DEVELOPMENT OF PINE PLANTATIONS ON POOR SOILS IN THE DONNYBROOK SUNKLAND OF WESTERN AUSTRALIA

D.J. Keene and K. Kelers
(Forests Department, Western Australia)

ABSTRACT

Broadscale planting of *Pinus radiata* commenced in the Sunkland in 1977. This paper deals with the background to the project, and methods used to overcome a unique combination of site factors. Firstly, to overcome periodic winter waterlogging on most sites, trees are planted on mounds. The soils are extremely infertile and nitrogen and phosphorus fertiliser has to be applied at time of planting and periodically after that. The soils are critically deficient in zinc and marginally deficient in manganese and copper. These minor element deficiencies are treated by a foliar application of the sulphate salts of these three elements in water.

Looking to the future, clover swards are being considered as the nitrogen source for the plantation. Inorganic nitrogen fertilisers are rapidly leached from the soil.

Each summer there is an extreme fire danger potential. About 20 per cent of the area will be managed under an agroforestry regime. Grazed areas will form broad fuel reduction buffers around and within the plantations. Periodic grazing on the remaining areas is an option that is available.

INTRODUCTION

A report of the House of Representatives Standing Committee (Anon) on Environment and Conservation into the Operation of the Softwood Forestry Agreement Acts of 1967 and 1972 stated that the isolation of Western Australia justified a softwood planting programme. The Forests Department has recognised the need to maintain wood supplies to the level of reasonable self sufficiency after the year 2000. To achieve this objective the Department has seen the need to plant pines at the rate of 3000 ha per annum (Forests Department of Western Australia, 1977).

To find suitable land for pine planting of this magnitude the Department has had to look to the Donnybrook Sunkland, an area of State Forest encompassing about 233 000 ha of generally poor quality jarrah forest. A considerable area of sandy soil in the Sunkland is suitable for conversion to pine. The area carries fire damaged jarrah forest, much of it infected with dieback disease and relatively low in productivity.

The proposal to convert 60 000 ha of this forest into pine plantations over about 30 years is described in a Statement of Intent on "Afforestation with Pines in the Donnybrook Sunkland" (1975).

The policies and principles of the Statement of Intent were incorporated into the Forests Department's General Working Plan No. 86 of 1977 (Forests Department of Western Australia, 1977), and approved by the Government on 27 January 1977.

Numerous research plots were established in 1971 and 1972. Two hundred and thirty hectares of operational and research trials were planted in 1974 to 1976. Planting operations are being scaled up from 428 ha planted in 1977 to 2500 ha programmed for planting in 1982 to 2006.

ENVIRONMENTAL DATA

The Donnybrook Sunkland is located south of Busselton and west of Nannup some 240 km south of Perth (see attachment 1).

It is a tract of land between two geological fault lines, namely the Darling Fault in the east and the Dunsborough Fault to the west. The landform is an undulating plateau between 100 and 180 m above sea level. There is a gentle slope generally from east to west. It is flat, poorly drained and very wet in winter. Approximately 1150 mm of rain falls annually on 120 to 150 days in the year (Gentilli, 1965).

The area is a mosaic of lateritic ridges with associated massive ironstone, and depositional sands in broad valleys. The pine plantations are being developed on the sands, the outstanding characteristic of which is their very low natural fertility.

The native vegetation comprises a jarrah (*Eucalyptus marginata*) - marri (*E. calophylla*) forest interspersed by treeless flats in low lying areas. Generally, the jarrah is slow growing and has been affected by jarrah dieback disease (*Phytophthora cinnamomi*) over much of the area. The high impact of the disease in this area is due mainly to the wet conditions, poor drainage and low fertility.

BROAD SCALE PLANNING

Approximately 20 per cent of the total land area will be planted with pines over the next 30 years.

Plantations range in size from 1000 to 10 000 ha. The plantations are separated by belts of native forest about 2 km wide. These provide for the retention of the full range of ecological types of the area and act as buffer zones for fire control purposes (see attachment 2).

Several areas of special significance have been recognised and set aside as management priority areas for biological, recreation and conservation purposes.

Plantations are selected following soil and vegetation surveys based mainly on soil depth. Within plantations, compartments are selected as management units, bounded by roads. Not all of each compartment is plantable. For example the gross area of each compartment will vary from 300 to 600 ha, whilst the plantable area may only total 200 to 400 ha, the

balance being unplantable lateritic ridges retained as native forest. The traditional larger continuous plantation area does not occur. An attractive blend of pines and hardwood forest results (see attachment 3).

IMPACT ON HYDROLOGY

The need to conserve waterways has been recognised by the provision of creek reserves. A strip of native forest at least 20 m wide is left along defined water courses.

The effect of the water resource of converting part of the forest to pine is being carefully monitored.

It is recognised that there will be a temporary increase in stream flow and some increase in turbidity. To minimise the impact, concurrent operations are spread over different plantations and catchments. To date there is no evidence to suggest that the natural low levels of salinity in the ground water will increase with clearing (McKinnell, 1976).

IMPACT ON FLORA AND FAUNA

The scattered distribution of the areas being converted to pine will minimise the impact on flora and fauna. Plantable sites occur largely in the broad depressions particularly susceptible to and affected by, dieback disease, which has already had significant affects on flora. Changes to flora and fauna will occur where plantations are actually planted, but the dispersed nature of plantations, unplanted natural enclaves within plantations, and creek reserves will allow abundant refuge for the native animals. Fauna surveys have revealed no rare or endangered species in the area (Skinner, 1974).

IMPACT ON RECREATION

The area is generally scenically unattractive and not a source for recreation, except adjacent to rivers and streams. Recreation management priority areas free of plantation development have been created. For example a three-kilometre wide recreation management priority area has been created adjacent to the Blackwood River.

SITE SURVEYS

Site assessment for delineation of plantable areas is based on soil and vegetation surveys using aerial photography and ground traverses (McCutcheon, 1978). This approach enables broadscale recognition of plantable sandy areas, while eliminating unplantable lateritic ridges. Detailed field work, involving soil probing then determines plantable boundaries based on soil depth.

SITE PREPARATION

Following thorough utilisation of the native forest, the area is cleared by bulldozing.

The area is thoroughly ploughed to a depth of 20 cm to reduce competition from native scrub. To alleviate excess surface water and provide aeration of the soil, it is essential to mound each planting line using a locally designed mounding plough. The mounds are constructed at right angles to the contour to shed any surface water. The mounds are 3.5 m apart and 0.2 to 0.3 m high. Where watercourses are ill defined it is necessary to construct shallow drains.

PLANTING

Because of the low lying nature of the Sunkland and the heavy winter rainfall, machine flotation is a problem. A planting machine adapted from the Lowther 3 point linkage type has been developed with the capability to plant on the mounds. Machines are pulled by two wheeled drive farm type tractors of about 70 horse power.

INITIAL FERTILISING

Agras No. 1 (18 per cent phosphate, 18 per cent nitrogen and 16 per cent sulphur) is applied at the rate of 100 g per tree at time of planting. The planter operates a fertiliser dispenser on the planting machine as he plants the trees.

TRACE ELEMENTS

Most soils in the Sunkland are critically deficient in zinc and marginally deficient in manganese and copper. These deficiencies are readily corrected by the foliar application of aqueous solutions of the sulphate salts of all three elements (e.g. 5 per cent zinc sulphate, 5% manganese sulphate and 0.2% copper sulphate) applied in spring following planting.

THE EFFECT OF CLOVER ON FUTURE ESTABLISHMENT

The sequence of ploughing, mounding, and fertiliser application outlined above is the existing standard treatment. Field trials have shown that nitrogen fixing legumes can play a significant role in plantation nutrition. The use of clover as a source of nitrogen is to be adopted in the Sunkland plantations.

Subterranean clover (Esperance and Trikkala varieties) mixed with fertiliser will be applied by air. Twelve kilograms of clover per hectare mixed with 250 kg per ha superphosphate and 250 kg per ha super, copper, zinc, molybdenum have proved to be satisfactory. We anticipate clover will be established one year prior to planting.

There appear to be substantial benefits to be gained from using clover in plantation establishment.

1. Soil nitrogen produced by the clover is available to the pines. Trial plots suggest that applied inorganic nitrogen is rapidly lost through leaching.

2. Trace element deficiencies may be corrected by maintenance topdressing of clover with super, copper, zinc, manganese mix. Foliar applications of trace elements could be eliminated.

3. Deep ploughing may not be required, except in special circumstances. Clover can be readily established on unploughed ground. The clover competes with and suppresses most native ground vegetation. The need for post planting cultivation could be eliminated.

4. Trial plots of some four years standing have indicated that planting on clovered sites will not require mounding, particularly if clover is established the year prior to planting.

5. The option to graze the area with stock is available and cash returns may result.

   It is stressed that the decision to use clover on a broad scale is for nitrogen supplies rather than as an agroforestry concept. If the clovered areas are grazed prior to planting, scrub competition should not be a problem.

6. If the pasture is established at least the year prior to planting, machine flotation will be assisted.

PROTECTION

The harsh summer conditions in Western Australia make plantation fire protection of paramount importance. Protection in the Sunkland is based on fuel reduction burning in the hardwood and grazed fuel reduced buffers in the pines. The fuel reduced buffers comprise approximately 20 per cent of the total plantation area.

SILVICULTURAL TENDING AND COSTS

Western Australia's pine silviculture is based on wide initial spacing (3.5 x 2.5 m = 1150 stems per ha) and early culling and thinning to produce a final crop of saw logs as soon as possible. Attachment 4 compares the current operation with an agroforestry regime, clover without grazing and clover with part grazing.

The net cost of a clover regime without grazing compares favourably with the current operation using inorganic nitrogen. Twenty per cent of the area will be managed under an agroforestry type scheme as a protection measure. Further cost savings appear likely using clover with grazing for part of the rotation on the balance of the plantations.

CONCLUSIONS

The Forests Department has undertaken an ambitious plantation development project in the Donnybrook Sunkland of Western Australia, with relatively new research information. One of the main problems has been the rapid leaching of inorganic nitrogen fertilisers. Field scale trials have indicated that nitrogen fixing by clover has overcome this deficiency early in the rotation. Exciting prospects in improving other facets of establishment appear likely. Further cost savings are possible in grazing fuel reduced buffers for fire protection requirements, and part grazing on a broad scale basis is an option that is available.

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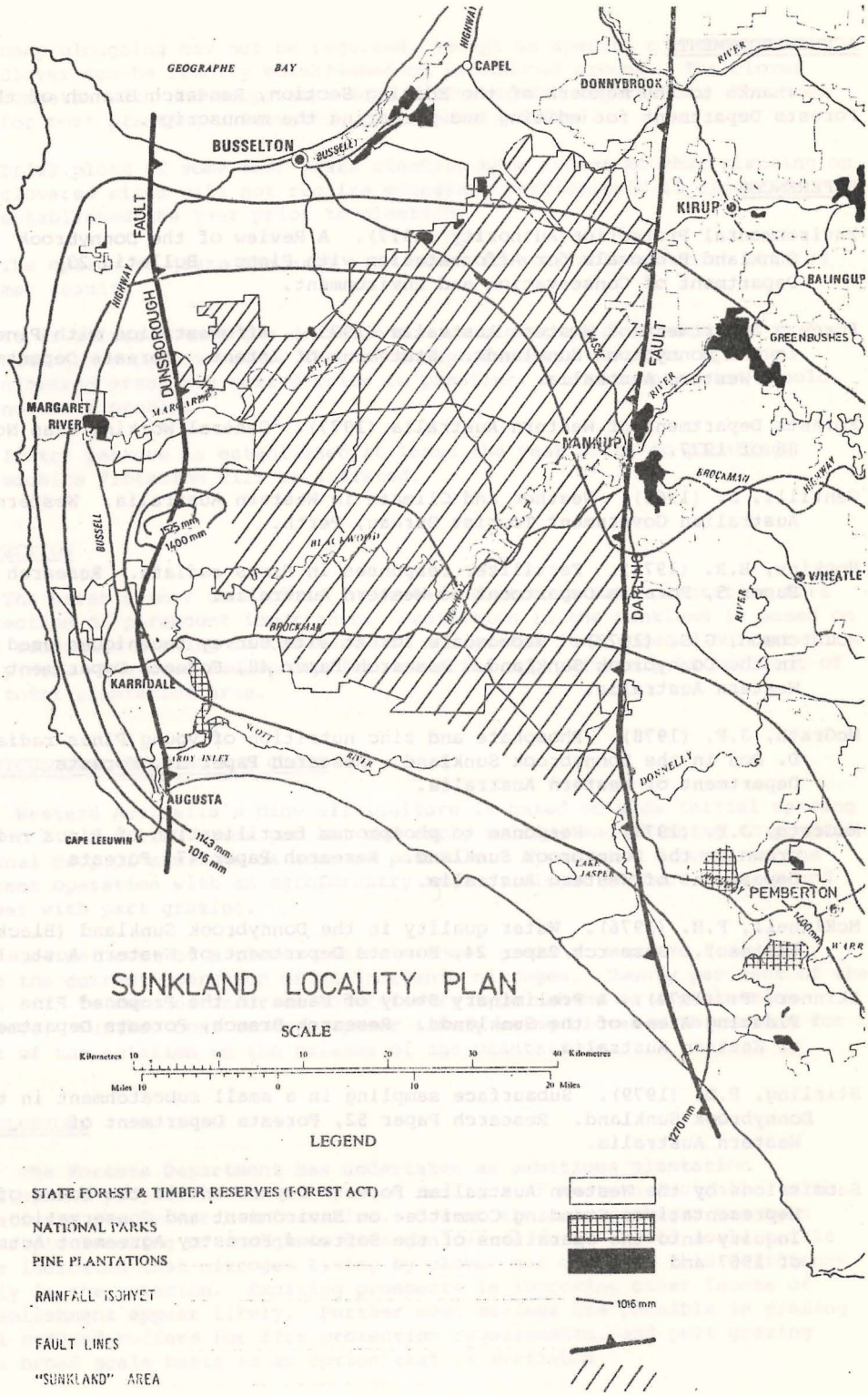
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CAPEL
HIGHWAY
RIVER
DONNYBROOK
BUSSELTON
BUSSELL
KIRUP
FAULT
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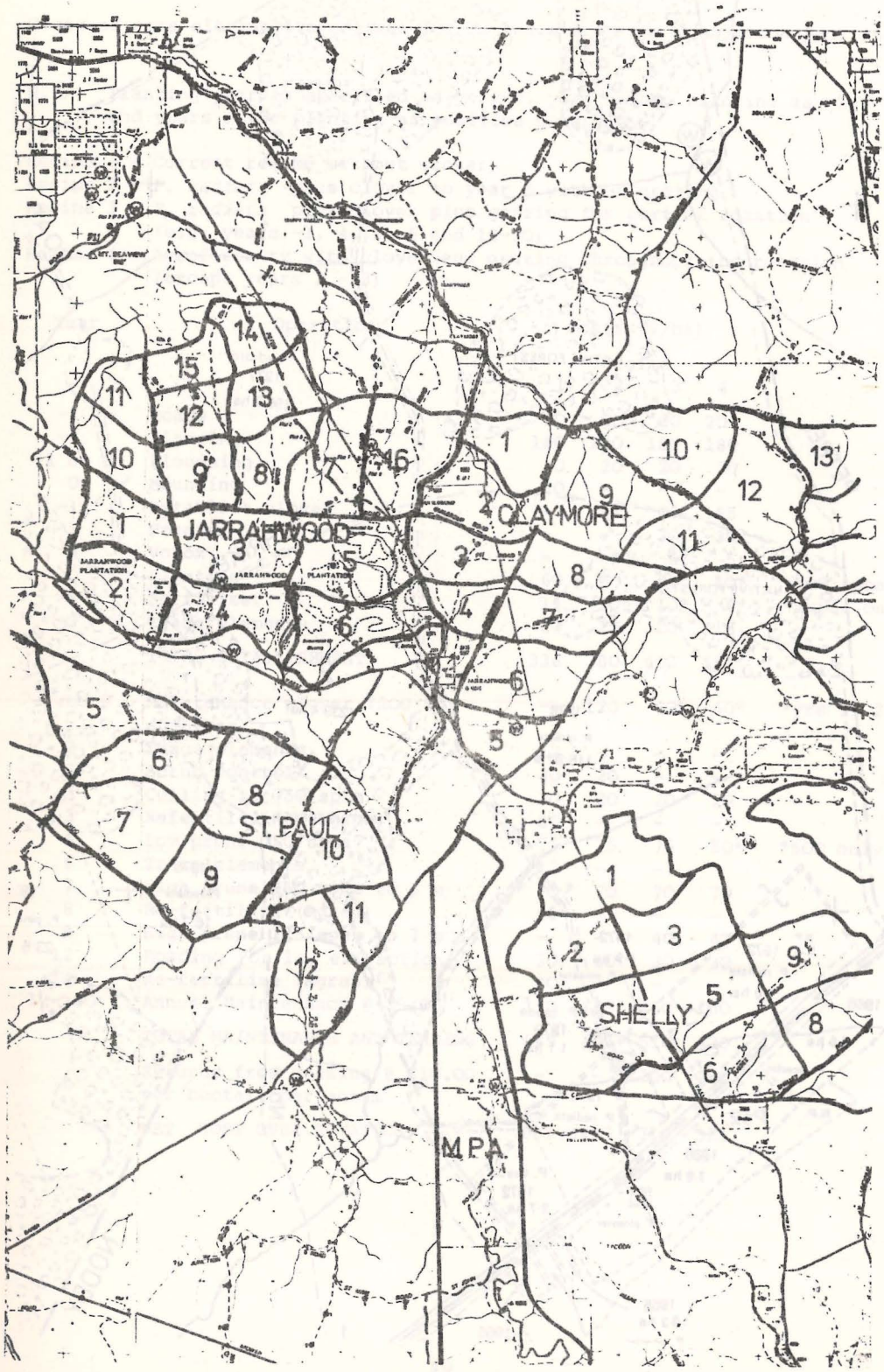
DUNSBOROUGH
BALINGUP
GREENBUSHES
MARGARET RIVER
MARGARET
RIVER
DANIUP
BROCKMAN
HIGHWAY
1525 mm
1400 mm
BUSSELL
BLACKWOOD
HIGHWAY
DARLING
WHEATLE
RIVER
BROCKMAN
KARRIDALE
SCOTT
RIVER
DONNELLY
AUGUSTA
CAPE LEEUWIN
1143 mm
1016 mm
LAKE JASPER
PEMBERTON
1400mm
1270mm
SUNKLAND LOCALITY PLAN
SCALE
Kilometres 10 0 10 20 30 40 Kilometres
Miles 10 0 10 20 Miles
LEGEND
STATE FOREST & TIMBER RESERVES (FOREST ACT)
NATIONAL PARKS
PINE PLANTATIONS
RAINFALL ISOHYET
1016 mm
FAULT LINES
"SUNKLAND" AREA



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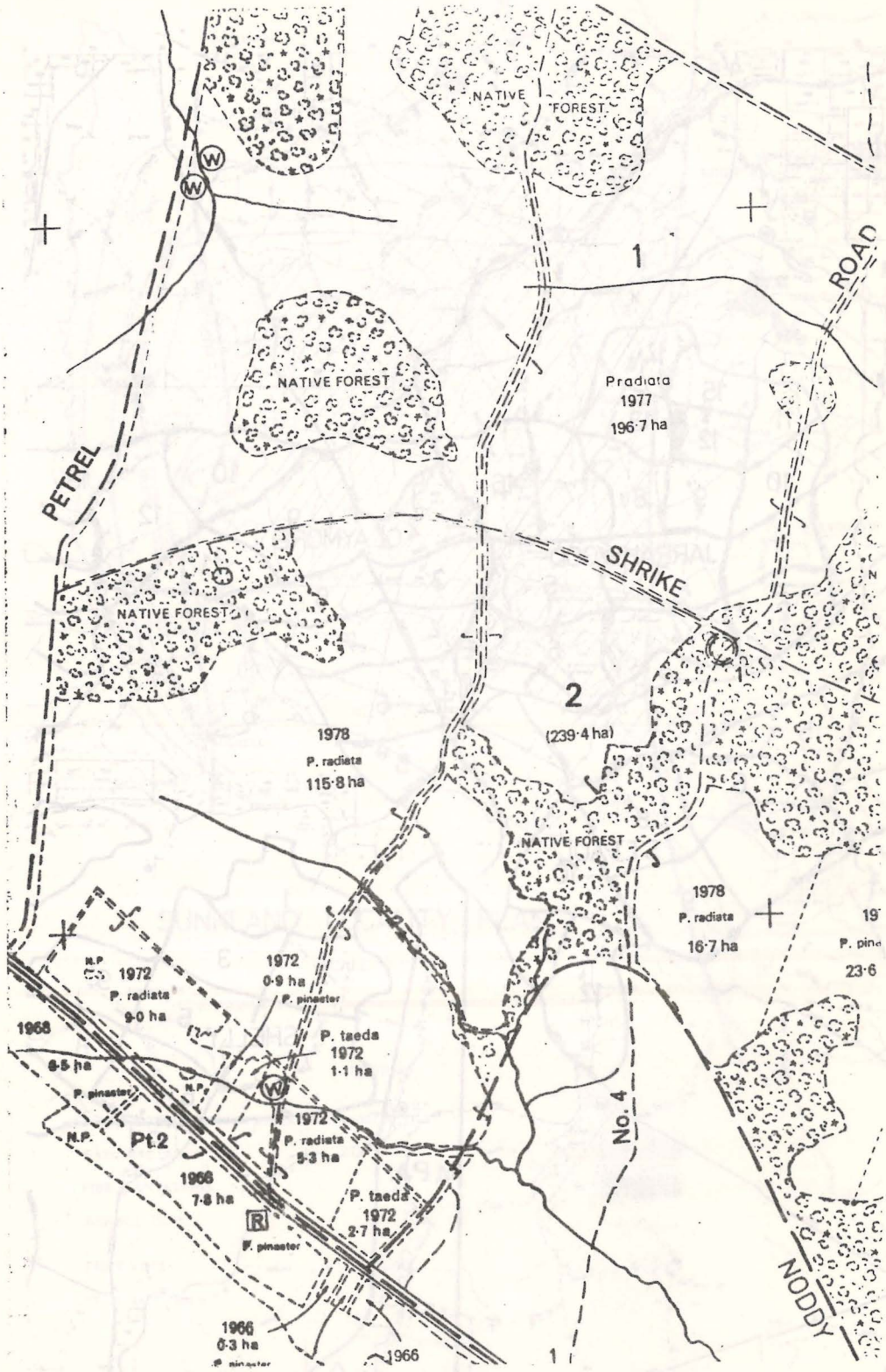
NATIVE FOREST
1
ROAD
Pradiata
1977
196·7 ha
NATIVE FOREST
PETREL
SHRIKE
NATIVE FOREST
2
(239·4 ha)
1978
P. radiata
115·8 ha
NATIVE FOREST
1978
P. radiata
16·7 ha
19
P. pine
23·6
N.P.
1972
P. radiata
9·0 ha
1972
0·9 ha
P. pinaster
1968
6·5 ha
P. pinaster
P. taeda
1972
1·1 ha
N.P.
N.P.
Pt.2
1972
P. radiata
5·3 ha
1966
7·8 ha
P. taeda
1972
2·7 ha
P. pinaster
No.4
NODDY
1966
6·3 ha
1966
1

ATTACHMENT 4

Costs of some alternative regimes for *P. radiata* in the Donnybrook Sunkland

N. B. Planting year is specified as year 0, year before planting as -1, and years after planting as positive numerals.

Regime 1 - Current regime without clover
Regime 2 - *P. radiata* plus clover to year 5 without grazing
Regime 3 - *P. radiata* plus clover plus grazing for part of rotation (e.g. years -1, 4, 5, 6 and 14-30)
Regime 4 - Agroforestry with clover and grazing throughout the rotation (except years 1 - 3)

Year	Operation	Costs ($/ha) Regime 1	2	3	4	
-1	Roads	20	20	20	20	
-1	Clearing	180	180	180	180	
-1 or 0	Ploughing	20	20	20	20	
0	Mounding	20	-	-	-	
-1	Establish clover	-	65	65	65	
-1	Fencing	-	-	20	30	
0	Vorox	-	5	5	5	
0	Planting	60	60	60	40*	*500 spha
0	Fertiliser	16	10*	10*	6*	*Super only
0	Trace elements	20	20	20	15	
	TOTAL ESTABLISHMENT	336	380	400	381	
-1 to 5	Maintenance clover (200 kg super/an)	-	120	60*	60*	*yrs 1, 2, 3 only
2	Trace elements	12	-	-	-	
3	Scrub control	40	20	-	-	
3	Culling to 750 spha	20	20	20	20	
3	Refertilising (Agras)	80	-	-	-	
5	Low prune 750 spha	75	75	75	50*	*500 only
6	Trace elements	12	-	-	-	
7	High prune 250 spha to 5 m	70	70	70	70	
8	Re-fertilise (Agras)	80	-	-	-	
9	High prune 125 spha to 7 m	-	-	40	40	
12	Roading for log extraction	30	30	30	30	
14	Re-fertilise (Agras)	80	-	-	-	
1 - 30	Annual Maintenance @ $5.00	150	150	150	150	
	TOTAL MAINTENANCE AND TENDING	649	485	510	420	
	Returns from grazing @ $10.00 per hectare per annum	-	-	200	280	
	NET COST OVER ROTATION	985	865	710	521	