Revegetation case study

(Alley farming with mallee eucalypts)

Landscape Goal

Provide hydrological protection to the landscape and prevent the introduction of weeds.

Land manager
(conservation)
OBJECTIVE(S)

Use regionally based native vegetation to buffer remnant bush against 1. watertable rise and 2. wind borne weed seeds, herbicide, pesticide and fertiliser.

Land manager
(agriculture)
OBJECTIVE(S)

Minimise ground water recharge by using deep rooted perennial plants at regular intervals across the landscape; Provide wind protection to agricultural land; and provide an opportunity for commercial return.

Central wheatbelt - WA

Department of Conservation and Land Management

Bushcare
The National Vegetation Initiative

Site characteristics:

Figure 1. Natural over-storey vegetation on this site was salmon gum (*Eucalyptus salmonophloia*), red morrel (*Eucalyptus longicornis*), wandoo (*Eucalyptus wandoo*) and York gum (*Eucalyptus loxophleba* subsp. *loxophleba*).

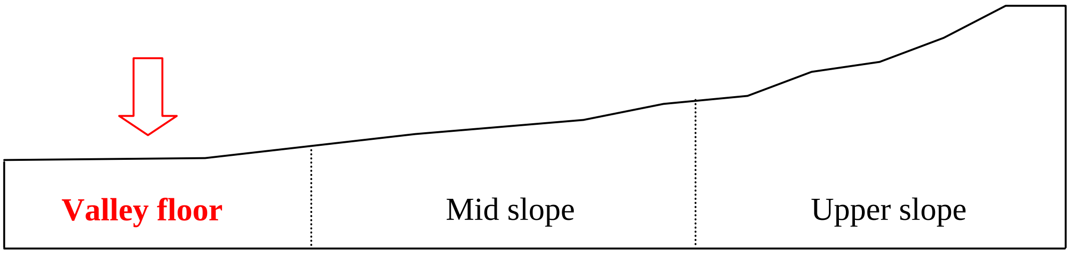

Figure 2. Landscape position of revegetation. This position is characterised by substantial upward ground water movement and very limited lateral ground water movement.

Soil types: Sandy loam over grey clay
Grey clay to the surface.

Ground water table: Depth to ground water ranges from 2 m to 4 m below the soil surface. Ground water salinity is about 3 500 mS/m (milli Siemens per meter – a unit of electrical conductivity)

Surface water ponding: Localised soil surface depressions combined with the flatness of the landscape position encourages water ponding. Ponded water can recharge the water table, creating a localised ground water mound. This is a particular problem where the water table is already high.

Design of revegetation:

Species Selection

A combination of factors influenced the species selection. These were suitability to the site, ease of management, biomass production and cineole content of the eucalyptus oil.

Smooth barked york gum (*Eucalyptus loxophleba* subsp. *lissophloia*), endemic to the eastern wheatbelt and the Goldfields was selected. The smooth barked York gum is a regional species to this site as it falls within the same botanical district as its natural distribution. Indeed the same species (different subspecies) occurs at this site - York gum (*Eucalyptus loxophleba* subsp. *loxophleba*).

Importantly, the species selected has some salt tolerance and a degree of waterlogging tolerance.

Characteristics to meet objectives

Nature Conservation Objectives

Use of a regional native species - avoids the risk of introducing an environmental weed.

Buffering of remnant bush from water table rise - dual rows (hedges) of mallees are spaced at 30 m intervals across the paddock directly adjacent to remnant bush (for explanation of spacing see: Agricultural land use objectives – Increased water use). The mallees contribute to overall paddock recharge reduction and thus, help to control ground water rise.

Buffering of remnant bush from wind borne weed seeds, herbicide, pesticide and fertiliser - the design and frequency of mallee 'hedges' dramatically reduces the linear distance that the soil surface is exposed to full wind speed. In addition, there is increased opportunity for small particles that may lift from the soil surface to be intercepted by the mallee foliage.

Even though the mallees will go into a harvesting regime, their rapid regrowth from the lignotuber (mallee root) will add protection to adjacent land uses for the majority of time.

Opportunities also exist to alter (stagger / decrease) the harvest frequency of the mallees, closest to the remnant bush.

Additional characteristics - food resources - provision of useful food resources for native fauna is provided by the mallees. Native birds have been observed foraging for insects amongst three and four year old mallees at this site.

Ecosystem process objectives

Level of diversity - two other mallee eucalypt species were planted at this site. These species are growing on small areas of different soil types. Smooth barked York gum, however, is the species most suitable to meet the challenges and the land management objectives of this site.

Replacability / stability - Ability to maintain water use given the threats of, for example, episodic fire events, drought conditions and insect attack, was the key objective. The mallee form is particularly well adapted to withstand fire events (regenerates from below ground growing points), drought (their lignotuber or mallee root stores moisture and nutrients as a survival mechanism) and insect attack, eg defoliation (the mallee has a strong regenerative capacity).

Hydrological issues - valley floors may become major ground water discharge areas of the wheatbelt.

Valley floors are characterised by low gradients and high clay content soils. These two features, combined with 1. on-site recharge and 2. pressure exerted from recharge in other parts of the landscape are major contributors to ground water rise.

The influence of recharge in this landscape position can be substantial. Increasing annual rainfall usage (decreasing potential recharge) is one of the main objectives of this particular revegetation (see table 1).

Table 1. Comparisons of recharge increase between high, medium and low rainfall areas before and after clearing native vegetation (Source: AgWA).

	Rainfall	Recharge	Recharge increase
Forest Cleared	1000 mm 1000 mm	5 mm 100 mm	**x 20**
Forest Cleared	500 mm 500 mm	0.1 mm 30 mm	**x 300**
Forest Cleared	300 mm 300 mm	0.01 mm 10 mm	**x 1000**

Establishing a perennial native plant (such as smooth barked York gum) that can dry the soil profile and grow in response to summer rainfall events has many hydrological advantages. These include minimising annual recharge and therefore reduce ground water rise and reducing the flooding and waterlogging potential associated with saturated soil profiles. Also, a small number of valley floor field observations indicate that eucalypt mallees can draw down existing, moderately saline ground water.

Importantly, any form of revegetation in this landscape position must be complimentary to surface water drainage. Surface water drainage is critical to minimising the impact of recharging water. Where ground water levels are high, recharging water from ponded areas can create a localised ground water mound. This may raise the ground water level sufficiently to allow capillary rise of the ground water to the soil surface and thus evaporation and concentration of salt at the soil surface.

Agricultural land use objectives

Increase water use – one of the main objectives of this revegetation was to increase wateruse. As this site has an existing water table at 2 - 3 m below the soil surface and has very limited lateral ground water movement (ie mostly upward ground water movement), it was considered that mallee 'hedges' spaced at close intervals over the whole paddock were necessary to address the issue. The effect of trees on ground water in low landscape positions was acknowledged to be relatively localised and so the need for close intervals.

A cropping alley of 30 m was chosen to facilitate machinery efficiency (multiples of current machinery widths) and also achieve a relatively high number of mallee stems per ha. The density at this site is 400 mallees per paddock ha, covering 15% of the land area. It was considered that these densities will greatly assist with increased annual water use and also drying of the soil profile.

Amenable to extensive production systems - wheatbelt farms are increasingly characterised by a high level of mechanisation with low labour inputs. The mallee eucalypt (as a prospective commercial species) can produce bulk commodity materials in extensive farming systems. They can be harvested and transported in mechanised systems not very different from conventional annual crop systems. In addition, the plants are robust and easy to grow.

Compatibility with present agricultural practice - Fencing is a minimal requirement for mallee eucalypts. Mallees selected for oil production are generally of low palatability to agricultural stock. After restricted grazing for 1 year post - establishment, oil mallees are generally unaffected by traditional grazing regimes. Prudent grazing management of coppice growth will ensure sustained mallee growth.

Competition with adjacent annual crops and pastures after six years of growth has been minimal. This will vary from site to site depending on soil and moisture conditions. The deep rooting ability of eucalypt mallees is thought to minimise competition with cereal crops. The low form of mallees also minimises loss of agricultural production from shading.

The above two characteristics allow the mallee to be dispersed across the agricultural landscape and integrated into the farming system with minimal disturbance. Dispersal of the mallees across the landscape was a critical factor in addressing the objective of reducing recharge.

In addition, mallees are tolerant to a number of agricultural chemicals, ie grass selectives.

Short rotation prospective tree crop - the cost of annual revenue foregone on land occupied by the mallees is minimised by a short harvest rotation. The mallees can be harvested 4 years after establishment and then about every two years thereafter. In addition, short rotation crops are, in general, more amenable to more rapid industry development than long rotation crops, such as trees for structural timber production.

Potential residue use options - the mallee eucalypts have an impressive range of potential products to choose from (see table 2). These products are in addition to the cineole content of the oil used in the pharmaceutical industry and as an industrial solvent.

Table 2. Residue use options of smooth barked york gum (*Eucalyptus loxophleba* subsp. *lissophloia*), - an oil mallee.

Category	Product
Reconstituted wood products	Panel board.
Carbon products	Charcoal, activated carbon.
Energy	Liquid and solid fuels.
Chemicals	Ammonia, methanol. Cellulose / lignin.

Note: All listed products are in the development phase.
All the product categories have sufficiently large markets to contribute to a broadscale industry.

All markets are relatively undiscriminating in feedstock required to produce the above products and all markets seek large volume, low cost, reliable sources of supply.

Establishment:

Surface water drainage structures - were planned, surveyed and constructed to a design outlined in an Agriculture Western Australia Farmnote (figure 4 and 5). Importantly, surface water control was implemented before the location of mallee 'hedges' was considered.

Orientation and location of mallee 'hedges' - mallees were oriented in a 'spider web' fashion, following the cultivation pattern of the paddock (figure 6 and 7). Corners or headland strips were left clear to allow machinery access and stock mustering points.

The paddock was cropped in the year of mallee establishment (1997) and cultivated after an early rainfall event. This allowed for the 5 m strips to be left uncultivated at the predetermined distance apart (30 m). The headlands were cultivated to clearly mark the end point of each mallee 'hedge'. The site was then ready for ripping.

Ripping - a D8 dozer was employed to rip two lines at 2 m apart. Ripping was completed early enough in the season (early May) to achieve a high level of subsoil clay shattering.

A tractor was then driven over the rip lines to crush clay boulders and minimise air pockets. This was followed up by towing four lengths of railway line angled inwards towards the rip lines. This action filled any large voids in the rip line with topsoil leaving a slight convex and smooth soil surface directly above the rip line (figure 3).
Maintaining a flat surface near to ground level was critical at this site for three major reasons. Firstly, a surface free from obstructions such as boulders of clay, roots or rock, is extremely important to tree harvesting operations (figure 8). Secondly, a flat surface near to ground level ensured that water flow in wet conditions in this landscape position was not obstructed. Thirdly, preparing a smooth flat surface was also critical to enable successful herbicide / soil contact and also eliminate the risk of concentration of herbicide in the rip line. The smooth surface also greatly improved ease of planting.

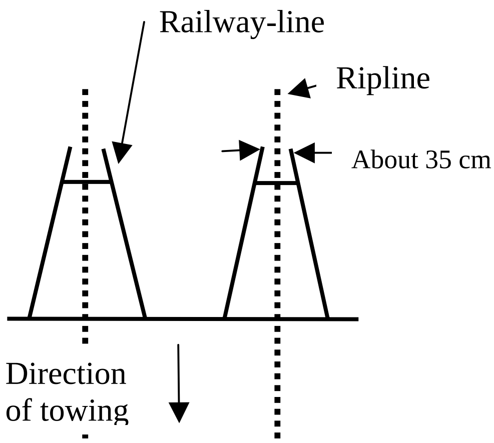

Figure 3. Plan view showing orientation and direction of towing of railway line steel. This method is used to drag in topsoil to the rip line, creating a smooth slightly convex soil surface for effective herbicide application and ease of hand (tube) planting.

Weed control - followed a standard prescription. This was:

Pre-planting: 1 Litre of glyphosate (knockdown herbicide) per ha (only if weeds are present) and 4 Litres of simazine (residual) per ha. Simazine will give up to about 3 months protection.

A withholding period is required for Simazine. Allow 50 mm of rain and at least two weeks before planting.

Post planting: 2 Litres of simazine per ha over-spray at 2.5 months after first application. This ensured adequate weed control throughout the growing season in the year of establishment. Note, an additional over-spray with 2 Litres of simazine per ha in the first summer may be required if there is sufficient summer rainfall to germinate weeds.

Second year weed control consisted of an over-spray of 3 Litres of simazine per ha after rainfall (sufficient to germinate weeds) in mid May.

A blanket spraying regime was employed and covered a width of 5m.

Planting method - 'pottiputki' hand planters were used. This method allowed excellent control over planting depth, seedling placement and soil compression around the seedling. Seedlings were planted slightly to one side of the rip line to minimise possible air pocket exposure of seedling roots and waterlogging.

Layout of surface water drainage structures:

Figure 4.

Surface water drainage on flat valley floor areas helps reduce recharge. View shows a surface water 'W' drain designed to link up ponded areas. Surface water drainage was planned and implemented in advance of designing the revegetation approach. Note that the 'W' drain is flat based and has a shallow channel. This is to ensure effective water transport without causing erosion.

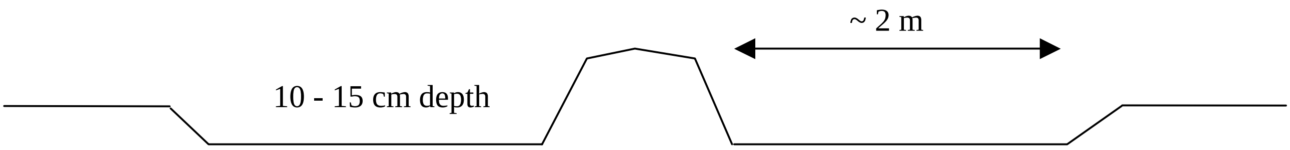

Figure 5. Cross sectional profile of the above 'W' drain. Note that surface water can enter from both sides of the drain.

Layout of revegetation:

Figure 6.

Viewing down a 30 m wide cropping alley, bordered with a 'hedge' layout of three year old eucalypt mallees.

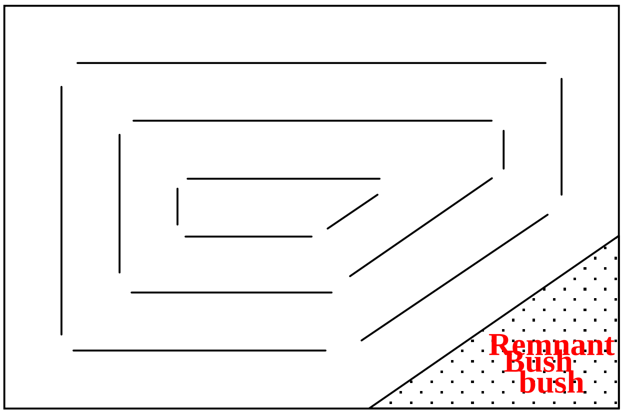

Figure 7.

Conceptual 'spider web' layout used at this site, allowing minimal disruption to paddock cultivation.

Figure 8.

Close-up of a one year old mallee 'hedge'. The juvenile foliage shown is characteristic of smooth barked york gum (*Eucalyptus loxophleba* subsp. *lissophloia*). Note the prepared surface is at ground level (allowing surface water flow), and free from obstructions such as boulders (allowing safe tree harvesting operations.

Monitoring:

Establishment

Establishment success - plant counts and general health of seedlings.

Management

Weed cover and type - monitor during the year of planting including the first summer and second year.

Grazing - ensuring mallees receive the best possible establishment conditions, eg excellent site preparation and weed control, high quality seedlings and correct planting will greatly influence the time period of grazing restrictions.

When reintroducing stock to the area, after about 1 year, monitoring for excessive damage to mallees is necessary. However, light grazing of vigorously growing mallees is unlikely to be a problem.

Outcomes

Nature conservation

Fauna utilisation of site - record bird species utilising site.

Buffering of remnant bush boundary - this will depend on the closeness of the first 'hedge' of mallees to the remnant bush and also the harvesting regime of the first 'hedge'. Even if initially harvested at the usual regime, opportunity exists to increase the harvest time interval of the first 'hedge' at some point in the future.

Agriculture

Ground water use - monitor revegetation growth rates (leaf area index) as a measure of water use.

Ponded water - record the extent of reduced area of water ponding.

Water table depth - use piezometers to record effect of mallees - directly under a 'hedge', in the middle of a cropping alley and in a similar untreated area.

Improved cropping alley microclimate conditions - It is expected that crop and pasture alleys will receive a degree of physical protection. This may translate into yield differences in particularly harsh seasons.

Stock protection - sheep at this site are often found along the edges of mallee 'hedges' in extreme weather conditions. Mallees provide for a cool microclimate in hot weather and provide protection from cold wind. Recorded observations and photos can be used to document isolated events.

In Brief – Cost of establishment per ha (2000)

Materials and activities	Options ($ per ha)	[1]Totals
Smooth barked york gum seedlings @ 34c each and @ 400 per paddock ha.	**$136.00 per paddock ha**.	
Ripping – D8 Dozer @ $210.00 per hour. Single 3PL tractor ripper[2].	@ 4 km per hour (single tine), and @ 0.6 km per paddock ha = **$30.00 per paddock ha**. Requires high horse power, traction and an extremely heavy-duty ripper (~ $20 per paddock ha).	
<u>Weed control</u> 1st application:1 L glyphosate and 3 L of simazine per ha. 2nd application: 2 L of simazine per ha over-spray. 3rd application: 3 L of simazine per ha over-spray (second year weed control).	 **$3.60 per paddock ha** + contract spray rate. **$1.80 per paddock ha** + contract spray rate. **$2.70 per paddock ha** + contract spray rate.	
Planting @ 10c each (contract rate) @ 400 per paddock ha.	**$40.00 per paddock ha**	

1 Totals are left blank intentionally. This is to allow for individual choice of options.

2 If soil is very hard, this activity can place excessive strain on the tractor.

In Brief – multiple objectives achieved

Nature conservation	❖ Use of a regional (same botanical district) native species (no potential for weedy species status). ❖ Regional native species integrated within the farming system. ❖ Buffering of remnant bush from water table rise. ❖ Indirect buffering of remnant bush from wind borne weed seeds, herbicide, pesticide and fertiliser. ❖ Provision of a limited food resource
Ecosystem processes	❖ Ability to maintain water use, given current landscape threats. ❖ Increase in water infiltration where it falls and a substantial increase in annual rainfall water use.
Agricultural land use	❖ Reduction in valley floor recharge and thus, risk of loss of traditional production from rising ground water. ❖ Provision of a degree of physical protection to agricultural land and stock. ❖ Mallees provide a short rotation bulk resource for prospective income generation. ❖ Mallees easily integrated into the existing farming system and managed as another crop. ❖ Mallees provide vastly improved aesthetic value to the agricultural landscape.

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