Office Copy
File 99 P

A REPORT ON
SANDALWOOD TRIALS
AT
NANGA STATION
SHARK BAY
MARCH 1991
BY

P C RYAN
FORESTER
GREENOUGH REGION

SANDALWOOD TRIALS

NANGA STATION SHARK BAY

A Report on Current Trials by P.C. Ryan Forester Geraldton

Background

Over the last few years a commercial pullers licence has been held by Mr John Sellenger and Mr Garth Pinnegar to pull sandalwood on a designated section of Nanga Station. This area is bounded by the Station track running North from No.1 bore to Petit Bore (both free flowing artesian bores) thence East to within 500m of the coast of Hamelin Pool thence South along the coast to the track that runs in a westerly direction to No. 1 bore. (Map 1)

Sandalwood density is such that initial indications were that a sustainable rate of extraction at 20 tonnes per annum was achievable. The purpose of the trial work is to determine if sandalwood would regenerate following extraction and to determine the best cutting and post cutting technique to ensure sustainability.

The contractors current technique is to develop a main access track which in general heads in a northerly direction. This track is never in a straight line to avoid wind damage on the exposed track. In fact it tends to meander on a path of least resistance with respect to the vegetation. This results in minimal disturbance to the overall ecosystem. From this track minor tracks run off to areas of sandalwood. It is notable that often the sandalwood tends to occur in discrete clumps, surrounded by areas of no wood at all. Trees are cut in the vicinity of the clump and carried by hand to the vehicle.

The technique causes minimal impact on the ecosystem. If coppice is the long term recommended technique, it will result in very little soil disturbance caused by the operation. Tracks will be able to be located again, as in this operation historical tracks are being located. Thus the long term management program should consider allocation of the licence for sandalwood extraction, to a fixed area which is subject to regular monitoring of the operation.

Vegetation: The broad description of the trial site is "bowdada or wanyu" thicket. The dominant species is *A ramulosa* (bowgada, wanyu) with *A tetragonophylla*, *A sclerosperma* and *A ligulata* (sparse). Sandalwood, *S spicatum* and bullock bush, *Heterodendron oleifolium* are emergent species together with *Brachychiton gregorii* (sparse). Understory is *Scaevola sp* (maybe *S Spinescens*), *Stylobasium spathulatum* and *Solanum ssp.* Ground covers which are sparse are mainly mulla mulla, *Ptilotus sp* but in open disturbed sites there are the introduced species of wild turnip and radish.

The vegetation complex is possibly at a climax with a large number of senescent *A ramulosa.* It is probably past the stage when, before whiteman, it would have burnt. With the continual grazing, there is no build up of understory fuel and the country would not carry a fire until the area is destocked. Even though there is a great deal of dead and dying *A ramulosa*, regeneration of this species is adequate with relatively large numbers of young plants emerging.

Soils

The soil type in general is a soft red sandy loam topsoil with a higher level of loamy clay at depth. The area has large regular depressions that appear to be at about sea level. These areas known as "birridas" are quite saline with sparse halophytic shrubs growing in a gypsum based soil. There is no sandalwood on the birridas but quite large trees grow on the red sands surrounding the flats.

Because of the structure of the soil it is extremely difficult to pull or push the sandalwood out by traditional methods such as a tractor or truck. This is due to the fact that the tap root of the sandalwood is quite well developed and the tree is firmly anchored. There would be much damage done to the surrounding vegetation and soils if traditional methods were used. The contractor therefore endeavoured to remove the stump by hand by digging around the stump and cutting it off as low as practicable.

It was also noted that some trees tended to reshoot as suckers from cut off roots and/or stumps. It was thought that by cutting the tree off at ground level it may regrow as coppice thus having a sustainable harvesting system. When one becomes familiar with the area there is ample evidence of mature trees that had been "coppiced" by previous historical pullers. These trees take the form of being multitrunked from the one general area or focal point. I am sure that the historical pullers would have had great difficulty in removing the stumps with their techniques.

The Trial

The broad aim of the trial is to determine if sustainable extraction can occur at Nanga Station.
Definition of Sustainablility: The usual definition of sustainability is the rate of increment (increasing wood volume) at least equals the rate of extraction. With the Shark Bay sandalwood it is not known whether the rate of increment is similar to or faster than that in pastoral areas. Another way of defining sustainability is that the numbers of trees extracted is equal to (or less than) the number of trees regenerated. Therefore in the case of Shark Bay we are looking at the tree replacement definition. A tree that coppices after harvesting is considered to be a new tree. A new seedling is also considered to be a new tree. A new seedling is also considered to be a replacement for a tree that has been removed.

The trial area is a part of Nanga Station and it is grazed by sheep and goats. Another question arose which needed to be addressed in the trial. It was - "would the grazing animals eat the coppice shoots?". Rabbits also occur in the area with varying densities and maybe these would also cause damage.

Therefore, the trial was set up along the track where the commercial pullers were operating in late 1988. This trial aims to:-

1. Define percentage of logged sandalwood that coppice in the Nanga area.

2. Assess the impact of sheep and goat grazing on regenerating plants whether seedlings or coppice.

3. Assess the impacts of rabbit grazing on regenerating plants whether seedlings or coppice.

4. Record the influence of shade in regeneration.

5. Quantify seed germination and survival adjacent to coppiced trees.

The layout of the trial is as follows.

25 sites with no treatment after removal
25 sites with brambles (tops of removed tree) put back over the site to protect any regeneration
25 sites fenced with ringlock to protect from sheep and goats
25 sites fenced with rabbit netting to protect from sheep, goats and rabbits.

There is one replication of each of these sites making 200 individual sites. Each site is marked with a star picket and a metal tag indicating site number.

LAYOUT

Site	Tree Number	Treatment
1.	1 - 25	control
2.	26 - 50	brambles over stump or area of operation
3.	51 - 75	fenced with ringlock
4.	76 - 100	fenced with rabbit netting
5.	101 - 125	control
6.	126 - 140	brambles over stump
7.	151 - 175	fenced with ringlock
8.	176 - 200	fenced with rabbit netting

RESULTS
(expressed as a percentage)

TREATMENT	SITE NUMBER	1989 COPPICE	1990 COPPICE	% CHANGE	1990 AVERAGE OF TREATMENT	1989 SEEDLINGS	1990 SEEDLINGS	% CHANGE	1990 AVERAGE OF TREATMENT
NIL	1	32	52	+63	52	40	36	-10	28
	5	28	52	+86		28	20	-28	
BRAMBLES	2	24	40	+67	56	12	8	-33	26
	6	16	76	+475		72	44	-39	
RINGLOCK	3	36	52	+44	62	20	4	-80	18
	7	24	72	+200		68	32	-53	
NETTING	4	40	72	+80	76	32	8	-75	16
	8	40	80	+100		72	24	-67	
TOTAL OF ALL TREATMENTS		30	62	+106	62	43	22	-49	22

DISCUSSION

Coppice - Overall - An overall average of 30% of all stumps/roots had coppiced at the end of the first year after cutting. This average had doubled to 62% at the end of the second year. When sites were checked in October 1990 most of the stumps that had not begun to coppice were still quite sappy in the bark. This would indicate that they still have the propensity to coppice and indeed observation of earlier cuttings by contractors indicates that it could take 2 - 3, even 4 years to shoot. In all 5 stumps (2.5%) had dried out and are now probably dead.

Coppice by treatment - The results indicate that the more intensive the treatment the higher percentage of coppice. On observation this is a mystery because there is little evidence of browsing by sheep, goats or rabbits on the unfenced sites although the coppice is usually quite lush looking. There may be greater pressure on these coppicing plants over summer when other feed is more scarce. The main browsing has been by insect. Caterpillars were quite prevalent when sites were inspected. Samples of larvae were taken but failed to arrive in Perth in a suitable condition for identification.

Some coppice had their tips eaten on the unprotected sites but it was never severe enough to do any long term damage. 13 out of 55 unfenced tree sites that show coppice (approx 24%) had some degree of browsing, sometimes just a tip prune but never destructively heavy. There was one coppice that had died but leaves and stems were still present so it wasn't eaten out. One possible explanation for the differences is that in the early stages of setting up the trial the contractor had been cutting some of the stumps out and leaving roots only to sucker. This was because the initial idea was to monitor 200 commercially pulled sites but as time went by the contractor stopped digging out the stumps and cut the trees near ground level.

Cutting started in August 1988 and finished in December 1988. Perhaps the later cut trees did not have so long to wait before a rainfall event so therefore initiated coppice quicker, but the dry stumps (tree numbers 45, 47, 106, 107 and 195) tend to be over the full time span of cutting.

Another influence may have been an impact of zinc leached from the galvanised wire. But site 5 with only brambles thrown over the tree site has a level of 72% coppice at this stage.

Seedlings - Many individual tree sites had a quantity of seed on the ground when the trees were cut although the trees cut in August and early September would have had slightly immature seed. In spite of this, a total of 86 sites (43%) had some germination of seedlings in the vicinity of the site. Regardless of protection there has been a reduction in the number of sites with seedlings over time, so that 2 years after cutting only 22% of all sites still had at least one seedling.

One option for conditions relating to extraction would be to only cut trees that have a recent seed crop to ensure maximum numbers of seed. This would mean contractors having to bypass suitable trees in some years and would have to return in other years to cut when seed is present. This would be somewhat impractical for a commercial operation.

Grazing of seedlings did not appear to be a problem. Some had the tips eaten off but usually in these cases the seedling was sending out new branches from the lower leaf axils.

There were a total of 11 sites that had seedlings to replace the extracted tree and no coppice was present.

Other seedlings - Many sites had immature trees ranging from stem diameter of 15mm upwards. Some of these trees were fruiting. There were 43 sites with an older stem left. It could be considered that 16 sites with older seedlings would replace the extracted tree in the absence of coppice and new seedlings.

There were three individual sites that could not be located this visit.

Shade: As the sandalwood tree tends to be the dominant tree at its own site, there can be a large area exposed after the removal of the tree. This means that the site is virtually unshaded by any surrounding vegetation except at sunrise and sunset. The remaining stump is fully exposed to the sun, especially in the heat of the day. There does not appear to be any detrimental affect to the emerging coppice from this exposure.

Some seedlings are also fully exposed but these appear to be quite tolerant of direct sunlight and heat. Seedlings that are wilted will probably have no attachment to a host and simply run out of moisture.

Summary - The current (October 1990) degree of replacement (sustainability) is as follows:-

	%
Replacement by coppice	62 %
Replacement by seedlings	5.5%
Replacement by older stems	8 %
Sites currently sterile (no coppice, no seedlings, no older stems)	23 %
Sites not found	1.5%
	100 %

As there are 5 sites (2.5%) with dead stumps it is still possible for the degree of coppice to increase by up to 20% which would give about an 80% replacement by Coppice.

Although the results seem to favour fencing, it is too early to be completely sure. The cost of installing fences on a commercial basis is not practical. The two unfenced sites combined have resulted in a 54% coppice rate and when combined with seedlings and older stems as replacement stock, there is a total of 62% replacement of stock. This may go higher over the next year or so.

Recommendations: At this point the additional conditions that should be put on the current licence for the area is to -

1. Cut trees at or just below ground level to encourage coppicing.

2. Bury any seed present on site at about 2.5cm deep.

3. In the event of no seed present, plant 10 seed of recently collected seed.

4. Cover stump and immediate area with any brambles that have been removed.

DIRECT SEEDING

Preliminary Results

The value of direct seeding is still unconfirmed but it is anticipated that large areas within an operational area could be seeded. To give some indications of how to do this a direct seeding trial was set up along the road east of No.1 bore. 4 sites were selected to represent the general landforms of the area. These were-

1. Site on an easterly facing slope.

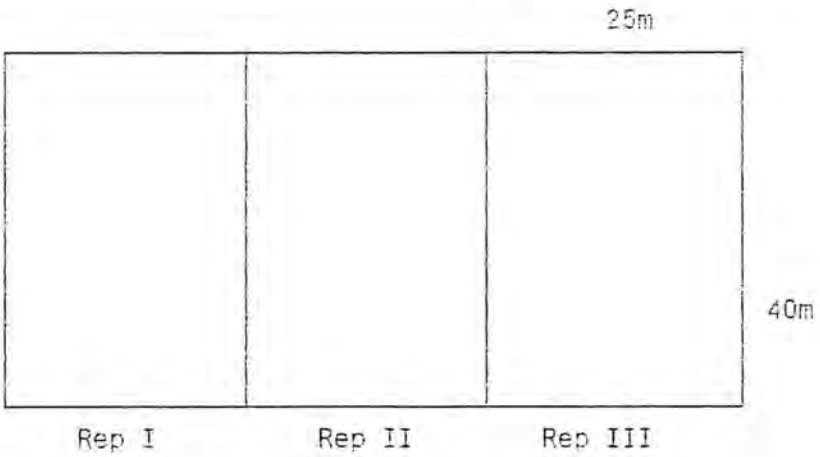
2. Valley Floor

3. Site on a westerly facing slope.

4. Ridgetop

At each site 3 replicates of 100 seed locations were sown with 3 seeds each. There were to be 3 replicates at each site but in 1990 there was insufficient seed to complete all sites. Each replicate was 40m x 25m and the seed wes sown in spots 2.5m apart, in rows 4m apart. No consideration was given to the position of the seed site in relationship with the potential host or with shade potential. It is hoped that some relationship might be demonstrated over time.

LAYOUT



The first seeding was done in late April 1990 and the site was measured for germination October 1990. Planting technique was to use a Nufab hand planter pushed onto the soil, opened up, 3 seeds dropped down and planter removed. If possible the sites were firmed in by foot.

Direct Seeding Trail
Nanga

Planted April 1990
Monitored 23 October 1990

Site	Rep	No of sites pl	Sites with germ	% sites	No of seed pl	Seed germ	% seed
East Slope	1	100	37	37	300	48	16
	2	100	31	31	300	45	15
	3	not planted					
Totals		200	68	34	600	93	15.5
Valley Floor Shell) beach) seed)	1	100	26	26	300	31	10.3
	2	100	23	23	300	28	9.3
	3	100	72	72	300	112	37.3
Totals		300	121	40.3	900	171	19
Excluding shell beach		200	49	24.5	600	59	9.8
West Slope	1	100	29	29	300	35	11.6
	2	100	43	43	300	56	18.6
	3	not planted					
Totals		200	72	36	600	91	15
Ridge Top	1	100	40	40	300	57	19
	2	100	28	28	300	36	12
	3	100	23	23	300	33	11
Totals		300	91	30	900	126	14

NOTE: - Seed Source for most of trail was Nilemah Seed except Rep III in Site 2 (Valley Floor) which had Shell Beach seed.

From the results so far we have had a 13.5% germination of seed with an average of 35% of sites having at least one seedling (excluding the Shell Beach seed.) The Shell Beach seed gave a 37.3% germination with 72% site establishment. This indicates the provenances are variable.

This trial needs to be monitored after summer to see what effect the summer drought has on the germinants. But we do have an indication that by planting, say, 10 seed per site, 100% site establishment would be possible. This implies that it may be feasible to establish large numbers of trees on relatively small areas for commercial operations.

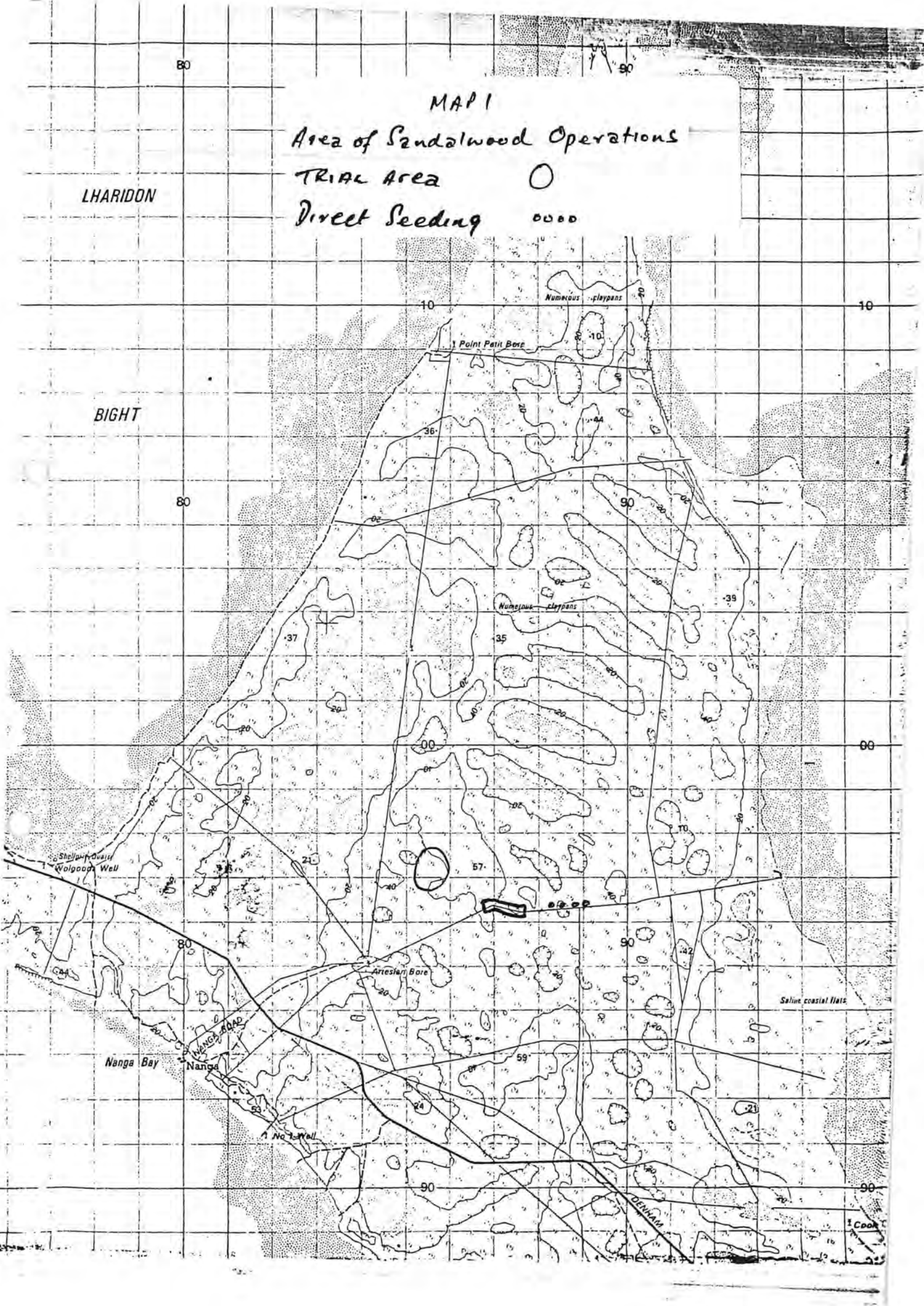
It is intended to plant up the unsown replicates in 1991 but to use 10 seeds per site to see if 100% of sites with germination is possible.

Future: There is no apparent reason that the commercial operation could not be allowed to continue at the current rate of extraction. In fact, if the pullers were prepared to carry out direct seeding as they move through the area it would be possible to increase the quota eg, from 20 tonnes to 30 tonnes per annum.

The current rate of pulling is approximately 2 km^2 per annum (200 ha/annum). The area involved in commercial pulling is about 9,000ha. Therefore provided the density is consistent, it will take up to 45 years to work through the area once. The small to medium size stems now left will be ready to pull and even the coppice may be ready by then.

The ability for sandalwood to coppice in the Nanga area is now well demonstrated. What has not been demonstrated is the need or otherwise to manipulate that coppice to produce extractable sandalwood in the future. There also may be mortalities of coppice over time irrespective of any treatments put in place.

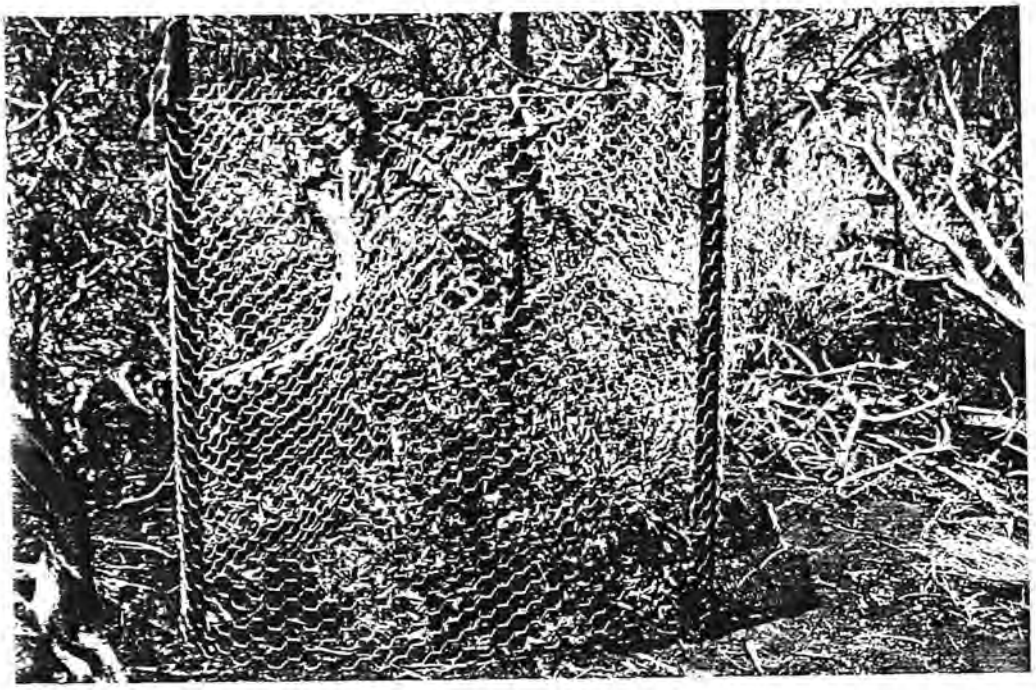
There will be a need for ongoing monitoring to follow through the coppice to ensure that it grows through to maturity and to the stage where seed is produced again.


MAP 1
Area of Sandalwood Operations
TRIAL Area
Direct Seeding
LHARIDON
BIGHT
Numerous claypans
1 Point Petit Bore
Numerous claypans
Shell Quail
Wolgooga Well
Artesian Bore
Saline coastal flats
Nanga Bay
Nanga
1 No 1 Well
DENHAM
1 Cook

Overview of vegetation dominated by A ramulosa

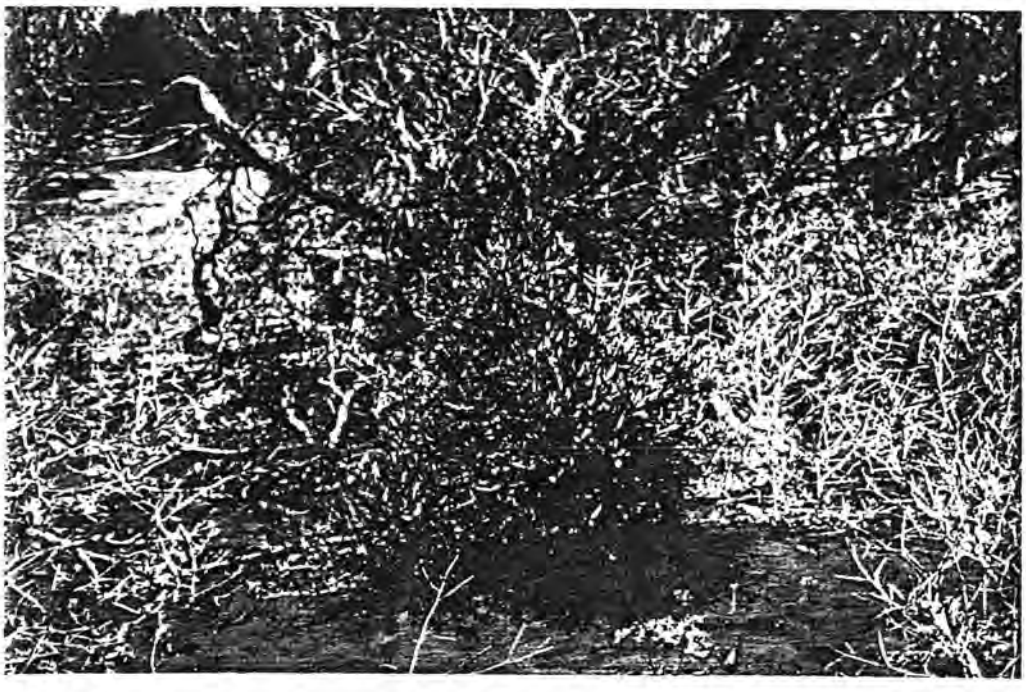
Vegetation showing senescent A ramulosa

A site with an older stem fruiting outside enclosure

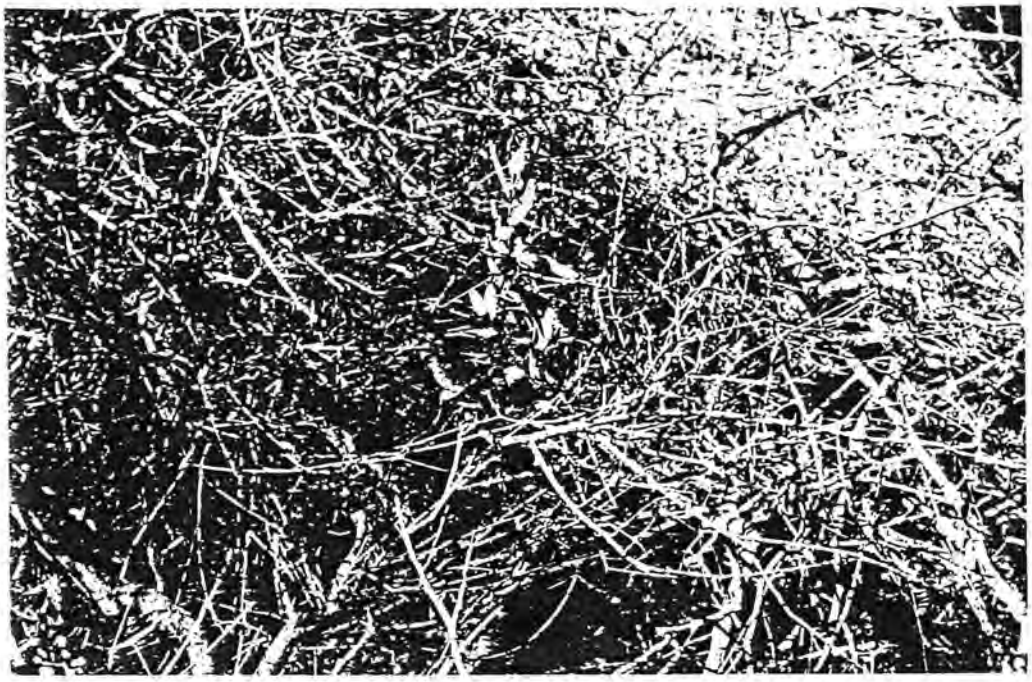


Two year old
in rabbit netting

Two year old
coppice in
ringlock

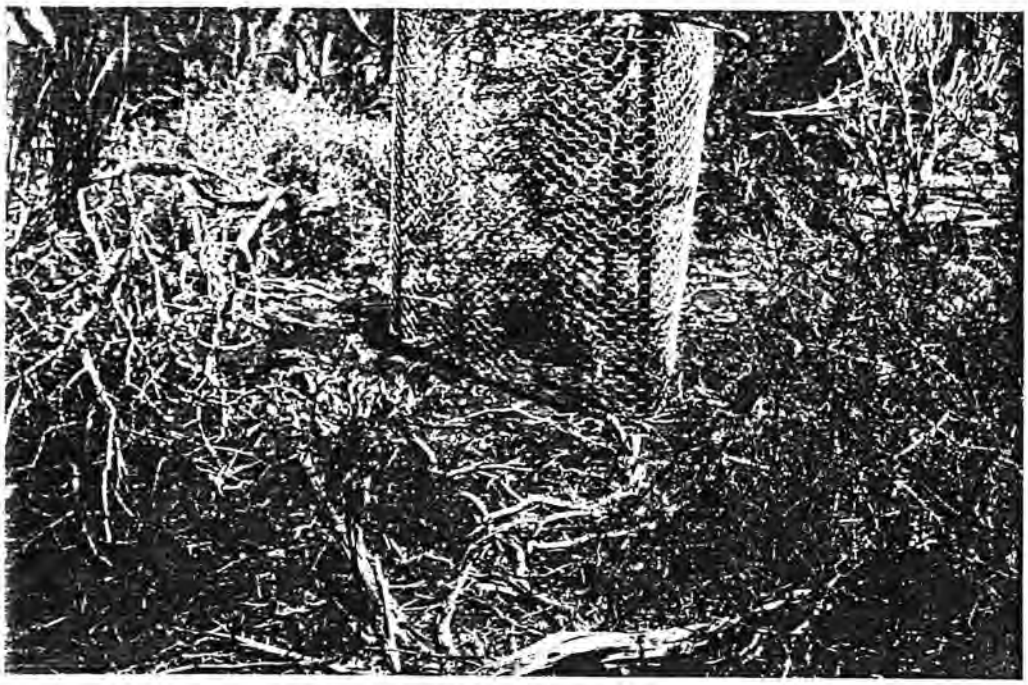


Two year old
coppice without
protection



2 year old seedling protected brambles

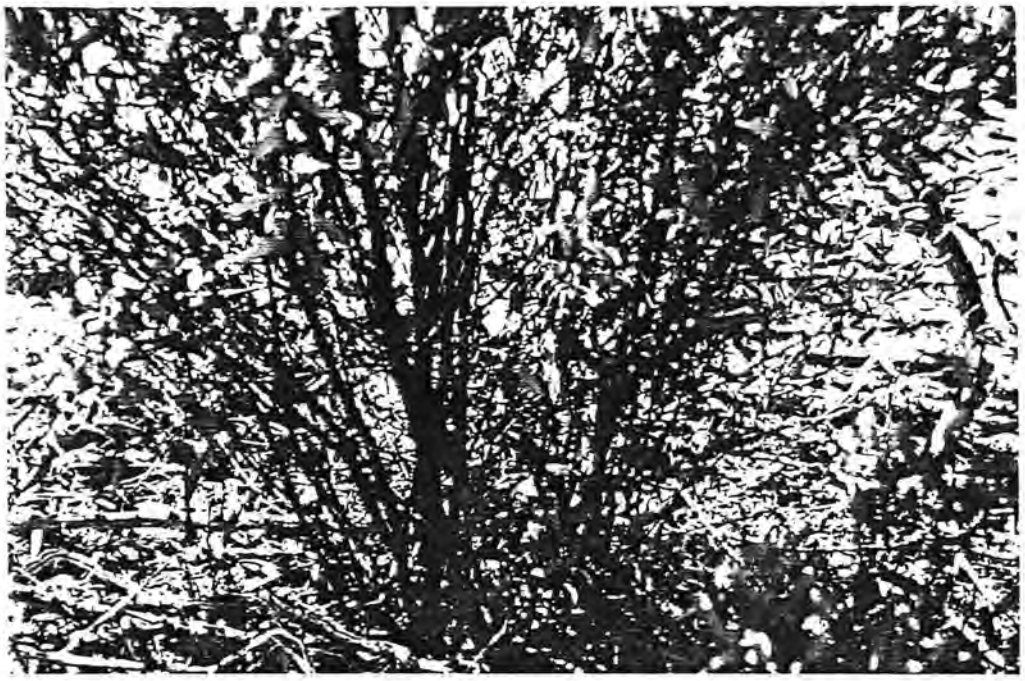
4 year old coppice protected by brambles



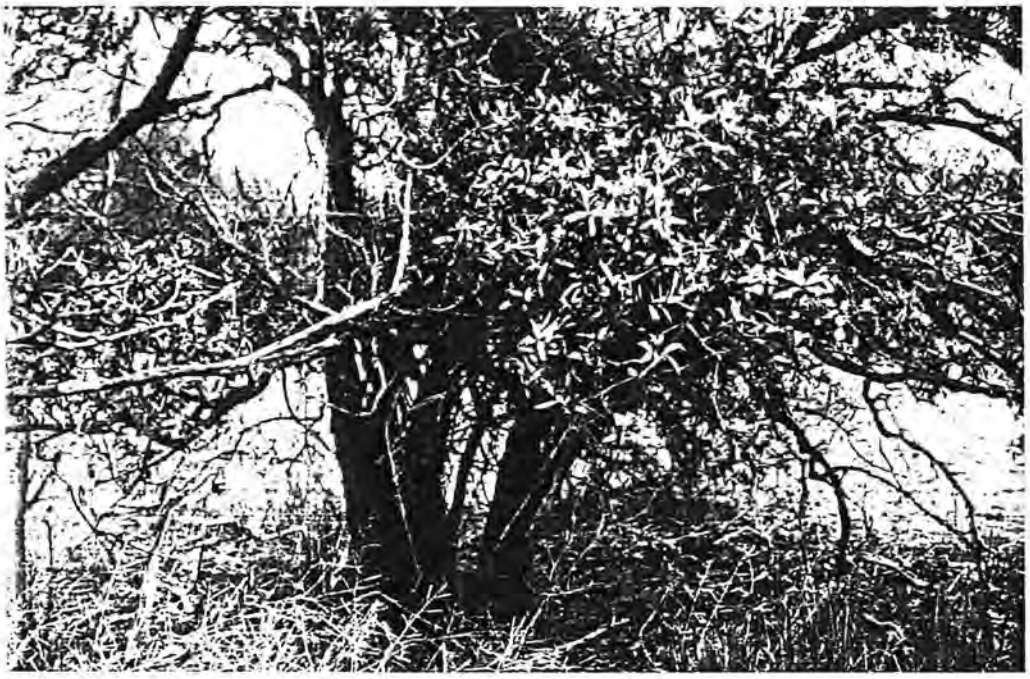
Young coppice in netting. Seedling at 4 year old

4 year old multi-stemmed coppice

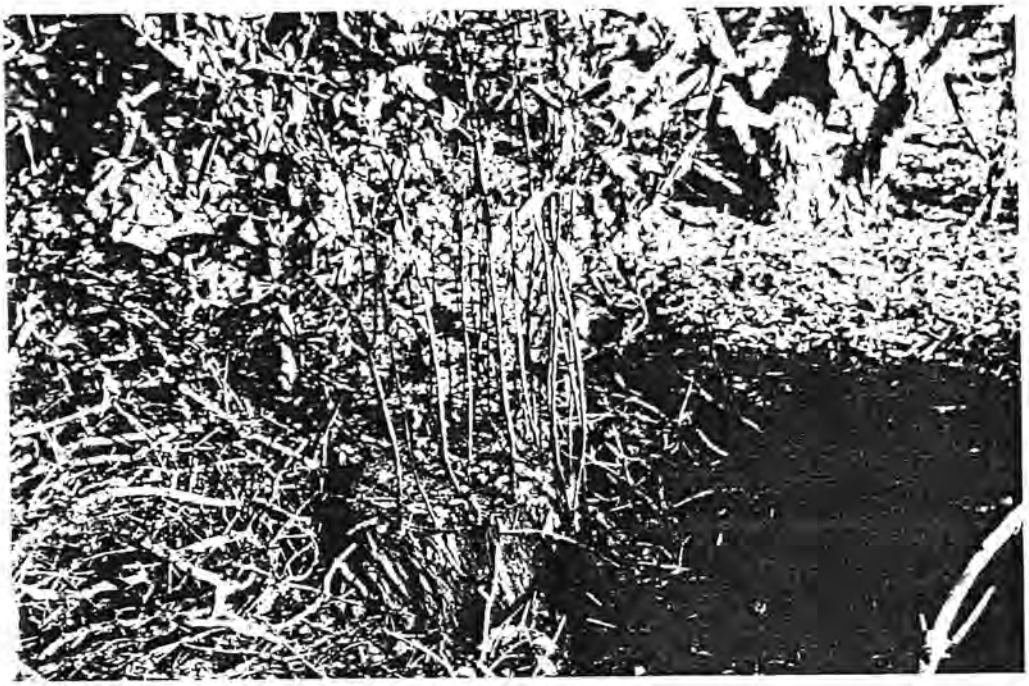
Multi-stem effect



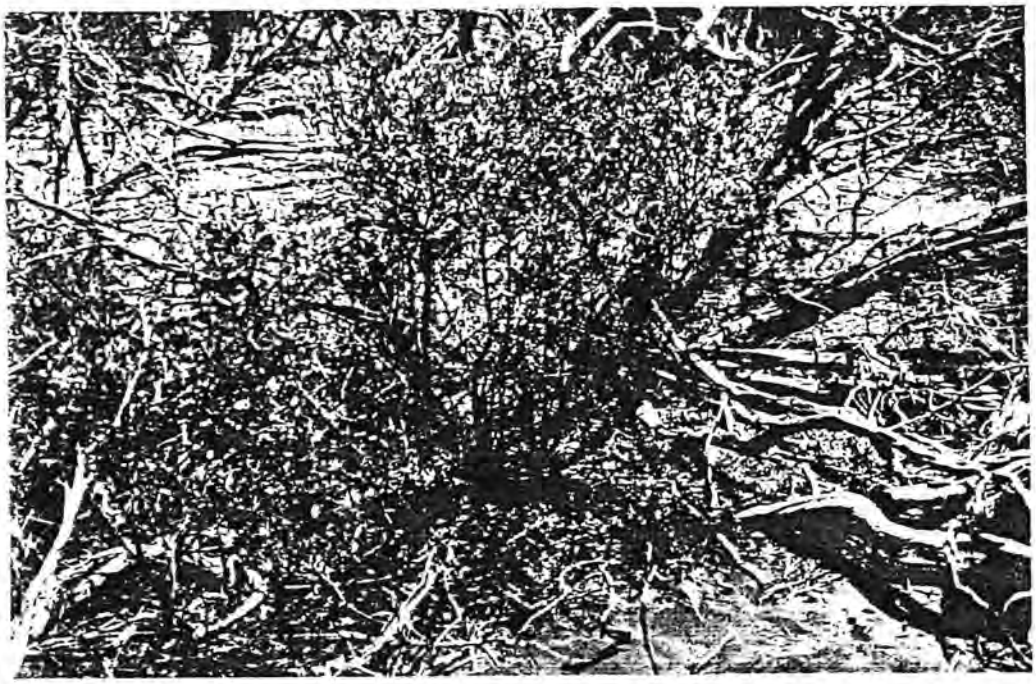
Same stump as above after hand removal of some of the smaller coppice stems



Presumed old coppice from previous pulling operations



Coppice from high cut stump - about 4 year old



5 - 6 year old coppice