STREAM SALINITY CONTROL BY REFORESTATION ON THE COLLIE RIVER CATCHMENT

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INTRODUCTION

Increasing salinity of rivers, developed as a result of past agricultural clearing is a major long term water resource problem of the South-West of Western Australia. (Public Works Dept, I979).

Under forested conditions the system in most catchments is in a near balanced condition with incoming and outgoing salts approximately equal. Removal of deep rooted forest cover has led to mobilisation of stored salts, rising groundwater tables and saline discharges (Peck I978).

The Collie River catchment is the most acute example of this regional salinity problem. Wellington Reservoir on the Collie River has an annual yield of I02 million cubic metres, used for crop irrigation and domestic supplies for thirty inland towns (Public Works Dept I979).

Up until I960, water supplied from Wellington Reservoir averaged about 250 mg/l T.D.S. At that stage only 9% of the total catchment area of 2830 square kilometres had been cleared. By I976 when bans on clearing were introduced, 23% of the catchment was cleared. Over the last two years salinity levels have ranged from 840 - 900 mg/l T.D.S. Even without further clearing, levels are predicted to reach II00 mg/l T. D. S.. (Public Works Dept I979).

Reforestation of up to 40% of the already cleared land has been recommended as the most suitable method for reversing the increasing salinity trend. A reforestation programme planned for the Collie River catchment, proposes planting over at least a ten year period, rising to 2000 ha per year within four years. The programme is seen as an important pilot study to provide practical experience for dealing with salinity in other catchments (Public Works Dept I979).

In I976, at the invitation of the Public Works Dept, reforestation trials commenced on a repurchased farm on the Collie River catchment, just east of the 800 mm annual rainfall isohyet.

Although Greenwood and Beresford (I979) have recently provided useful information on transpiration of several Eucalypt species in their juvenile stage, limited data was available at the commencement of the trials on the overall impact on salinity discharge which reforestation would make and how long it would be before any effects could be observed.

The large differences in groundwater tables beneath native forest and adjoining cleared pasture land, as revealed by the extensive transects of groundwater bores established on the repurchased farm, gave some indication though of the possible long term effects of reforestation. (Fig.2 , Fig.3).

Therefore whilst well aware that the impact which reforestation would make on saline discharge was not fully known, the objectives of the planting trials were to:

(I). Identify key factors involved in establishing and maintaining tree growth on the various sites, including saline affected areas.

(2). Establish reliable cultural techniques for tree establishment.

(3). Measure the effects of tree growth in reducing groundwater tables and saline discharge.

METHODS.

Planting Pattern.

The trials were located in a I46 ha cleared section of the Bingham River Valley. Clearing in the main valley occurred around I964 - 65 and extended upslope between I968 - 70. Two salt patches developed along the river flat about I974 and appeared to be extending upslope.

To test whether partial reforestation was compatible with continued farming practice, reforestation was made in a series of 40 metre wide strips occupying about 20% of the cleared study area. (Public Works Dept I977).

The planting pattern (Fig. I) was based on the following considerations (Public Work Dept I977).

(I) In an endeavour to draw water tables down locally, thus minimising capillary rise of salts during summer and saline discharges during winter, strips were placed to encircle the salt patches.

(2) Strips were then placed upslope about 200 metres. The assumption being that 40 metre wide strips, 200 metres apart would act as groundwater pumps and cause local groundwater drawdown.

(3) A strip was placed parallel to the Collie - Williams road to minimise effects of any groundwater moving from the 28 ha cleared area south of the road.

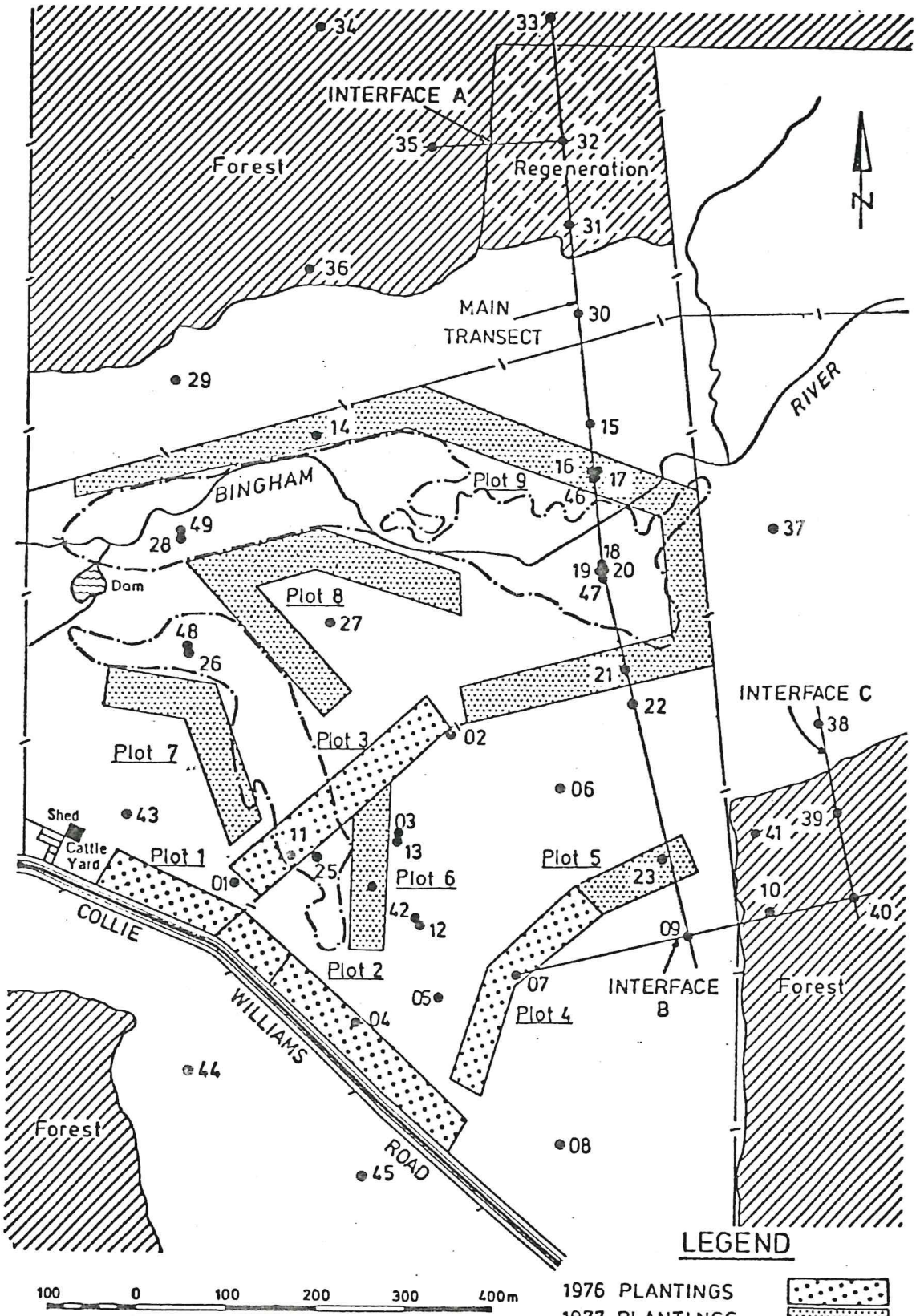

Fig.1 Map of reforestation layout & borefield .

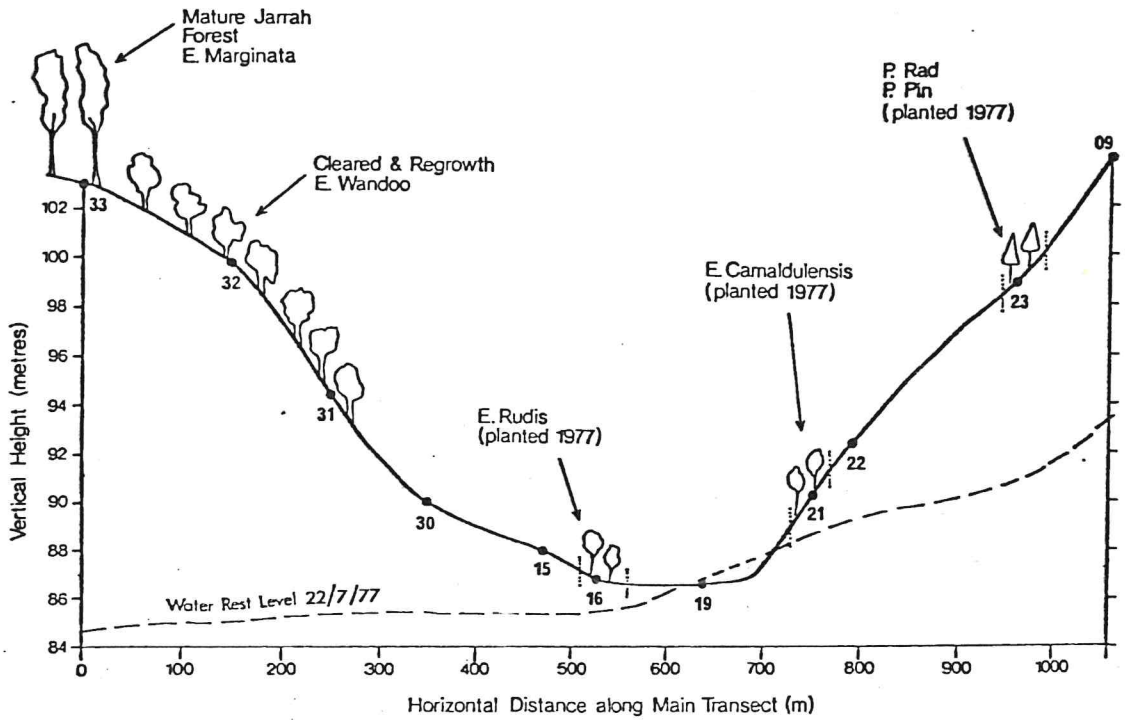

Fig. 2 Vegetation and groundwater profile of main transect

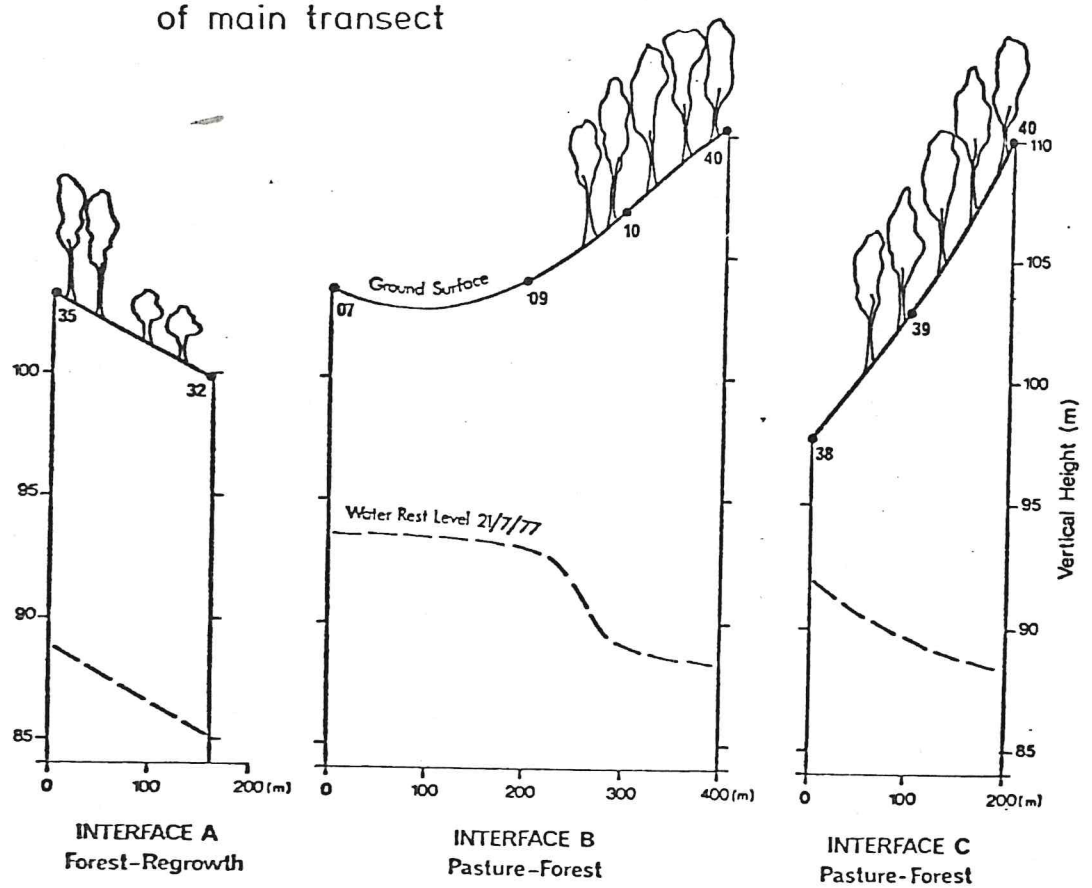

Fig. 3 Groundwaters across forest-regrowth and forest-pasture interfaces

Establishment Techniques

Cultivation.

Planting areas were cultivated with a multi- tyne chisel plough to a depth of about 25cm. Planting rows in lower lying areas were mounded with a mound plough to a height of 25cm above the natural surface.

Weed control

Burning the seed bearing heads of annual grasses by a running fire in late Spring was used to reduce the number of viable grass seeds (Pearce and Holmes I976). Planting lines were strip sprayed with the weedicide Vorox A.A. just prior to planting when grass germination was about 2cm high. An application rate of 5 kg/ha was used which represents I.6 kg each of the active ingredients amitrol and atrazine.

Planting

Se ven month old seedlings raised in 6cm x 6cm x 6cm peat pots were planted using a 4m x 2m spacing to give an initial stocking rate of I250 plants per ha. A fertilizer application of I00 gm per plant of Agras I2 : 52 (I2% Nitrogen,52% Phosphate) was made shortly after planting.

Trials

Leader trials were established to test alternative techniques likely to lead to simpler and less expensive establishment. This is important in view of the large areas being considered for reforestation. Items examined were as follows.

Type of planting stock

Seedlings raised in large peat pots have proven to be very reliable over many years of planting. Considerable savings in nursery,plant transport and the actual planting operation would be possible if smaller containers were proven reliable. Plantings were made using small peat pots, (3cm x 3cm x 4cm) and paper pots (4cm x 4cm x 5cm). Open rooted eucalypts were also tested as they can be raised relatively cheaply. Six levels of fertilizer application including the use of fertilizer tablets were tested. Application rates per seedling ranged from I0 gm to 200 gm of N:P fertilizer.

Direct seeding

Natural regeneration of Eucalyptus rudis, Endl. is commonly seen beneath shade trees in cleared farmland, particularly where grazing is excluded. Bartle, Mc Cormick and Shea (I978) describe use of the method for relatively low cost rehabilitation of bauxite mined areas.

In I978, 3 x 0.75 ha plots covering the full range of topography from dry upper slopes to moist valley floors, were broadcast sown with an equal mixture of seeds of four eucalypts, Eucalyptus wandoo,

Blakely,, Eucalyptus rudis, Endl., Eucalyptus camaldulensis, Denh. and Eucalyptus calophylla, R.Br. Six weeks prior to sowing, the plots were sprayed with Vorox A.A. using the standard application rate for grass control.

RESULTS.

Planting pattern

Establishment in areas affected by salt scald or severe waterlogging has proven difficult. Although water logged sites can be ameliorated by mounding, the practice is costly. Experience has been that by the time annual grasses had germinated, the sites were often so wet that tractors were unable to traverse the ground to apply weedicide. Currently these sites are not planted. When upslope plantings reduce the waterlogged condition, planting can then proceed with more chance of success.

Survival rates on upslope sites have been greater than 90%. Initial planting densities on these sites is now often reduced to 625 per ha for this reason.

Strip planting patterns have been discontinued for the time being. The high cost of fencing together with additional future management problems is favouring plantings to be in larger compact blocks. A typical block planting pattern is shown for a recently purchased property (Fig. 4.). The strategy is to block plant all probable intake and valley seepage sites. Arrangements would be negotiated with adjoining landowners to surround streamlines on their land with block plantings. In return the adjoining owner would be offered use of the unplanted areas on the repurchased farm.

Based on species performance since reforestation commenced in 1976, six core species are currently used. Table I. summarises the planting location of species in relation to topography.

TABLE I. Planting location of core tree species.

Eucalyptus rudis, Endl.	-	Flooded Gum	Lower slopes
Eucalyptus camaldulensis, Denh.	-	River Red Gum	
Eucalyptus wandoo, Blakely.	-	Wandoo	Mid slopes
Eucalyptus calophylla, R.Br.	-	Marri	
Eucalyptus globulus, Labill.	-	Blue Gum	Upper slopes
Eucalyptus accedens, W.V.Fitzg.	-	Powder Bark	

The aim is for a mixture of rapid growers and slower native species possibly more reliable in the longer term. This should provide some tree cover rapidly but will guard against possible failure of some species. As more information becomes available on transpiration performance of individual species the list will be reviewed. Criterion Transpirational ability alone is unlikely to be the ~~criteria~~ for species selection; factors such as long term survival and fire tolerance will remain important.

In 1979 a 80 ha arboretum containing 54 species and 24 provenances was established to provide useful long term information on likely species.

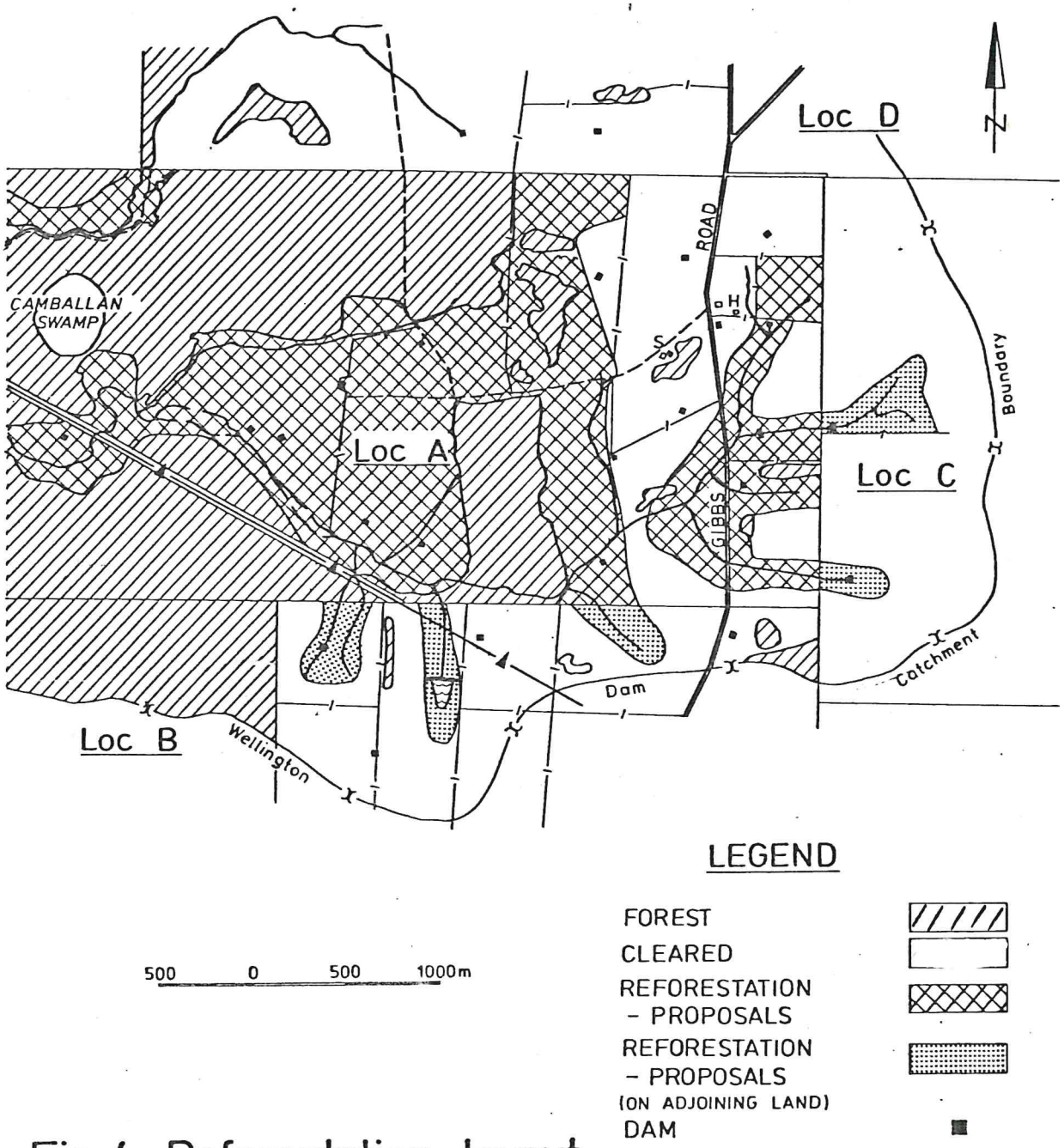

Fig.4 Reforestation layout block planting.

Cultivation

Penetration by the tynes of a chisel plough was variable on well compacted sites. Current practice is to now use a single tyne subsoil ripper to rip individual planting lines. Penetration is very even and averages 40 cm or deeper.

Weed control

Burning of grass in late Spring resulted in an approximate 30% reduction in viable seed numbers (Table 2). The cost of burning plus the need for weedicide control of the subsequent albeit reduced grass germination means that burning will probably be discontinued as a standard treatment.

TABLE 2. Reduction in viable seed numbers following late Spring burn

	Burnt samples				Unburnt samples			
	surface		5 cm below		surface		5 cm below	
	% Germ	% Dead	% Germ	% Dead	% Germ	% Dead	% Germ	% Dead
Grasses	II	85	33	63	60	36	62	27
Clover	30	3	25	I	50	I	-	-
Others	I8	82	5	95	36	64	I	97

Abnormal seeds not included.

Type of planting stock

Survival of open rooted eucalypts and seedlings raised in small paper pots has been very low. Further trials with 2 year old open rooted eucalypts will be tested although the drier sites may be too harsh for reliable establishment with this type of stock.

Direct seeding

Results have been promising. Successful establishment as at age I8 months after sowing is set out in Table 3. The seedling distribution has been arbitrarily subdivided into one of three topographic positions. Growth rates compare favourably with similar age seedlings in peat pots.

TABLE. 3 Tree establishment following seeding rate trial

Seeding rate kg/ha	Seedlings per ha at I8 months		
	Upper slopes	Mid slopes	Lower slopes
I.0	215	I390	545
I.5	225	I350	675
2.0	425	2850	~~4430~~ 1205.

Obtaining the required seed quantity would be a major problem if broadcast seeding was to be used on a large scale. Even if 0.5 kg/ha proved to be a satisfactory seeding rate, one tonne of seed would be required each year for a 2000 ha per year programme. More efficient use of seed by way of pelleting and spot sowing may be appropriate and we propose to test these techniques.

Reduction of water tables

Groundwater levels in the study area are measured by the Public Works Department at approximately monthly intervals. As might be expected no reductions have occurred as yet in water tables as a result of the 1976 plantings. Eucalyptus globulus,Labill., in Plot 2 is now over 6 metres in height so some effect may occur beneath these plantings within the next few years.

CONCLUSIONS

Results from three years of reforestation trials in eastern parts of the Collie River catchment have yielded some useful information on establishment methods. More work is required to improve techniques and also to understand what is needed to maintain the new forest cover.

The scale of the reforestation programme and possible extension to other catchments could result in a new forest resource being created. Although the primary reason for reforestation will be for hydrologic reasons, use for other forest values is likely to follow.

ACKNOWLEDGEMENTS

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REFERENCES

Bartle, J. R., McCormick, J. and Shea, S. R.,(1978). Direct Seeding of Native Species for Revegetation of Disturbed Jarrah (Eucalyptus marginata, Sm.) Forest. Proc of a meeting on Rehabilitation of Mined Lands in Western Australia. W.A. Inst Tech. 1978, 99 - 103

Greenwood,E.A.N and Beresford, J.D.,(1979). Evaporation from vegetation in landscapes developing secondary salinity using the ventilated chamber technique, I. Comparative transpiration from juvenile Eucalyptus above saline groundwater seeps. J.Hydrol., 42: 369- 382.

Pearce, G.A. and Holmes, J.E. (1976). Annual ryegrass - managerial and cultural control. W.A. Dept of Agriculture. Farmnote. 40/76.

Peck, A.J., (1978). Salinization of non-irrigated soils : a review. Aust. J. Soil Res., 16: 157 - 168.

Public Works Dept, West Aust, (1977). Groundwaters Associated with Reforestation Upslope From Salt Affected Land. Water Resources Information Note No 1.

PublicWorks Dept, West Aust, (1979). Clearing and Stream Salinity in the South West of West Aust. Document No. M.D.S. 1/79

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19th November, 79

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PAPER FOR A.N.Z.I.F. CONFERENCE

Please find attached, draft of a paper for presentation to the Australian New Zealand Institute of Foresters Conference to be held in Auckland New Zealand in May 1980.

We would appreciate it if the draft could be read and permission given to proceed with production of a final copy.

I spoke recently to Mr E. Shelton of P.W.D., the officer in charge of catchment clearing and reforestation and have given him an outline of the proposed paper. He has no objection to mention of the material we would be using. He advises that the P.W.D. publications we have quoted are freely available to the public. He discussed the matter of an acknowledgement to the P.W.D. with Mr Brian Sadler who advised that this was not required; for this reason an acknowledgement to P.W.D. has not been made.

The deadline for submission of final papers to Canberra is 30/11/79. I would appreciate it if approval could be given by November 26th if possible.

D Spriggs

.....
Regional Leader,
Administration.

DS:MS

Att.