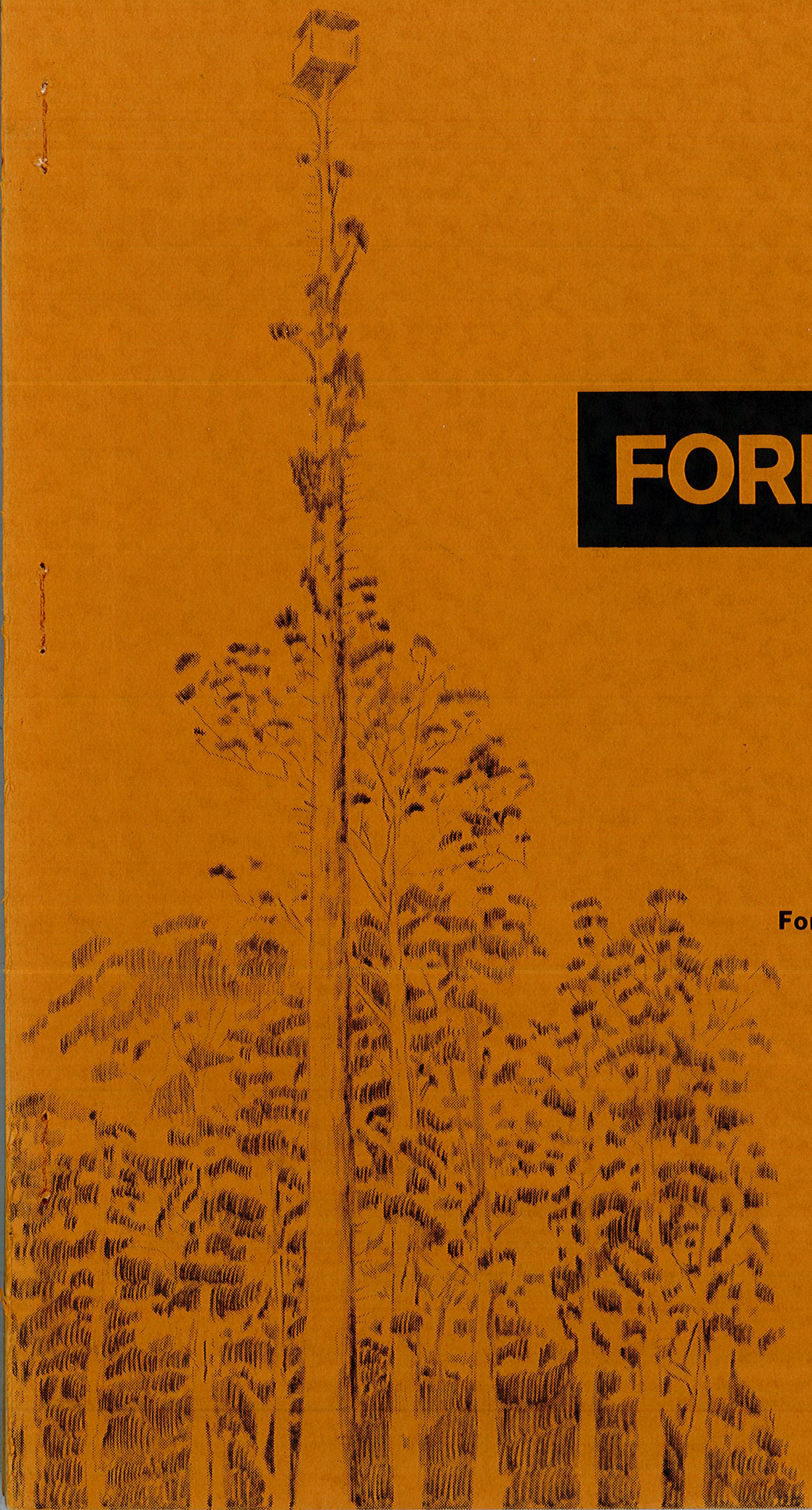

FOREST NOTES

Forests Department Perth Western Australia

VOL 9 NUMBER 3

F O R E S T   N O T E S

Volume 9 - Number 3

December 1971

Editor: R.J. Underwood

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BIRDS IN PINUS PINASTER PLANTATIONS - A FREQUENCY COUNT

by

J. McCormick

Being aware of the adverse effect exotic conifer plantings have on native plant life one is moved to enquire into what effect these plantings might have on native bird life, for surely they will favour some bird species in preference to others. If there is an answer to this question it may never be found and perhaps the best one can do is prepare a list of birds observed in local pine plantations, as was done by naturalist H. Butler for the Gnangara area, and by making frequency counts from time to time.

A frequency count was made (see table) in coastal pine plantations over a six month period, April to September 1971, using Mr. Butler's list as a guide to identification of bird species. It was thought that if members of Dwellingup fire research staff recorded the name and number of each bird species sighted during visits to the plantations - Myalup, McLarty, Somerville and Gnangara in the normal line of duty, a frequency table might be produced which would be of interest.

No attempt was made at "bird watching" and the time taken in recording the data was no greater than that given to filling in the vehicle running book each day. The record includes birds sighted by the recorders whilst travelling through or working in any plantation; the one stipulation being that only birds sighted within or above the plantation would be recorded.

In all, 49 visits were made during the six month cold-half of the year. Such an assessment could well provide a different answer were it carried out during the hot season.

It is evident that the seed eating cockatoos and parrots will be the numerically dominant species in Pinus pinaster plantations followed by the ground feeding magpies and ravens, whilst the presence in good numbers of the carnivorous butcher birds and kookaburras can be taken as a good omen. Many small birds appear to find sustenance from the pine trees by pecking about in the thick bark, among the branches and in dead thinning tops, whilst there is no shortage of winged insects for swallows, flycatchers, etc.

Where the smallest birds are concerned, the question of habitat comes to mind for during the survey, wrens, silvereyes and several other small birds were observed mainly among scrub bushes in swamps or in young plantings which still contained scrub bushes. It would appear that uncleared swamp areas, no matter how small, within pine plantations, would be beneficial to numerous small birds as nesting places.

Frequency Table

Birds Observed in Pinus pinaster Plantations

April to September 1971

NAME	NO.	NO. VISITS	NO. PER VISIT
White tailed cockatoos	1,643	21	78.23
28 parrots	200	30	6.67
Magpies	122	23	5.30
Red tailed cockatoos	57	1	57.00
Fantails	47	19	2.47
Little wattle birds	47	19	2.47
Scarlet robins	38	19	2.00
Grey butcher birds	37	24	1.54
Ravens	34	16	2.13
White cockatoos	32	2	16.00
Splendid wrens	29	6	4.83
Yellow tailed thornbills	25	5	5.00
Kookaburras	24	14	1.71
Pipits	22	6	3.67
Golden whistlers	21	13	1.61
Black ducks	17	5	3.40
Spotted scrub wrens	11	3	3.67
Pallid cuckoos	10	8	1.25
Swallows	9	5	1.80
Silvereyes	7	3	2.33
Bronzewing pigeons	7	2	3.50
Rufus whistlers	5	1	5.00
Wagtails	4	3	1.33
Restless flycatchers	4	1	4.00
Western thornbills	4	1	4.00
Spotted pardelotes	3	1	3.00
Emus	2	1	2.00
Rosellas	2	1	2.00
Western warbler	1	1	1.00
Wedge tailed eagle	1	1	1.00
Yellow robin	1	1	1.00

RECREATIONAL USE WITHIN STATE FORESTS

by

F. Batini

This article is based on observations made during a visit to the National Parks and National Forests in the States of North Carolina and Tennessee.

GREAT SMOKY MOUNTAINS NATIONAL PARK

The Great Smoky Mountains National Park, situated in the Appalachian Mountain chain, is located on the border between North Carolina and Tennessee. It is one of the most popular of the U.S. parks with 6.78 million visits in 1970. This represents an increase of 50% over the 1960 figures. Over half these visits occur in the months of June, July and August. The six months from May to October account for about 83% of all visits.

The themes of this park are to show the visitor a forested mountain scape and to provide an insight into the lives and culture of the mountain pioneers. The park can be used for either camping (1,400 campsites are provided) or day use (the nearby town of Gatlinburg and private caravan parks cater for the excess). Park fees are $3 per day per campsite with a maximum stay of one week in the summer months.

A full time staff of 125 caters to the needs of the public. This staff is greatly increased during summer using casual staff recruited primarily from colleges and schools.

The organisation is divided into four Divisions (excluding the Superintendents' Office) these are :

Division of Interpretation	7 positions
Division of Administration	9 positions
Division of Resource Management and Visitor Protection	33 positions
Division of Maintenance	71 positions

DIVISION OF INTERPRETATION

This division operates the visitor centres (over 900,000 visits in 1970). These centres are excellently laid out with maps, models and photographs of the park. Literature is available on a wide range of topics and is supplemented by films, tape - slide shows and a museum.

Guides for all nature trails are available at 10c. each. (This is based on an honour system and 49% are in fact paid for.) Demonstrations on the following aspects of mountain life are available : Ploughing with oxen, firing a muzzle loading rifle, grinding corn, arts and crafts of the mountain people, splitting shakes, brewing moonshine, etc. This is in addition to the natural history and camp fire programmes on vegetation, wildlife, black bears, bird watching and fishing.

Some of the mountain settlements have been rebuilt and are an appealing attraction. Damage and graffiti by vandals are an unfortunate but common occurrence. During 1970, informational and interpretative programmes contacted 3.68 million visitors (over 50% of all visitors).

DIVISION OF MAINTENANCE

It is obvious from its staffing that this Division has plenty of work. Nevertheless, the Park was extremely clean during the period of my visit. Undoubtedly this is influenced by the attitudes of the park user. Americans, in general, appear to be much more conscious of litter than is the case here in Australia at the present time.

DIVISION OF RESOURCE MANAGEMENT AND VISITOR PROTECTION

This Division has, undoubtedly, the responsibility for managing the biggest problem of the park - the park user. The great increase in the number of visits in recent years is proving to be an ever increasing headache to the park planners and managers. On busy days, some 12,000 cars per hour (40,000 per day) enter the main gate. On the major routes through the park these visitors crawl along in bumper to bumper traffic that would rival that in the biggest cities in the U.S. The sudden appearance of a black bear causes an immediate stoppage and complete jam as people evacuate their cars for a "look see".

Rangers speak of the park being loved to death! I saw little evidence of damage to vegetation on a broad scale. However in limited, high use areas, there is obvious evidence of soil compaction, plant death and erosion. It is quite obvious that most of the visitors see and use only the half chain strip either side of the major roads or the nature trails. There is little evidence that large numbers of people explore the park in depth. Thus the user impact is restricted to a very limited area.

One of the more serious problems is the management of the visitor himself. A well equipped park ranger carries a loaded .45 revolver, handcuffs, a nightstick, a billy club, a can of chemical mace and a loaded shotgun in his car. The vehicle is equipped with radio, flashing lights, siren and yelp. The back seat of a standard sedan is separated from the front by a $\frac{1}{4}$" steel mesh. There are no door or window handles in the back seat portion.

All rangers have to attend an 8 week police school on law enforcement. Special schools on narcotics and crowd control are run by the F.B.I. The chief rangers' library would do credit to a C.I.B. detective - but not a forester. Over 700 court cases were dealt with by park rangers during 1970. Most dealt with driving offences and the breaking of park rules regarding vegetation, wildlife, fish, etc. There is an increasing drug problem in the National Parks in the U.S.A. Recently, over 1,000 hippies had to be physically evicted from Yosemite.

Temporary rangers are also armed after a brief introductory course of one week. One of these was involved in an altercation with some youths last summer and shot one of the youths dead. This occurred on the Lake Mead National Recreation Area and the court investigations of the case are still proceeding.

Another problem is to find adequate space for the ever increasing demand for campgrounds. Over 1,400 sites are available but these are totally inadequate for the demand. Campsites involve problems such as sewage treatment plants, adequate rubbish disposal systems and crowd control. The quiet hours of 10 p.m. - 6 a.m. have to be enforced, the one week's maximum stay likewise, children have to be rescued, Mr. Smith has to be found as there is an important long distance caller waiting ....

Increasing the number of campsites is no real solution. These are quickly filled, the staff needed to manage the park is no longer adequate and the problems are still there - in increased numbers. In 1960 82% of campers used tents and required minimal facilities. In 1970 this figure has fallen to 40%. The remaining 60% use either caravans or tent trailers. In increasing numbers, the "woodsman" of today wishes to hook up his caravan to electricity, water and sewage outlets. Shower and shopping facilities also need to be provided.

NORTH CAROLINA NATIONAL FORESTS

The National Forests of North Carolina are located within 100 miles of the Great Smoky Mountains National Park. These forests received over 2 million visitor days of recreational use in 1967. During 1970, over 6 million Americans drove through or camped in these areas. Recreational use is thus the fastest expanding use on these forest lands. Recreational development include 50 sites with 767 camping units and 500 picnic units. The development programme is far behind the demand for these facilities, in fact current demand exceeds the supply by more than 7 times. Demand projections show a total demand for 22,000 camping units and 8,000 picnic units by 1976. In the next 5 years it is expected that the existing gap between demand and supply will widen even more.

The pressure on environmental issues within the U.S. continues to increase. Forestry, which in that country has had a reputation and an image far better than it has in Australia, is suffering the back-lash of these activities. The public feels that too great an emphasis is being placed on production forestry. Conservation and pressure groups are badgering Congress into forcing the U.S. Forest Service into more and more recreational use. Silvicultural practices such as control burning and clear felling are under attack, though formerly these were quite acceptable. The Federal Service is finding, more and more, that publicity is an important aspect, if it is going to continue responsible management programmes. There is now a real need to "sell" these programmes to the man in the street.

Criticism of the lack of suitable recreational areas has led to suggestions that National Forests be excised from timber production and converted into National Parks. This has already occurred with some National Forests. Recreational pressure has already forced several water companies into the additional cost of water treatment plants in order to accommodate recreational use on the water resource.

The N.C. National Forest Supervisor and his foresters are keenly aware of this political pressure on the forest estate. "Travel influence" zones are mapped out along well used roads. The verges are managed for aesthetic appeal and not production values. These verges are also used as screens between the road and clear cutting coupes. Each Divisional office has 3 professionals, the O.I.C. and

2 assistants. One of the assistants deals with production values, the other solely with recreational, wildlife and aesthetic aspects. The Head Office staff includes 4 recreation foresters, 3 landscape architects, a soil scientist, a hydrologist, a wildlife biologist and 8 foresters. Of these 8 only 3 are involved with production forestry.

Land use and management plans for recreational areas have been prepared. Campground fees are $1 per day with a maximum stay of one week during the summer months. Sewered toilet blocks and sewage treatment plants are being provided on the larger recreational sites. Lifeguards are also provided on recreation beaches and streams. This is apparently very necessary to avoid legal action being taken against the Department in case of personal injury. The North Carolina forests include part of the Biltmore estate. This is where the first forestry school in the U.S.A. was established. The school and ancilliary buildings have been reconstructed as part of the "Cradle of Forestry" project. Though far from finished, this project attracted 77,000 visitors in the first 6 months after it was opened.

National surveys indicate that conservation problems are ranked as the 6th most important issue among U.S. youth. 97% of the people polled wanted more access to green grass and trees, 95% favoured Federal funding of projects related to environmental issues and 75% were willing to pay added taxes in order to fund these projects. There is a feeling that, if foresters are too defensive in dealing with these issues, the potential conservationist can readily become hard-core preservationists.

Conclusions

I am personally in favour of recreational development within the forest areas of this State. I think that it would be unwise to deny the people access to their forests. I also consider that a lot of good feeling can be promoted by encouraging more recreational use. The work being conducted by the Divisions is commendable and the preliminary "user" surveys are of great value. In the light of my U.S. experiences, however, very careful thought must be given before recreational programmes in Western Australia are to be expanded. Unless this development is carefully planned and budgeted for, we may end up with some of the serious problems which currently face the U.S. Forest Service - an unhappy public (there are too few facilities), a great cost (campsites, sewage and garbage disposal), drugs and crowd control problems and the possibility of court actions against the Department in cases of personal mishaps to the forest user. These problems I consider to be very real. I cannot see any reason why they should only be peculiar to the U.S. and not be applicable to Australia in time.

Time appears to be one factor on our side of the ledger. If we plan adequately in advance, some of these may be alleviated, or even overcome. I shall base my thoughts on the premise that user pressure on forested areas for recreational enjoyment will continue to increase. The other assumption is that, even should we desire to stop this, we are in fact nearly powerless to do so. Both of these premises have some basis in the light of U.S. experience.

The major problems appear to be associated with permanent campgrounds. I consider that the Department should encourage drives for pleasure and day-users of the forest, but would have very serious misgivings about the development of campsites within the forest. This type of development could well be provided by the private sector, in areas adjacent to the forest. We could in fact provide advice on layout, silviculture etc., to these private developers. The forest could then be retained as the source of the recreational experience and foresters retained as silviculturists and not law enforcement officers. Whatever development takes place, it will cost money. Campsites cost a lot of money if they are to be adequately developed and conform to future air and water pollution regulations. It is difficult to see how we could justify these projects from the current timber royalties. If additional recreational areas are considered desirable, an alternative source of funds should be sought. U.S. experience suggests that this source should be considerable and available in ever increasing amounts.

Matters such as the respective role of foresters and police in supervising the forest user should also be considered. The likelihood of court actions against the Department must be given some thought and an approach to Crown Law could be desirable. It would indeed be a sad day if forest rangers have to be armed in order to perform their duties.

The silvicultural problems relating to forest use by the public are rather less serious than the social and economic problems outlined. This is also the sphere in which our basic training lies. Adequate land use planning in the early stages should help overcome these. Foresters in W.A. should try to apply the U.S. experiences in their everyday forest management. The public is becoming increasingly conscious of the environment. If our management is inadequate, or even if it is considered to be inadequate, serious repercussions on the Department could occur.

We cannot enter into an expanding recreational programme lightly. If we do so, we may find that we have spawned a situation which we are unable to handle successfully.

BURNING IN KARRI FORESTS

by

Frank Quicke

Having read with interest, articles by Nicol, Ward and Christensen, I am prompted to add to these articles.

In considering karri burning, the questions arising are -

1. How many litter types are there?

2. What is the correct rotation timing for successful burning of each litter type?

In an attempt to answer the questions, we may best do this by dividing the litter into grades of types. P. Christensen refers to a karri scrub type consisting of -

i. Bossiaca aquifolium (netic)

ii. Acacia pentadenia (karri wattle)

iii. Trymalium spathulatum (hazel and other less dominant species)

It is true that five years after a heavy fire, a community dominated by any of the three major species will be covered by an almost impenetrable stand of mixed scrub.

It is also true that this stand of scrub will not burn in mild conditions at this age and thus usually grows for 10 - 15 years when it becomes a scattered stand of large bushes of karri wattle or hazel of up to 40 feet in height.

The ground litter is made up of grass, tree crown debris, fallen karri wattle and netic and karri bark, making many tons per acre of highly inflammable material.

Often, this type of karri litter is burnt accidentally e.g. lightning strike, and is also very difficult to burn without contributing to a heavy crop of karri wattle and the other undesirable scrub types.

It appears therefore, that this particular karri scrub make up can be divided into three ages : 0 - 3 years, 4 - 15 years and 15 years plus.

Assuming that 15 years plus scrub has been burnt and a dense regrowth of karri wattle, netic and hazel is produced we have -

<u>KARRI LITTER TYPE I</u> From 0 - 3 years old

<u>Composition</u>

Dense karri wattle 4 - 6 feet high, some hazel and netic, bracken fern, grass, a few wild flowers, tree debris (on the ground) with a small amount of tree debris hung up in karri wattle crowns.

This type of litter at three years old will burn with a 6 - 12 inch flame on the ground in "High Summer" conditions.

The result from such a burn is not obvious at the time of burning but never the less, kills the karri wattle and does not germinate a lot of karri wattle seed.

What does grow is bracken fern, wild flowers not seen before and scattered karri wattle. Karri seedlings also appear but will not survive where crown cover is great.

The follow up from this burn is to note that tree debris can fall to the ground and not be caught in karri wattle crowns. After three years another light burn will diminish further karri wattle and encourage smaller plant life to grow. (Orchids will appear and many other plants not previously seen.)

The late Forester, Jack Rate demonstrated this type of treatment in karri forest more than ten years ago and some burning was done like this on the Shannon - Walpole roadside near Mount Burnside with very pleasing results in 1966 - 67.

A three year cycle is possible and can be handled in warmer conditions than exist in our present burning season.

<u>KARRI LITTER TYPE II</u> From 4 - 12 years old

If type I is allowed to grow 4 - 12 years, the karri wattle becomes very dense, will not support other plant growth and tree debris does not all fall to the ground.

Burning is very difficult and often impossible except under very high conditions. Such fires result in severe damage to the forest and fauna.

Walking lanes must usually be prepared for burning off by hand.

Litter should not be allowed to grow to this type.

KARRI LITTER TYPE III

This has already been described as very old open scrub and highly inflammable. This type can be burnt fairly easily but will often carry another fire within six months if burnt too lightly, thus defeating the purpose of a light fire in retarding scrub regeneration.

Often walking lanes are not necessary for hand burning.

CONCLUSION

Control burn types i and iii and then rotate burning no more than three yearly.

That more burning will therefore have to be done during our hotter months, will mean an extended burning season and will not interfere with wild flowers displays as early spring burning does.

Hotter conditions, but smaller fires will result in ease of lighting and handling, reduced scorch, more wild flowers and easier access for management.

To support small fauna, some areas will no doubt have to be set aside to avoid fires reaching them in the hotter burning conditions.

Try a three year cycle and burn in early summer. Autumn is not favoured because karri wattle seed is mature and will be germinated. By contrast, most wildflowers are sustained by root systems and survive late spring and summer burning.

THE WINDSOR RW 30 TREE HARVESTER

by

Roger Burke

I recently had the opportunity of working with the Windsor Tree Harvester, being demonstrated in Mount Gambier Radiata forests by Bill Kerruish of the Forestry and Timber Bureau.

The harvester is a machine developed by Bill as an example of how he envisages young plantation management a few years from now.

Briefly the argument runs thus : rising costs, mainly wages are forcing foresters to delay first thinning to an age where they will yield a reasonable economic return, a point beyond the silvicultural optimum. The solution is to mechanise as much as possible, eliminating the most unstable cost - wages. This will enable the thinning to be carried out when the stand will benefit most - with less regard to financial returns. And this is where RW 30 comes in.

The harvester is built around a Timberjack 303, four wheel drive and hinged in the middle. A 32 foot overhead boom runs the length of the tractor, mounted on which is a hydraulically operated "de-limbing" carriage. At the front - bearing quite a resemblance to a huge marron claw, is a clamp and shears - also hydraulic, on an 8 foot swivelling arm. The driver's cabin is at the right hand front side and a carrying tray on the left.

In operation the Harvester drives up to a tree - grasps it at ground level with the clamping jaws, and cuts it off with the shears. The tree is then lifted bodily and laid on the boom and delimbing carriage. The jaws of the carriage then close forming a collar around the tree, and the carriage moves rapidly to the other end of its boom, removing the limbs as it goes. When it reaches the end of the boom or the minimum diameter of crown required, another pair of shears removes the unwanted crown which is passed out the back while the log rolls down onto a carrying tray.

The standard of trimming naturally varies with the form of the tree, but generally is a little below that of hand trimming. Stumps, if anything, are lower than saw cut stumps, and surprisingly there is practically no shatter from the biting action of the shears, on the stump or the log. Double leaders can be treated as one if they're not too large. In the case of a tree unable to be treated - examples were large multiple leaders, trees with very heavy branching - or trees too small to be treated, they are still cut but passed to the rear by the de-limbing carriage and discarded.

The harvester was operated in medium to low quality thirteen year old P. radiata at Caroline Forest, and good second rotation radiata, twelve years old, belonging to Softwood Holdings at Kongorong. Both areas were cut on a third row outrow system, i.e. one row in three removed. The "claw" at the front of the machine is able to swivel about 40 degrees left or right, so is able to selectively thin the row on either side of the outrow.

Results were far better at Kongorong than Caroline solely due to the better form of the trees there. Poor form at Caroline caused a number of trees to be rejected and some time wasted on others. However, time per tree, taken over the whole operation averaged around 20 - 30 seconds, and surveys of wastage are in progress at the moment, but preliminary figures indicate only about 2 - 3%.

The shears can handle a tree up to 16 inches diameter at the ground, but the size handled most comfortably is 5 - 10 inches. The system envisaged by Kerruish is suing the Windsor as a forwarder - carrying logs from the outrows - necessarily fairly short, to waiting transport.

In about fifteen months of operation so far the Harvester has been tried in pine - up to sixteen years old and eucalypt regeneration up to 9 inches diameter. A 16 degree slope was handled well, as long as the rows run up and down the hill, however areas cleaned and broadcast burned present problems in so far as logs and stumps hindering the machine.

To be successful mechanised thinning, along the lines of the Windsor Harvester, will need several things. The concept of row thinning - be it third, fifth or anything else, could be a bitter silvicultural pill to swallow after so many years of well spaced, hand selected plantations. However, it is essential to mechanical operation.

The loss of selectivity of thinning should be largely offset by more uniform quality of trees coming from improved seed sources as breeding programmes progress. This also is important when the tree is to be handled by a machine from the stump to the mill. Problems of trees with abnormal form at Caroline demonstrated this.

Plantations will need to be planned for the type of operation intended. Various things will become apparent when a system like the Windsor becomes practice; as the Windsor is planned as a forwarder it would be more suited to short rows between access tracks, the degree of pre-planting clearing is important for access purposes, planting spacings could be revised to suit row thinning, and so on.

The Windsor Harvester was financed about one third by A.P.M. and the remainder by the Commonwealth. The cost of the machine to date is about $38,000. It is the first prototype and work is due to commence on the MK II version shortly.

My impressions were that this system could be worked in Western Australian plantations, more successfully in coastal plain areas, and moderate hills plantations provided the degree of initial clearing was good enough. Also an outlet for the large volume of small diameter material is necessary. Pulp and chip industries take care of this adequately in Mount Gambier and also the plantations areas here are fairly evenly distributed in a twenty to forty mile radius of the town, so transport distance is no problem.

A NEW SPECIES DESCRIBED

by

N.G. Ashcroft

Over the last few years reports have been drifting into the Walpole Office concerning a strange new type of "plant" appearing in the District. Further investigation has shown this species to have the following distinctive characteristics -

"Occurs as a complete ribbon - like corolla which flowers perpetually. Flowers glabrous, generally yellow though red has also been reported. Hangs mainly as a parasite on branches of trees or on tree shrubs and wooden pegs, but also found occasionally along roadsides as a prostrate vine. This species is most common on lateritic based ridges but is also found on a variety of other soil types. Major associations include short shallow trenches and deep narrow holes."

The local populus has expressed anxiety at the presence of this new species - its rapid spread intimates a noxious weed perhaps. Widespread total destruction has resulted from associations not unlike this one in the northern jarrah forests.

No known method of eradication is known however, although the political medium may hold the key. Intelligent use of fire is suggested as a means of temporary control as, unlike most Australian plant species, this one is not resistant to fire. This of course suggests it to be an introduced species.

The plant has hitherto been unknown locally, and finding no ference to it in "Index Kewensis" or "Flora Australiensis", I have called it (for the want of a better name), "Prospectus floribunda".

It is hoped this dissertation will prompt further investigation on this misnoma with a view to its being correctly located within the Plant Kingdom.

STOP PRESS

Have since found that our little problem is no more than a Bauxite indicator, its spread being therefore manipulated by man.

A STUDY OF SMALL MAMMALS IN THE NORTHERN JARRAH FOREST

by

M.L. Mason and W.G. Schmidt

Most would agree that the wildlife resource of Western Australia, as an integral part of the forest community, requires "proper management". There would probably be less agreement, however, as to what form this management should take. In brief, we have only a limited idea as to the consequences of many of our past and present forest practices on the fauna of this State. One such practice that falls into this category is controlled burning.

The use of fire as a management tool for manipulating wildlife habitats is not a new concept. For over 300 years, fire has been used in the moors of Scotland to recycle and maintain the heathland vegetation necessary for a balanced environment for red grouse (2). Similarly, controlled burning is used in parts of North America to provide suitable food and cover for quail, deer, elk and other species.

In Australia, controlled burning is commonly used to reduce the risk of uncontrollable wildfires. However, as Hodgson (2) states, ... "There are few examples where it (fire) is used as a tool to produce or conserve a particular example. But this is not because fire is not involved in the ecology of other forest values. It is because many of these values do not have a direct dollar value and there is no interest from people prepared to spend money in establishing the ecological relationships. For instance, fire is quite definitely a major factor in the occurrence, distribution and conservation of acacias and heaths and the animal populations associated with them. But rarely do we ever see fire being deliberately used to conserve these values."

It seems obvious that field investigations into the effects of controlled burning on the forest fauna are needed. In mid-April, following the Fauna School conducted by Mr. Harry Butler, a fauna survey was undertaken in the Dwellingup Division to investigate the implications of the Department's controlled burning practices on fauna in the northern jarrah forest. A 2-staged approach was devised with the following basic objectives.

Stage 1

(1) A field evaluation of the effectiveness of various trapping techniques.

(2) An extensive trapping programme to determine what mammal species occur locally and the type(s) of vegetation they inhabit.

Stage 2

(1) A periodic, detailed survey of several study areas to assess both the effects of controlled burning and fire exclusion on population numbers, distribution, etc., of mammls selected for study.

In Stage 1, the procedure has been to trap various vegetation types using several different trapping techniques. Animals that were live-trapped were anaesthetised, measured and weighed, marked by toe clipping for future identification and released. Interim results indicate that of the 9 species of mammals trapped, three occur in relatively large numbers locally and are readily caught using box traps, while another species can be trapped with wire snares. These mammals are respectively the introduced ship rat, the yellow-footed marsupial mouse or mardo, the short-nosed bandicoot and the short-tailed pademelon or quokka (refer to Tables 1 and 2). Rat (killer) traps have also proven successful, but their use is not envisaged in Stage 2 investigations.

Other mammals such as the chuditch or native cat (Dasyurinus geoffroii), the brush-tailed possum (Trichosurus vulpecula), and the common wambenger (Phascogale tapoatafa), all which have been reported in the Dwellingup area, have not been encountered in the trapping programme as yet.

Referring to Table 2, it appears that swamps, in contrast to upland sites, provide the most suitable habitat for many of the small mammals in the northern jarrah forest. If further investigations support this conclusion, then some system of deferred rotational burning for swamps may prove desirable from the standpoint of insuring adequate food and cover for a given area.

Of the 169 catches recorded, 59 were recaptures (animals previously caught, marked and released). A few animals, particularly mardos, became "trap prone" and were retrapped 6 - 7 times. These recaptures show that the mardo, in comparison to the ship rat, ranges over a larger area in search for food. Individual mardos were found to move as far as 10 chains in a 24 hour period while the furtherest movement recorded for a rat was 7 chains.

As part of the second phase of the fauna survey, 6 study areas (3 control areas and 3 areas to be aerial burned during the spring in 1971) will be systematically trapped at regular intervals over a period of several years. Information from this study should provide answers to some of the questions raised earlier. For, as Dunbavin Butcher (1) stated, we not only must learn how animal populations react when fire is used as a forest management tool, but we must also learn more about the ways in which fire can be used primarily for the management of wildlife.

(1) Butcher, A. Dunbavin. 1970. Fire and the Management of Wildlife. Second Fire Ecology Symposium, Monash University, November 28, 1970.

(2) Hodgson, A. 1970. Fire as a Forest Management Tool. Second Fire Ecology Symposium, Monash University, November 28, 1970.

(3) Ride, W.D.L. 1970. A Guide to the Native Mammals of Australia.

Table 1. Summary of the effectiveness of 2 trapping methods.

Trap Type 1/	No. Trap Nights	No. Catches	Catch Rate (%)
Box traps	1,494	137	9.2%
Rat traps	1,158	32	2.8%
Totals	2,652	169	6.4%

1/ Other types of traps tested include spring and noose snares, pit traps and wire funnel traps.

Table 2. Distribution of Species trapped in relation to cover type.

Species 2/	Type of Habitat 3/				
	Swamp Edge	Darling Scarp	River Basin	Up-land	Totals
No. of trap nights	1,325	293	220	814	2,652
Ship Rat (Rattus rattus)	46	24	3	1	74
Mardo (Antechinus flavipes)	60	-	-	5	65
Common house mouse (Mus musculus)	3	-	4	1	8
Short-nosed bandicoot (Isoodon obesulus)	10	-	-	-	10
Western water rat (Hydromys fuliginosus)	-	4	-	-	4
Ferral cat (Felis catus)	3	-	-	-	3
Little mouse sminthopsis (Sminthopsis murina)	1	-	-	-	1
Spotless crake (Porsana tabuensis)	2	-	-	-	2
White-breasted robin (Eopsaltria georgiana)	1	-	-	1	2
Totals	126	28	7	8	169

2/ Not included in the above list are the quokka (setonix brachyurus) and the black-gloved wallaby (Wallabia irma). Three of each species have been trapped in swamp vegetation with wire snares.

3/ Representative vegetation for the different cover types is as follows -

(a) Swamp edge - tea-tree, Swamp banksia, cut-rush, sharkstooth, macrozamia, xanthorrhoea and lepidosperma.

(b) Darling scarp - overstory of E. marginata, E. calophylla and E. laelii; understory of macrozamia, xanthorrhoea, acacias, grevillia, watsonias and cut-rush.

(c) River basin - overstory of E. marginata, E. calophylla and E. patens; understory of dense macrozamia and bracken.

(d) Upland - overstory of E. marginata and E. calophylla with a wide variety of understory species including macrozamia, xanthorrhoea, acacias, etc.

LEFROY BROOK REGROWTH PLOTS

by

B.E. Harvey

The karri forest is an impressive sight and the Lefroy Brook karri 100 year old regrowth stand is a showpiece within that forest.

This stand is still a piece of forest which a forester can proudly present as a good example of karri forest management.

But is it? On investigation it was clearly seen that the stand is obviously well overstocked, even the thinned plot. Deaths of some trees within the thinned plot and obvious suppression of other stems make it clear that the stand is due for another thinning, and a rather heavy one at that.

History reveals that in the early 1860's, Mr. G. Decourcey Lefroy cleared an area of 23 acres, and in 1865 cultivated and grew a crop of wheat, leaving it abandoned in 1867.

Lane-Poole estimated the date of establishment of karri as 1875 by counting the annualar rings (41) in 1916.

An unthinned and a thinned plot have been subsequently established within the stand.

Plot No. 7A unthinned, was established in 1917 and remeasured in 1927.

An area was thinned in 1928 by A.C. Harris and plot 7B (1 acre) was established within it in 1949.

Both plots were measured in 1954, 1960, 1965, 1967, and now in 1971.

The process of natural suppression and dominance of stems is illustrated by the number of stems remaining alive at each measurement.

Year of Measurement	Plot 7A Unthinned	Plot 7B Thinned
1949	102	48
1960	78	44
1967	71	44
1971	64	40

The loss of trees since 1967 in plot 7B thinned were due to suppression leading to death of the stems. This fact alone gives an indication of an overstocking.

Basal Area figures provide further proof of this -

Year	(Sq. Ft.)	7A Unthinned	7B Thinned
1960		218	178
1967		223	174
1971		208	174

These results illustrate the climaxing of growth within the thinned stand, a stage where the previous thinning no longer shows an effect.

Both plots are now at the stage where the total basal area varies only slightly, balanced by the loss of trees through suppression and subsequent deaths, and actual increment to the remaining stems.

To gain a more realistic comparison of the two plots and the effect of the thinning in plot 7B, the largest stems in each plot were used to calculate c.a.i. and m.a.i. figures for g.b.h.o.b. and b.a.o.b.

10 Largest Stems

B.A.O.B.

	1960	1971	c.a.i.	m.a.i.
7A Unthinned	63.44	71.074	0.6442	0.7404
7B Thinned	69.338	79.359	0.8457	0.8267

G.B.H.O.B.

	1960	1971	c.a.i.	m.a.i.
7A Unthinned	107.2	113.5	0.5316	1.1823
7B Thinned	112.0	119.75	0.6540	1.2474

20 Largest Stems

B.A.O.B.

	1960	1971	c.a.i.	m.a.i.
7A Unthinned	105.556	116.83	0.9514	1.2170
7B Thinned	111.741	126.813	1.2719	1.3210

G.B.H.O.B.

	1960	1971	c.a.i.	m.a.i.
7A Unthinned	97.75	102.8	0.4262	1.0708
7B Thinned	100.5	107.1	0.5570	1.1156

30 Largest Stems

B.A.O.B.

	1960	1971	c.a.i.	m.a.i.
7A Unthinned	140.356	155.415	1.2708	1.6189
7B Thinned	139.711	157.424	1.4948	1.6398

G.B.H.O.B.

	1960	1971	c.a.i.	m.a.i.
7A Unthinned	92.00	96.25	0.3586	1.0026
7B Thinned	91.75	97.4	0.4786	1.0146

These results express the effect of thinning in plot 7B 53 years ago.

The effect is greatest in the 10 largest stems, but even here it is only small.

It is only in the 10 largest stems that the c.a.i. is higher than the m.a.i. (0.8457 sq. ft. per annum c.a.i. compared with 0.8267 sq. ft. per annum m.a.i.), but for the largest 20 and also 30 trees the m.a.i. is greater than the c.a.i. In all girth figures the m.a.i. is greater than the c.a.i.

Has the thinning in plot 7B resulted in larger girths?

It can be seen that the difference in girth in 1960 and 1971 for the largest stems is not great and that the overall effect is only small.

Difference in G.B.H.O.B. -	1960	1971
10 largest stems	4.8 "	6.25"
20 largest stems	2.75"	4.3 "
30 largest stems	-0.25"	1.15"

Thus it can be deduced that the thinning has had little effect and that thinning at age 50 seems worthless.

It appears that both stands, unthinned and thinned, have reached a situation where some stems are adding volume, some are being suppressed with small increments and some are being phased out due to suppression leading to deaths.

Both b.a.o.b. increments are slightly negative (unthinned = -0.8439, thinned -0.3375 sq. ft. per annum) as a result of the expression of dominance and the subsequent loss through deaths.

The thinned stand appears well overstocked in its present stage and a thinning appears necessary.

Several methods of deciding upon a suitable thinning regime in plot 7B have been investigated and each results in a reduction to 20 stems per acre.

Using a crown/diameter ratio, a suitable spacing of about 45 to 50 feet between stems points to approximately 20 stems per acre. The K/D ratio for 100 year old forest is between 18 and 20.

An occular appraisal revealed that the stand had sorted itself well into approximately 20 dominants and vigorous codominants, and 24 suppressed, worthless or dead stems.

Comparison of c.a.i. and m.a.i. figures for both g.b.h.o.b. and b.a.o.b. further supported the appraisal by eye.

The Lefroy Brook area is a good stand and a showpiece of our karri forest, but its appearance is marred at present by this overstocking.

The thinned plot 7B will be marked for thinning to a proposed 20 stems per acre, and the thinning probably carried out early in 1972.

ASSESSMENT OF FIRE DAMAGE IN KARRI POLES

by

R. Voutier and R. Sneeuwjagt

INTRODUCTION

The Manjimup fire research section conducted over 100 experimental fires in a 40-year old stand of karri poles from October 1970 to March 1971. The fires ranged from light, patchy burns of 50 B.T.U./sec./ft. to intense, all scrub-consuming conflagrations of up to 800 B.T.U./sec./ft.

The range in fire behaviour within a uniform stand presents an ideal opportunity to assess the effect of fire on both crown and bole damage.

This study sets out to determine the extent of damage incurred by the stand with the aim of setting limits of fire behaviour in these forests.

METHOD

Location

The study area located at Four Mile Road consists of a mostly pure karri pole stand averaging 80 feet in height, and ranging from 60 feet to 120 feet. The area had been divided into plots ranging in area from $\frac{3}{4}$ acre to 8 acres and which contained at least one experimental fire each.

Fire Intensity

A pilot study indicated that approximately 40 chains of assessment would be required to obtain an acceptable level of accuracy in estimating crown and bole damage.

An attempt was first made to carry out the assessment through three levels of fire intensity. These levels were defined as hot, mild, and cool. The level for "cool" was between 0 and 150 B.T.U., for "mild" between 200 and 300 B.T.U., and "hot" from 350 to 800 B.T.U. The intensities were determined from Byram's formula: I = h.w.r., where I = intensity, h = heat of combustion (6), w = weight of fuel consumed (T.P.A.), r = headfire rate of spread (feet per minute).

Twenty four permanent assessment lines, 5 chains long and 1 chain wide were pegged through plots falling into one of the above intensity levels. Lines were located so as to include the densest grouping of pole and sapling size trees present within each experimental-burning plot. From inspection of the burning plots chosen, it was obvious that in some cases the calculated fire intensities did not reflect the extent of fire damage observed. For example, a plot defined as "mild" had sustained far more scorch than another defined as "hot".

It was decided to obtain another estimate of fire intensity by the use of an alternative formula which employed simply headfire flame length.

The formula is

$$I = 5.62\ h^{2.17}$$

where h = headfire flame length (feet)

The fact that the above formula requires an estimate of only one easily determined variable makes it an improvement over the first formula of, I = h.w.r. which employs two hard-to-measure variables. A field check revealed that the new fire intensity estimates correlated with fire damage to a greater degree than the first estimates. It was decided to use the flame-length derived fire intensity values.

The modification of fire intensity values meant a reclassification of intensity levels. The level for "cool" became 0 to 100 B.T.U., for "mild" between 110 and 300 B.T.U., and for "hot" between 310 and 800 B.T.U.

The new distribution of assessment lines are -

Intensity	No. of Chains
Cool	45
Mild	30
Hot	45

Damage Assessment

Trees within the line plots were placed in one of four damage categories of fire killed, epicormic crown, bole epicormics and normal crown.

Within each damage category stems below 12" D.B.H.O.B. were separated into the following diameter classes - 0 - 3.0", 3.1" - 6.0", 6.1" - 9.0", 9.1" - 12.0". The stems above 12" D.B.H.O.B. were separated into the G.B.H.O.B. classes of 36" - 60", 60" - 80", greater than 80".

The trees were noted for their dominance or suppression within each size class.

Any sign of butt damage was noted, however it was realized that this damage would be best detected about 12 months after burning when the trees had shed their bark.

It is planned to conduct the damage assessment annually so that such damage as butt scarring and drysiding may be detected as well as the scorch damage.

RESULTS

The results of assessments in the four fire damage classes are given in Table 1. There were a total of 2,647 trees observed in the 120 chains (12 acres) of line assessed. 762 of these were dominants and potential crop trees.

(i) Fire Killed

As the table shows, fire deaths occurred in 55 per cent of the trees with diameters less than 9.0 inch, and no deaths occurred in the larger trees. Of the fire killed trees only 0.7 per cent belonged to the dominant crown category, and the rest belonged to the suppressed category. The percentage of deaths occurring in the three classes up to 9 inch d.b.h.o.b. was plotted against the calculated fire intensity. See figure 1. The curves show that death begins to occur in the 0 - 3.0 inch class at the low intensity of 10 B.T.U. per second per foot, and that these increase very rapidly to 90 per cent at 50 B.T.U.'s and 100 per cent at 80 B.T.U.'s.

In the 3.1 - 6.0 inch d.b.h.o.b. class, deaths first occur at about 50 B.T.U.'s, and increase up to 60 per cent at 200 B.T.U.'s, and 70 per cent at 800 B.T.U.'s. In both size classes the fire killed trees were nearly all suppressed.

In the 6.1 to 9.0 inch d.b.h.o.b. class, deaths first occur at 100 B.T.U.'s, and increase gradually up to 35 per cent at 780 B.T.U.'s.

No deaths occurred in the larger size classes.

(ii) Bole and Crown Epicormics

Of the live trees counted, 23 per cent contained bole epicormics and 3 per cent contained crown epicormics. Bole epicormics were found mainly in the less than 12 inch d.b.h.o.b. classes, called small poles, whereas crown epicormics showed up mostly in the large poles (greater than 12 inch d.b.h.o.b.) treated with high intensity fires.

(iii) Normal, Replaced Crowns

Most of the trees with normal crowns belong to the large pole classes. In fact, 78.7 per cent of large poles had normal crown, compared with 17.0 per cent in small poles. Of the latter 34 per cent were dominant, whereas 92 per cent were dominant in the larger pole classes.

In order to illustrate the relationship between fire intensity and tree damage, the calculated fire intensity was plotted against the percentage ratio of the number of trees showing any damage, including death, over the total number of trees within each size class. This analysis was not done on the large pole sizes as there were insufficient tree numbers present in these classes. (See figure 2)

DISCUSSION

The damage assessment results indicate that stems up to 6 inch d.b.h.o.b. suffer heavy losses at even low levels of fire intensity. Of the survivors very few have escaped without severe crown or bole damage, so that the use of fire in this class must be approached with great caution. If this size class should contain the potential crop trees, then it is inadvisable to burn under them unless intensities can be maintained below 20 B.T.U.'s (or headfire flame length of 1.5 feet). However in most cases (e.g. Four Mile Road) this size class represents the suppressed and dying individuals and is of no commercial value. Mild burning may be a useful tool in the thinning of these redundant trees.

The 6.1 to 9.0 inch d.b.h.o.b. class suffered fewer losses but survivors sustained a high degree of epicormic development even at low fire intensity levels.

There were no deaths recorded in trees with d.b.h.o.b. greater than 9 inches, even at the highest levels recorded (780 B.T.U.). There was a considerable development of crown epicormics at the high intensity levels in the larger trees. It may be concluded that whereas this treatment killed the small trees, it was the cause of crown damage in the larger dominant trees.

The results indicate that the maximum safe level for prescribed burning under pole size trees is 80 B.T.U.'s. This is achieved with a headfire flame length of 3.0 feet. Above this the extent of damage increased markedly.

CONCLUSION

The fire damage assessment revealed the close relationship between the extent of damage, including deaths, occurring to karri poles and fire intensity. These relationships make it possible to calculate desirable burning limits on fire behaviour under stands of pole size karri trees.

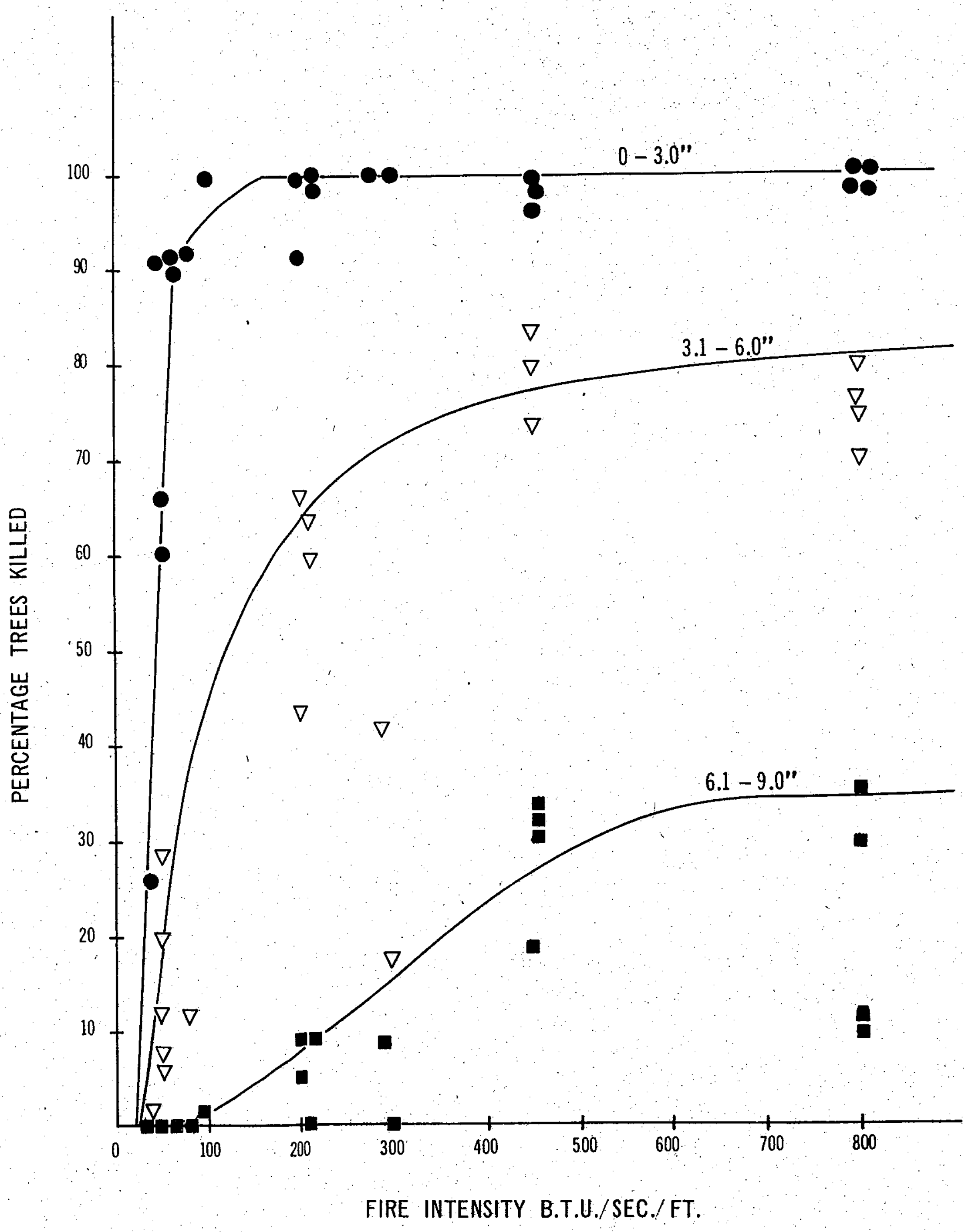
The assessment is the first of a series to be conducted annually on the stand.

TABLE 1. RESULTS OF FIRE DAMAGE ASSESSMENT - FOUR MILE ROAD

Size Classes	Fire Intensity Classes	% Dominants	% Suppressed	% Fire Killed	% Crown Epicormics	% Bole Epicormics	% Total Damage (Incl. Deaths)	% Normal Crown	No. of Trees
0-3.0" dbhob	Cool	2	98	90.0	.01	8.5	99.0	0.6	456
	Mild	0	100	99.0	0	1.0	100	0	83
	Hot	0	100	99.0	0	1.0	100	0	289
	Mean	1	99	96.0	0	3.5			828
3.1-6.0" dbhob	Cool	28	72	10.0	5.5	56.0	81.0	19.0	224
	Mild	1	99	48.0	0.8	44.0	92.0	8.0	122
	Hot	8	92	71.0	0	27.5	98.0	2.0	269
	Mean	12	88	46.0	2.1	42.5	90.5	9.5	615
6.1-9.0" dbhob	Cool	31	69	0	9.0	32.0	41.0	59.0	116
	Mild	4	96	7.0	1.7	56.0	65.0	35.0	116
	Hot	12	88	26.0	0.5	51.0	78.0	22.0	193
	Mean	17	83	11.0	3.5	46.5	61.0	39.0	425
9.1-12.0" dbhob	Cool	60	40	0	1.0	4.0	5.0	90	57
	Mild	47	53	0	16.0	20.0	36.0	64	55
	Hot	42	58	3.5	1.0	37.0	42.0	58.0	113
	Mean	50	50	1.5	6.0	20.0	27.5	72.5	225
36-60" gbhob	Cool			0	13.5	12.0	25.5	74.5	75
	Mild			0	12.0	12.0	24.0	76.0	141
	Hot			0	10.5	13.0	23.5	77.0	143
	Mean	100	0	0	12.0	12.0	24.0	76.0	359
61-80" gbhob	Cool			0	12.5	6.0	18.5	81.5	48
	Mild			0	21.5	8.0	29.5	70.5	51
	Hot			0	19.5	12.0	31.5	68.5	41
	Mean	100	0	0	18.0	9.0	27.0	73.0	140
80"+ gbhob	Cool			0	6.0	0	6.0	94.0	16
	Mild			0	11.0	0	11.0	89.0	9
	Hot			0	16.0	6.0	22.0	78.0	30
	Mean	100	0	0	11.0	2.0	13.0	87.0	55

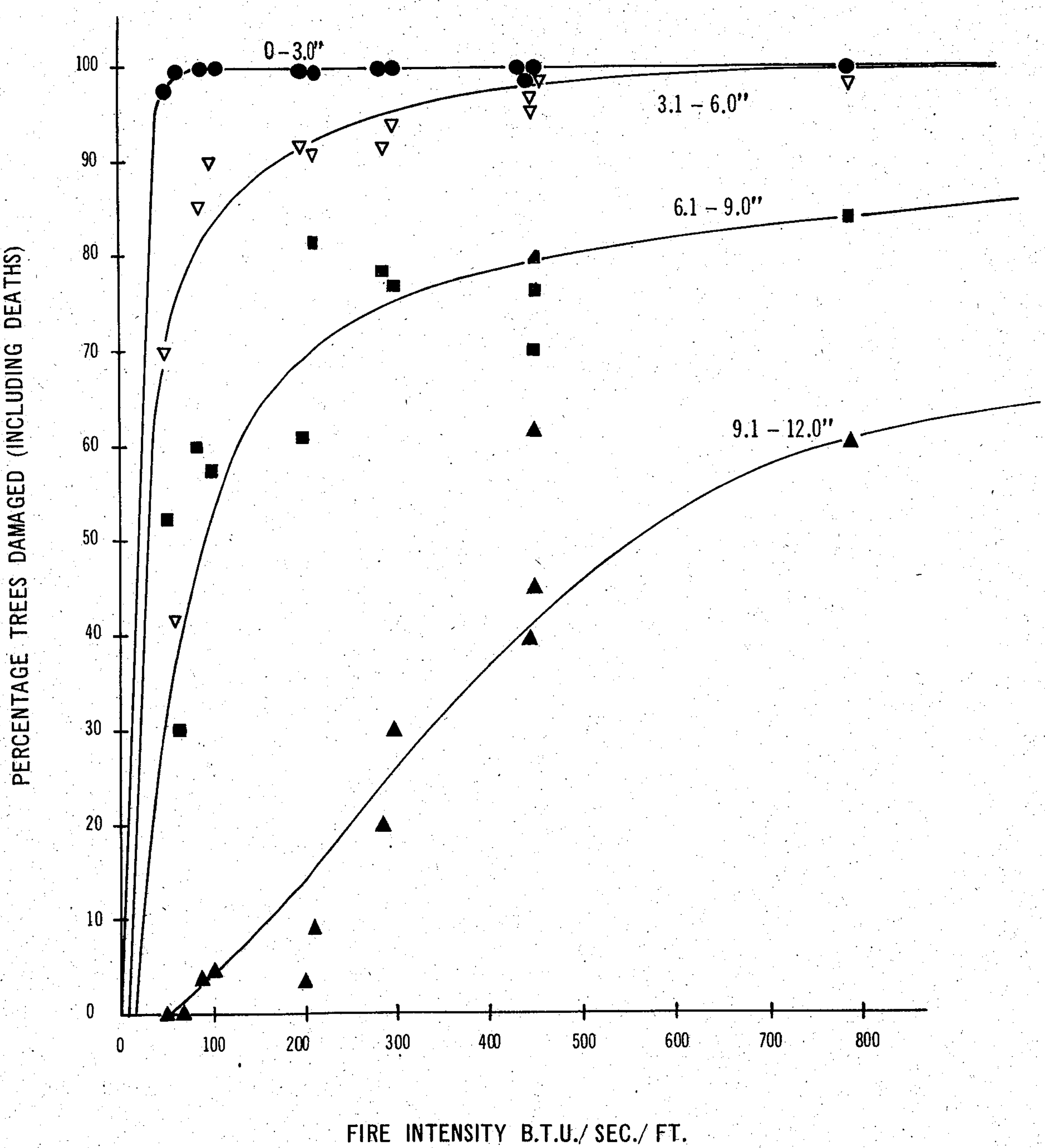
RELATIONSHIPS BETWEEN THE PERCENTAGE OF TREES KILLED (0–9.0" d.b.h.o.b.) AND CALCULATED FIRE INTENSITY.

Figure 1.



RELATIONSHIPS BETWEEN THE PERCENTAGE OF TREES DAMAGED (INCLUDING DEATHS) FOR KARRI POLES FROM 0–12.0" d.b.h.o.b. AND FIRE INTENSITY.

Figure 2.



TINGLE STAND

by

B.J. White

I wish to have recorded in Forest Notes the existence in the Walpole Division of a small stand of tingle which appears to have some characteristics of both red and yellow tingle, and others peculiar to itself.

The precise location requires a further check, but it is fairly certain to be either side of Boronia Road, three quarters of a mile east of the Mountain Road - Baronia Road junction. Most of the stand is in Soho Block, with a small portion in London Block : Reference JO 114. The stand follows a creek and is mixed with jarrah, marri and a few isolated bullich. The only visible feature distinguishing the site from many other yellow tingle - jarrah mixtures, is the extremely deep incision made by the gully which is 10 - 12 feet deep, narrow with vertical sides, indicating a deep erodable subsoil.

I believe the stand was first discovered by assessment teams in the early 1950's. Since then it has been mentioned by others associated with road location and construction, and lately renewed interest has been shown by Steve Quain.

The general external appearance of the tree is that of red tingle (E. jacksoni). It has straight form, whereas yellow tingle is usually more irregular in form, almost indistinguishable from its jarrah associates.

The wood however, is creamy yellow in colour, like yellow tingle, different entirely from the brown-red of red tingle.

The capsules resemble red tingle more than yellow, though they are slightly bigger than the red tingle, and have a tendency to be longer, rugose, and in some cases almost ribbed. The strap-like peduncle of yellow tingle, the most favoured distinguishing feature short of the axing into the bole, is absent.

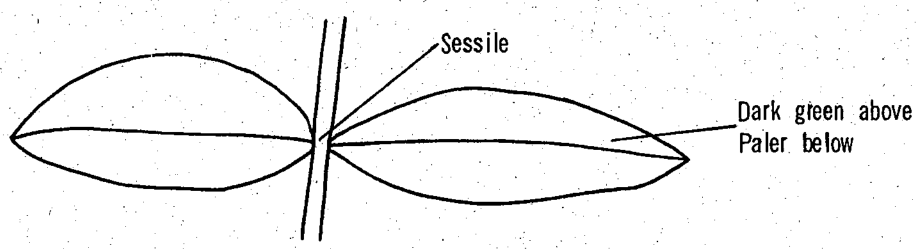
Another distinct feature was the juvenile foliage found growing from epicormic sprouts from fire damaged younger trees. Stems were distinctly glaucous, with a reddish colouration towards the tips. Leaves were alternate, and in shape tended to be cordate - ovate.

This stand is within the usual yellow tingle occurrence, but some 10 miles from the very restricted red tingle occurrence, which is confined to the Nornalup National Park and State Forest 42 to the south.

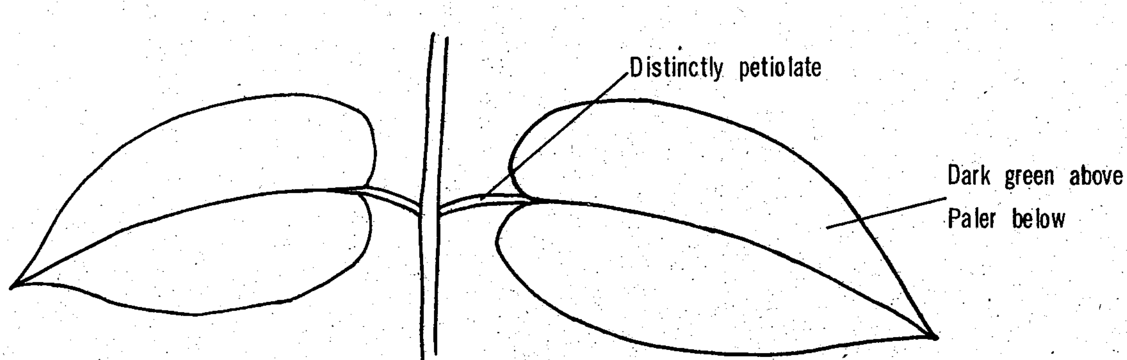
Some seed has been collected and seedlings raised together with some red tingle and yellow tingle. The three are now planted out in the Pemberton arboretum.

The juvenile leaves of the young seedlings of the three species are very distinct.

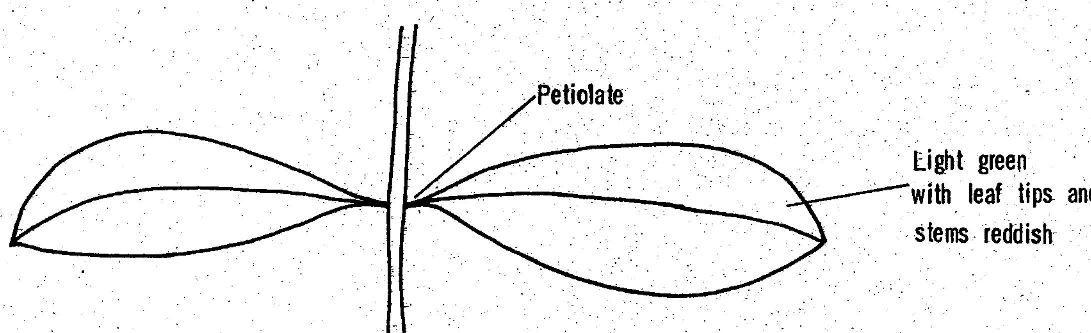
RED TINGLE E. JACKSONI



BORONIA ROAD TINGLE E. ?



YELLOW TINGLE E. GUILFOYLEI



A CONTROLLED EXPERIMENT TO STUDY FACTORS INFLUENCING FIRE RATE OF SPREAD IN P. PINASTER LITTER

by

D. Ward

INTRODUCTION

To study fire rate of spread in relation to independent variables under natural conditions can be compared with attempting to play bridge without knowing the rules. An attempt has been made therefore, to discover some of the rules of fire rate of spread by burning beds of P. pinaster needles under controlled conditions. The independent variables studied were fuel depth, moisture content, slope, and wind speed.

APPARATUS AND METHOD

(a) Fire Model

The fire model was circular, of two-foot radius. Such a circle was described upon a metal-covered board by a perimeter of upright six-inch nails. After ignition at the centre, rate of spread was timed with a stop-watch over the radius, a visual estimate of flame height being recorded at the same time. Sufficient interval was allowed between fires for the metal sheeting to cool.

(b) Control of Litter Moisture Content

The bulk fuel was stored in an old tobacco kiln, which was equipped with a heating system. High moisture contents were achieved by sprinkling the litter with water over a period of several days. Once the needles were saturated, then the temperature of the kiln was raised, whilst the litter was constantly turned and mixed to ensure uniformity. As soon as the litter was dry enough to burn, experimental fires were commenced, and the fuel drying continued until an O.D.M.C. of 5% was achieved. Moisture contents were determined from tin samples collected immediately before each fire.

(c) Control of Fuel Depth

The beds of litter were prepared upon the metal-covered board mentioned above. Litter was spread as evenly as possible, then ten depth readings taken with a gauge. The mean of these readings was accepted as the fuel depth for that bed.

(d) Control of Slope

A range of slopes was obtained by propping the board up at a progressively greater angle. The angle was measured with a clinometer.

(e) Control of Wind

The fires were burnt inside a shed, thus excluding natural wind. Figure 1 shows how a range of controlled wind was obtained. The shed was divided into two compartments with a gap under the partition. A vigorous fire was lit in one compartment, causing a convective updraught, which escaped through a vent in the roof. This led to a horizontal airflow through the gap under the partition, and the speed of this flow could be altered by changing the intensity of the convection fire. The size of the gap was also changed by means of a sliding door, but this was not so effective. Fresh air was admitted through a tunnel to exclude external gusts, and an anemometer in the tunnel recorded air-speed. The experimental fire was placed in the horizontal airstream.

RESULTS

(a) Fuel Depth and Moisture Content

These were studied together under conditions of nil slope and nil wind. Depths of litter burned ranged from 0.5" to 7.0", and moisture contents from 5% to 40%. The results are shown in Figure 2. Rate of spread is influenced by both variables. In general, the greater the fuel depth, and the lower the moisture content, the faster the R.O.S. An interesting relationship was also noted between flame length, fuel depth, and rate of spread, and this is shown in Figure 3.

(b) Slope

A range of slopes from 5° to 40° was studied, the back and headfire R.O.S. being recorded. The backfire, burning down the slope, appears to be the same as the basic rate of spread, determined by fuel depth and moisture content. The headfire R.O.S. however, increased with slope and Figure 4 shows the exponential relationship between slope and the ratio of H.F.R.O.S. to basic R.O.S.

(c) Wind

A range of winds from 0 to 6 m.p.h. at ground level was recorded, and again H.F.R.O.S. and B.F.R.O.S. noted. Figure 5 shows an exponential relationship similar to that for slope, with the interesting difference that the effect of wind seems to be determined by the quantity of fuel present, here represented by fuel depth. Hence the ratio of wind to fuel depth bears an exponential relationship to the ratio of H.F.R.O.S. to basic R.O.S.

DISCUSSION

The experiment yielded some clearly defined functions for the four independent variables studied. The effects of fuel depth, moisture content, and slope are straightforward. The effect of wind is slightly more complex, and deserves a little discussion. If we consider a fire burning under still conditions, then there will be a vertical convection column, the velocity of which will be a function of the quantity of fuel burning. If now we apply a horizontal wind, then we have a vector situation, in which the resultant will govern flame angle, and so H.F.R.O.S. Hence for a constant vertical convection velocity, increasing horizontal wind will increase the H.F.R.O.S. For a constant horizontal wind, however, an increase in vertical velocity due to an increase in available fuel will decrease the ratio of H.F.R.O.S. to basic R.O.S. It should be remembered here that the increase in available fuel will increase basic rate of spread, and so the actual H.F.R.O.S. may increase or decrease, depending on the particular situation.

It is intended to apply the results here obtained to a study of R.O.S. under natural conditions. Whilst recognizing that the controlled conditions are different from natural ones, it is felt that enough similarities exist to make it probable that the functions will remain similar. It will be necessary to define what fuel depth in nature is equivalent to the fuel depth measured in the experiment, and the flame length, R.O.S., fuel depth relationship will be useful for this purpose.

The sequence visualised is firstly to establish a basic R.O.S. from fuel depth and moisture content. This basic R.O.S. will then be multiplied by a factor representing wind effect, and another representing slope effect, to give an adjusted R.O.S. To this will be added a spotting R.O.S. giving a final predicted H.F.R.O.S.

ACKNOWLEDGEMENTS

Thanks are due to Messrs. T.D. Leftwich and R.H. Smith for construction and design of the wind tunnel and other apparatus.

Figure 1.

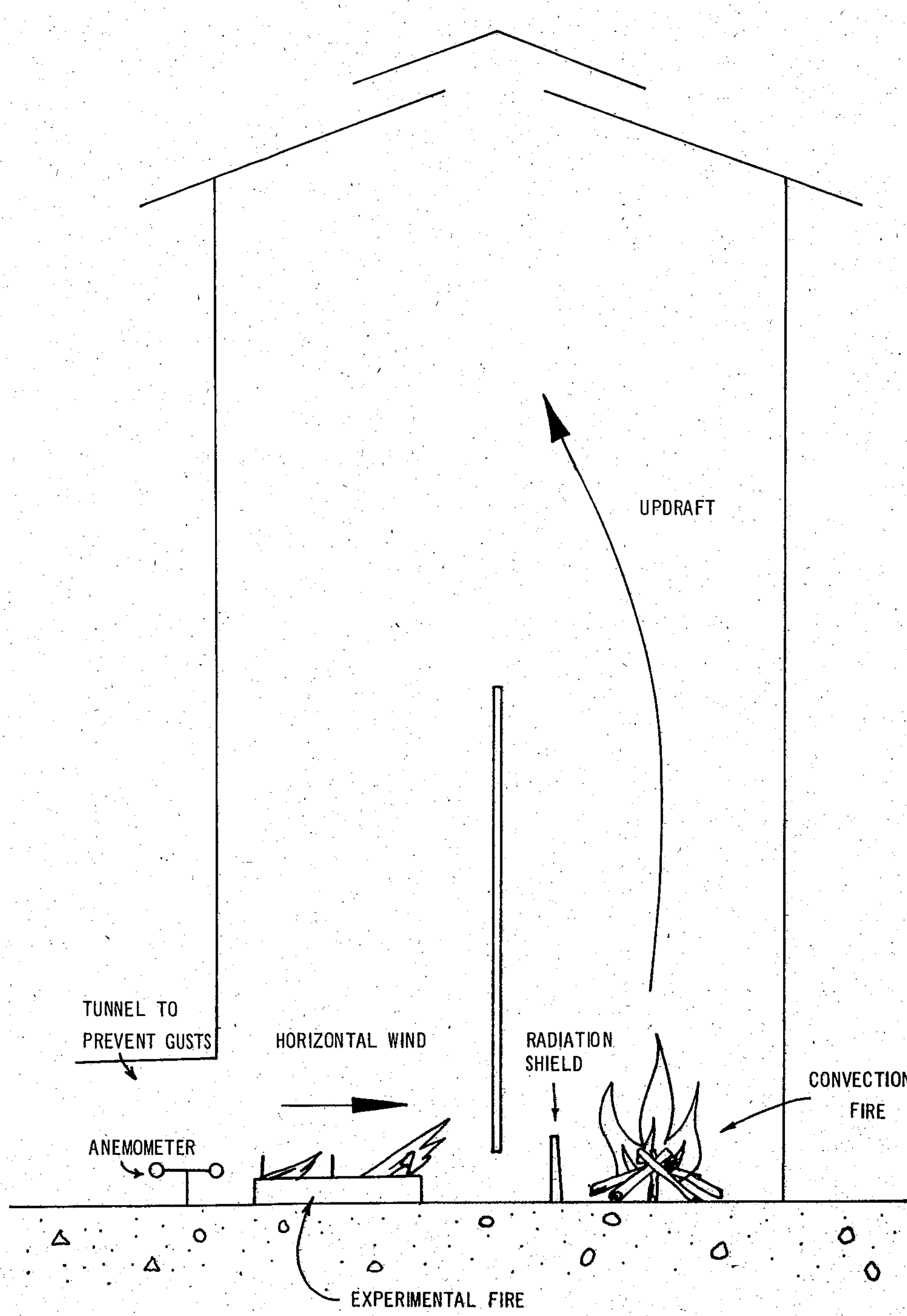
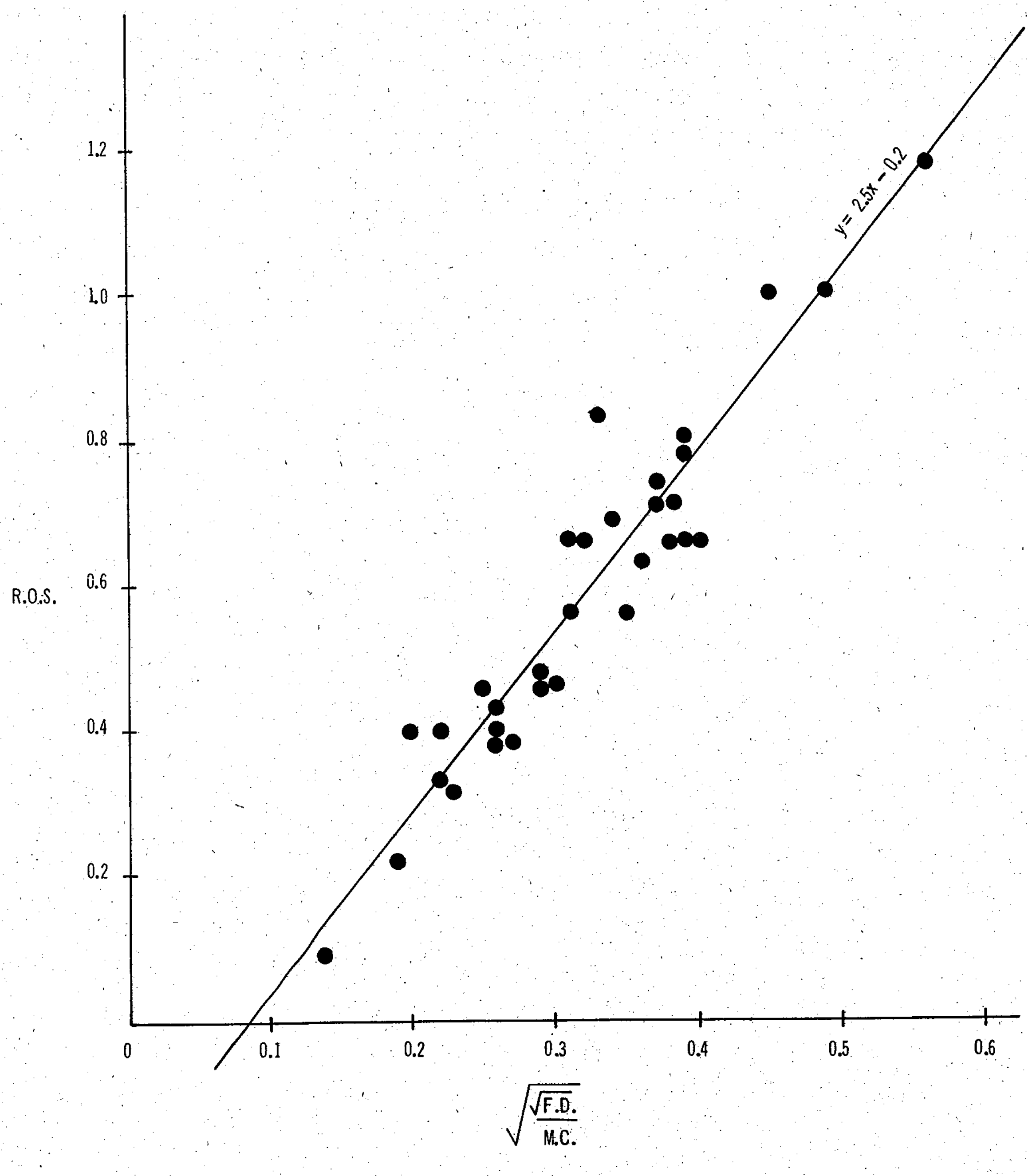
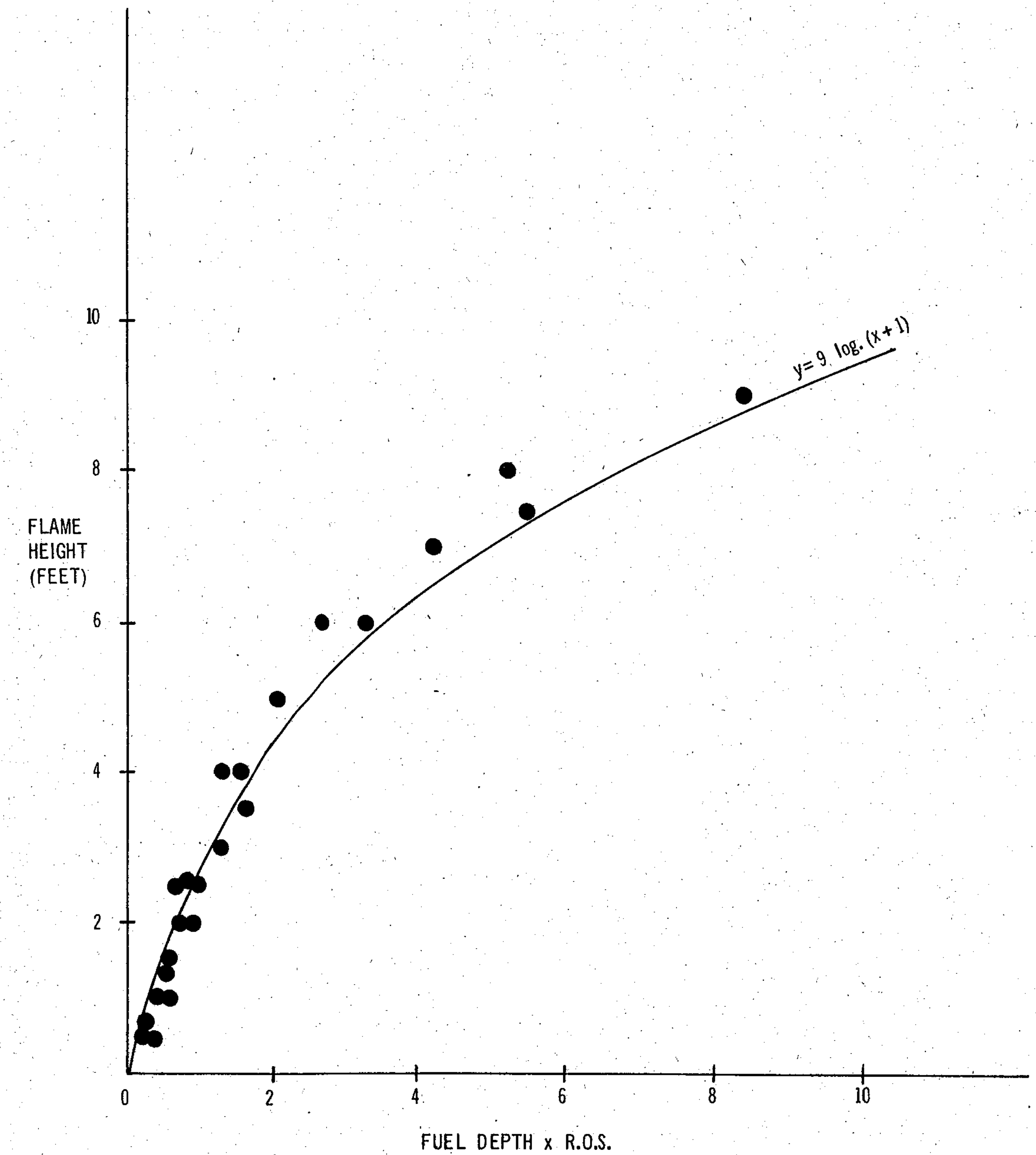

UPDRAFT
TUNNEL TO
PREVENT GUSTS
HORIZONTAL WIND
RADIATION
SHIELD
CONVECTION
FIRE
ANEMOMETER
EXPERIMENTAL FIRE

Figure 2.



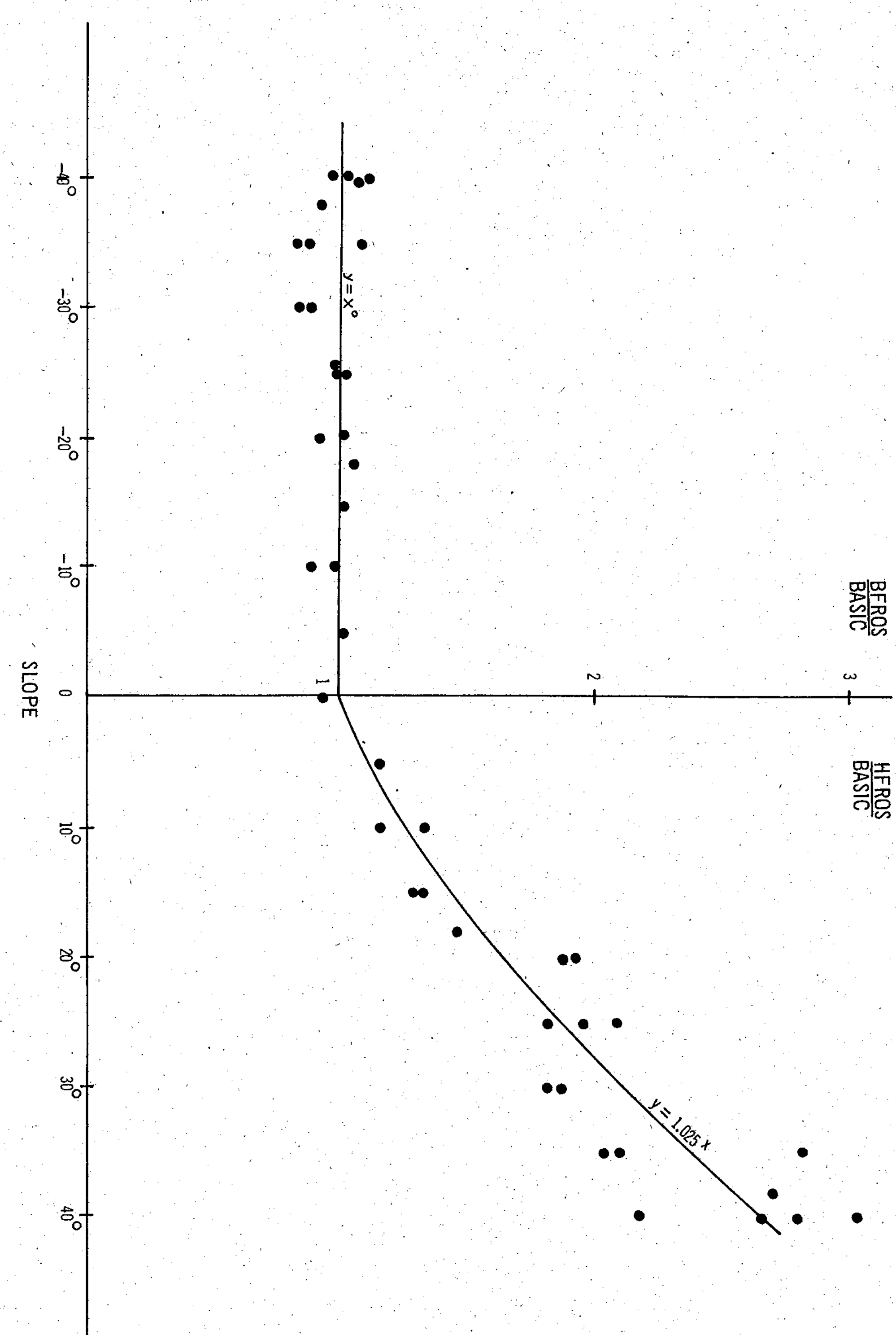
P.PINASTER – NO WIND – NO SLOPE

Figure 3.



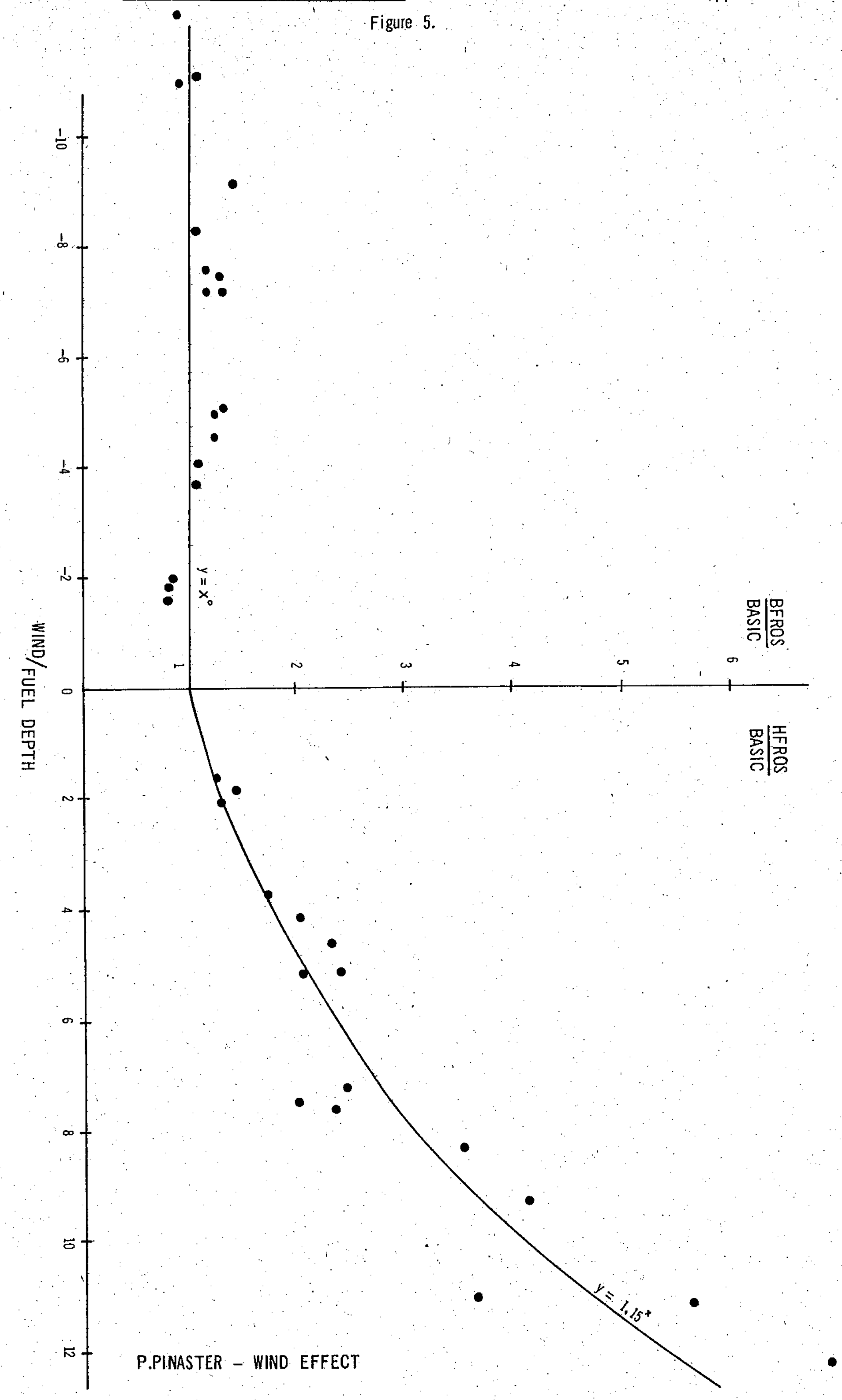
P.PINASTER – NO WIND – NO SLOPE

Figure 4.



P.PINASTER – SLOPE EFFECT

Figure 5.



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