SUMMARY OF FIRE RESEARCH IN WESTERN AUSTRALIA N.D. BURROWS 1985.

INTRODUCTION

Given the high fire proneness of south west forests, it is not surprising that the Western Australian Forests Department has engaged in fire research since the early 1950s. Following the Dwellingup wildfires in 1962, greater emphasis was placed on fuel reduction burning as a direct preventative measure against devastating wildfires. While the WA Forests Department and other fire control authorities had considerable experience with prescribed burning, this alone was not an adequate base from which to plan and safely implement a large scale, wildfire hazard reduction programme, nor was it adequate for determining the best fire suppression tactics. Fire research at this stage and up until 1976, concentrated on understanding the fire environment so that the interactions between fire, fuels, topography and weather could be predicted within reasonable limits.

This required research into fuel accumulation rates, fuel structure, fuel moisture, the amount of fuel available for consumption and studying the behaviour of fire under carefully monitored conditions of fuel and weather. Aside from being able to predict fire behaviour, research also aimed at improving controlled burning techniques (such as using aircraft) and wildfire detection and suppression methods (such as spotter aircraft, accurate prediction of wildfire behaviour, action plans and strategies, training etc.). The Forests Department was and is committed to protecting life, property and the forest estate from devastating wildfires. Much of the research which contributed to achieving this aim (and which is still on going) has not been published but is in the form of internal reports, prescriptions, handbooks and guides. A considerable amount of this research is summarised in "Forest Fire Behaviour Tables for Western Australia" by Sneeuwjagt and Peet, 1976, while some specific projects have been published as internal Research Notes, Bulletins or Handbooks or externally in forestry journals, symposia proceedings etc. For this reason and because of the enormous task to itemise early fire research in Western Australia the following is a summary of topics prior to 1977. More detail is given for fire research projects carried out since 1977.

Neil Burrows
FIRE RESEARCH OFFICER

Major Fire Research Topics and Discussion Papers
1960 - 1977

1. Rotation Burning in Karri.
2. Some Aspects of Controlled Burning in Jarrah.
3. A Fire Danger Rating for the Jarrah Forest.
4. Growth Considerations in controlled Burning of the Jarrah Forest.
5. Burning under Jarrah Regeneration.
6. Pine Plantation Burning.
7. Fire effects on Stand Structure in the Jarrah Forest.
8. The effect of a 4 Year Burn Cycle on Jarrah Regeneration.
9. A Flame Height - Rate of Spread Relationship in the Northern Jarrah Forest.
10. Controlled Burning from Aircraft.
11. Fire Hazard Rods and P. pinaster Fuel Moisture Content.
12. A Study of Scrub Flammability.
13. Effects of Mild Burning on Jarrah Girth Increment.
14. Effectiveness of Fire Breaks in Pine Plantations.
15. Aero Burning in Pine Plantations.
16. The role of Water Bombing Aircraft in Western Australia.
17. Burning in the Karri Forest.
18. A Controlled Experiment to Study Factors Influencing Fire Behaviour in P. pinaster.
19. A Guide to Measuring Forest Fuel Quantity.
20. The Effect of Frequent Burning on Jarrah Forest Soils.
21. Jarrah Forest Fire Behaviour Studies.
22. Jarrah Forest Litter Moisture Trends.
23. Jarrah Forest Fire Damage Studies.
24. Jarrah Forest Growth Studies after Prescribed Fire.
25. Fire Behaviour Studies in P. pinaster.
26. Fire Behaviour Studies in Jarrah Forest.
27. Fire Behaviour Studies in P. radiata.
28. The effect of fire on Growth and Damage of Jarrah Poles.
29. The Effect of Fire on Crown Search and Recovery.
30. The Effect of Fire on Karri Poles.
31. Fire Weather Studies.
32. Karri Scrub Fuel Assessment.
33. Karri Scrub Flammability.

34. Fire Behaviour in Karri Scrub.
35. Fuel Accumulation in Karri Forest.
36. Fire Damage to Karri.
37. Fire Behaviour Studies in the Stirling Ranges National Park.
38. Fire Behaviour Studies in Dryandra Forest.

Major Fire Research Projects
Manjimup Research Station
January 1977 - December 1984

Title:

Fuel removal, fuel conditions and seedbed preparation in karri slash disposal burns.

Objectives:

To investigate the relationship between fire intensity and fuel conditions and between fire intensity and seedbed preparation.

Status:

Completed.

Principal Findings:

Fuel removal cannot be guaged reliably by fuel moisture content alone, and fuel removal does not necessarily correlate with seedbed preparation. The WA Forests Department's slash burning prescription provides adequately for seedbed preparation.

Publications/Reports:

Forests Department of WA Research Paper No 42, 1978.

Title:

The effectiveness of aerial application of fire retardants.

Objectives:

To evaluate the effectiveness of aerially applying three different retardants on four forest types in the south west.

Status:

Completed.

Principal Findings:

Amgard and Phoscheck had similar properties in drop pattern and fire retarding potential. Firetrol was inferior to both. Greatest penetration of retardant through the forest canopy and onto the ground fuels was achieved in thinned pine forest (P. radiata). Dense karri regeneration severely impeded retardant penetration. Grassland and heavily thinned pine stands showed most potential for operation use of aerial retardant application.

Publications/Reports:

Internal Report.

Title:

Fire behaviour and fire effects in young even-aged karri regrowth.

Objectives:

To define the conditions of fuel, weather and stand development under which the initial fuel reduction burn can be safely implemented in young karri regrowth.

Status:

Major research project. Active.

Principal Findings:

Young karri are fire sensitive. The flammability of fuels in young karri stands steadily increases with time and with stand development. At an early age (younger than 10 years) fuel and microclimate are such that fuels would only burn under severe weather conditions. Basal area and site/vegetation types are key indicators of fuel and stand dynamics. While

age alone is not a reliable indicator, most stands cannot be safely and effectively burnt for fuel reduction until about age 15 - 20 years.

Publications/Reports:

Several internal reports and burning guides.

Title:

Quantifying Pinus radiata slash fuels.

Objectives:

To develop a practical, simple and precise means of assessing the weight of residual tops, hence the fire hazard, following thinning operations in pine stands.

Status:

Completed.

Principal Findings:

The weight of fuel components in residual tops is closely related to stem diameter. This relationship was used to develop tables for predicting the area loading of needles, branchwood and stemwood fuels left after thinning operations.

Publications/Reports:

Forests Department of WA Research Paper No 60, 1980.

Title:

Crushing the thinning slash problem.

Objectives:

To evaluate the effectiveness of mechanically crushing aerated slash fuels (under Pinus radiata stands following thinning) to reduce the fire hazard.

Status:

Completed.

Principal Findings:

The hazard posed by the highly flammable residual tops can be vastly reduced by crushing them about 3 - 4 months after thinning. The rate of spread can be reduced by up to one third by treating slash in this way.

Publications/Reports:

Forests Department of WA Research Paper 62, 1980.

Title:

The developments of an electrical ignition devices and techniques to extend the capacity of the Forests Department to safely carry out an increasing workload of regeneration burning.

Status:

Completed.

Principal Findings:

An electrical ignition system was developed, field tested and costed. While not envisaged as a substitute for conventional lighting techniques, it can be a valuable aid when greater and safer control of fire intensity is desired.

Title:

Retardant Durability on Pine Needlebed.

Objectives:

To test the effectiveness and durability of four types of retardant on stopping needlebed fires when the moisture has evaporated from the retardant.

Status:

Shelved, incomplete.

Principal Findings:

Study not completed. Retardants were effective in slowing low intensity

needlebed fires when the moisture had been allowed to evaporate from retardant. The same low intensity fires were stopped by moist retardant.

Between 2 and 4 mm of rainfall in one event was sufficient to leach retardant from needles. No retardant appeared to have superior durability qualities.

Publications/Reports:

Nil.

Title:

Grazing to reduce the fire hazard in P. radiata plantations.

Objectives:

To determine the effectiveness of grazing by cattle on reducing the fire hazard beneath pines in the Blackwood Valley.

Status:

Completed.

Principal Findings:

Cattle can effectively graze down palatable pasture beneath pines thereby significantly reducing the fire hazard. Careful management of pasture, stock and stand are critical if grazing is to be successful in reducing grass fuels. Grasses must be grazed to less than about 10 cm in height if reasonable fire protection is to be afforded to young pine stands. Grazing is best used to create strategic fuel reduced buffers within plantations from which wildfires can be fought.

Publications/Reports:

For. Dept. W.A. Research Paper.

Title:

Radiata pine slash burning guide (MK 1).

Objectives:

To develop guides and procedures for safely and effectively reducing the fine, aerated fuels present in thinning slash.

Status:

Completed.

Principal Findings:

Fire can be effectively uaed, under carefully selected fuel and weather conditions, to successfully remove the aerated needles in thinning slash. To prevent fire damaging the trees, intensity must be kept to less than 250 kW/m. To achieve this, selecting the correct fuel moisture and weather conditions (as specified in the Burning Guides) is critical.

Publications/Reports:

Internal report - Burning Guide MK 1.

Title:

Determining the quantity of fuel available for burning in P. radiata thinning slash.

Objectives:

To develop a procedure for readily determining the quantity and type of slash fuel which will burn under various fuel moisture and weather conditions.

Status:

Shelved, not completed.

Principal Findings:

Aerated needles have a moisture content of extinction of 27%. The quantity of woody material which is available to burn has not yet been determined.

Publications/Reports:

Internal progress report.

Title:

Fine fuel flammability index.

Objectives:

To develop an index of the flammability of fine (needle) fuels beneath pine stands. This would enable (i) the planning of prescribed burning and (ii) estimating fire hazard in plantations at various times of year.

Status:

Shelved, not completed.

Publications/Reports:

Internal report.

Title:

Occular estimate of pine slash fuel quantity.

Objectives:

To design a simple and cheap instrument for easily determining the quantity of thinning slash in the field.

Status:

Shelved, not completed.

Principal Findings:

A simple hand held instrument was designed to provide a measurement of slash height. Knowing the observers distance from the target and given fuel bulk density correction factors, a good estimate of the quantity of logging slash could be arrived at. Unfortunately, the procedure is rather slow, so doesn't readily lend itself to operational use. Project cancelled.

Publications/Reports:

Internal progress report.

Title:

Clearing burns in the Donnybrook Sunklands.

Objectives:

To investigate and report on the effectiveness (in terms of debris removal and resultant scrub regrowth) of three clearing techniques used to establish P. radiata plantations.

Status:

Completed.

Principal Findings:

Broadcast burning after chaining the native bush promotes the dense regeneration of "fireweeds" which compete with pine plantings. Chaining, then windrowing and burning the debris in windrows is a superior method of removing debris and produces significantly less "fireweed" regeneration. This technique is more costly.

If the scrub is chained and windrowed in winter/spring, then the windrows can be successfully burnt the following autumn. It is not necessary to leave the debris "downed" for two years. Optimum weather condition for windrow burning have been described.

Publications/Reports:

Internal reports.

Title:

The Mount Soil Dryness Index for use in the south west of Western Australia.

Objectives:

To compare and contrast the S.D.I. and the Byram and Keetch Dryness Indices for use in fire control in the south west.

Status:

Completed.

Principal Findings:

The BKDI seriously under-estimates the drying rate of fuel dryness hence the buildup in increasing fire hazard with season. With modifications, the SDI is better able to reveal the seasonal buildup of forest fuel dryness.

Publications/Reports:

Internal reports.

Title:

Fuel accumulation rates beneath P. radiata stands.

Objectives:

To determine the annual needlebed fuel accumulation rate beneath different stands of P. radiata and to examine re-accumulation after fuel reduction burning.

Status:

Shelved, not completed.

Principal Findings:

Accumulation of needles on the forest floor is a function of stand age, stand basal area and site quality. In young stands (12 years old) the effect of low intensity ($\lesssim$ 250 kW/m) needlebed burns was lost after 2 years. Needle weight had accumulated to pre-burn levels. In older stands, the effect of burning on fuel reduction was longer lived.

Publications/Reports:

Internal report.

Title:

Back pack sprays and fire suppression.

Objectives:

To evaluate several designs of pack sprays for their suitability in fire control in W.A.

Status:

Completed.

Principal Findings:

Pressurised pack sprays were less laborious to use and delivered a good jet of water. However, they needed re-charging at short intervals and these packs could also explode if exposed to radiant heat and the pressure release value mal-functioned. Plastic packs with hand pumps were cheap, light and easy to use.

Publications/Reports:

Internal reports.

Title:

Second rotation *P. radiata* site preparation techniques in the Blackwood Valley.

Objectives:

To determine which of six methods of 2R site preparation yielded best initial growth and produced the least fire hazard.

Status:

Completed.

Principal Findings:

Broadcast burning of logging debris prior to planting with pines resulted in the poorest early growth rates (volume) and the most severe fire hazard (dense stands of "fireweeds"). Mulching the logging debris produced superior growth (volume) and after two years, the fire hazard was considered to be low with very light scrub development.

Publications/Reports:

Being prepared for publication.

Title:

The Behaviour of small jarrah forest fires under dry fuel conditions.

Objectives:

To study and model the behaviour of small jarrah forest fires under summer conditions.

Status:

Completed.

Principal Findings:

The true performance of fires burning under dry fuels cannot be appraised on small plots. Most fires examined had not reached a steady state and were accelerating when they had burnt the plot out. However, it was obvious that the existing fire prediction systems under estimate potential spread rates when fuels are dry. Also, fires developing from a point source accelerate very slowly at first and the early stages of fire behaviour can be very misleading as to the fuel extent of fire behaviour later on. Line fires behaved far more erratically, accelerated and burnt more severely than "structured" point source fires. Hence, back burning under dry fuel conditions can be unwise.

Publications/Reports:

Internal reports.

Title:

The behaviour of large scale, massed fires under dry fuels in jarrah.

Status:

Active, ongoing.

Principal Findings:

Data continue to be analysed. Predictions of fire rate of spread were

below that observed, often by a factor of 10. Existing fire models do not adequately describe the dynamic behaviour of accelerating spot fires burning in close proximity. Fire behaviour was highly variable in time and space, with the variation increasing as burning condition became more severe. Fires burning on a low F.D.I. showed no signs of inter-action or erratic behaviour and accelerated very slowly. Predictability decreased, acceleration rates increased and fires behaved far more erratically with decreasing fuel moisture content and increasing severity of surface burning conditions. Fire shape crucially effects both the behaviour and predictability of fire. Point source fires burnt with a "structured" shape and a continuous (endless) perimeter. These fires were less responsive to changes in surface burning conditions, were more stable and far less extreme in behaviour than line fires or edge fires which had lost shape and continuity of perimeter.

Conditions and methods can be described for safely and successfully carrying out prescribed burns in summer and under dry fuels.

Publications/Reports:

Internal progress reports.

Title:

Biotic descriptors of fire.

Objectives:

To determine and describe characteristics of fire which best account for the physical effects of fire on the biome.

Status:

Recently commenced, ongoing.

Principal Findings:

To date; the extent of soil heating is largely a function of soil dryness and the quantity of ground fuel burnt. The level of above ground (canopy) damage caused by fire.

Publications/Reports:

Internal progress report.

Title:

Using controlled fire to reduce the abundance of Banksia grandis in the jarrah forest.

Objectives:

To determine whether fire can be used to reduce the abundance of B. grandis (hence improve the dieback resistance of the forest). If so, to describe the best fire regime to achieve this.

Status:

Completed.

Principal Findings:

Fire of moderate intensity (600 - 1000 kW/m) killed back to ground level, a large number of B. grandis. Many smaller plants re-sprouted from lignotuber, but many of the large plants were killed. On a large scale, prescribing fires of moderate intensity would be difficult. Fires would be difficult to control (as they would be required to spread at about 200 m/hr on light fuels i.e. 8 t/ha) and the effects would be very patchy. It is recommended that where Banksia control is desired, then fuels should be allowed to accumulate to about 12 t/ha. These areas can then be burnt under less severe weather conditions. A more uniform treatment will result.

Publications/Reports:

In press.

Title:

Fire effects on plants in the jarrah forest.

Objectives:

To study and describe the long term effects of several fire regimes on jarrah forest flora in forest near Nannup.

Status:

Just commenced, plots established and some data collected. No results to date.

Title:

Lake Muir Wildfire Study.

Objectives:

To assess the extent of fire damage to trees and to correlate this with fire behaviour. To study the occurrence of Acacia sp. regeneration.

Status:

Completed.

Principal Findings:

Fire intensity of 6000 kW/m caused extensive bole damage to large jarrah trees (>20 cm dbhob). Fifty percent of large trees were drysided and almost all smaller trees were killed to ground level. There was no obvious correlation between fire behaviour and the regeneration of Acacias. This appeared to be mostly related to site.

Publications/Reports:

Internal report.

Title:

Jarrah Fire Damage study.

Objectives:

To determine the relationship between fire behaviour, tree size and severity of bole damage caused by fire.

Status:

Data collection completed. Analysis continuing.

Principal Findings:

The extent and severity of bole damage to jarrah was a function of the

quantity of fuel burnt, fire intensity and fuel dryness. Under a range of fuel and weather conditions in summer, the level of fire damage to small trees (< 20 cm dbhob) increased by 42%. Trees larger than 35 cm dbhob were not damaged by moderate intensity fires. Most severe damage to boles were caused by nearby burning logs or stumps.

Publications/Reports:

Being prepared for publication.

Title:

Coupe preparation techniques for establishing young karri.

Objectives:

To monitor growth rates and fire hazard development in young karri regrowth stands after different methods of treating residual logging slash. Treatments include mulching the slash, broadcast burning and windrowing the slash.

Status:

Plots established. Treatments have not yet been carried out. No data collected, no reports.

Title:

Fire Management Plan for Dryandra Forest.

Objectives:

To provide planners with data, information and understanding to enable the formulation of a fire management plan which will protect and enhance Dryandra forest values and protect nearby land owners from wildfires.

Status:

Field work completed. Data being analysed.

Principal Findings:

Fuel accumulation rates are variable, but generally very slow. Fuel

accumulation, fuel structure and distribution is dissimilar to the higher rainfall jarrah forests. There is evidence that legume thickets can regenerate in the absence of fire, but best regeneration is obtained following fires in summer.

Publications/Reports:

Being prepared for publication.

Title:

Wildfire Register.

Objectives:

To develop a computer based wildfire information storage and retrieval system.

Status:

The system has been developed on the Perkin-Elmer's M.T.M. Past Wildfire data are currently being loaded.

Principal Findings:

Records of past wildfires are poorly maintained, contain only limited information and are not readily accessible for any statistical analysis. The new system (Wilbur) is working well and data can be readily analysed using SPSS.

Publications/Reports:

Internal report.
