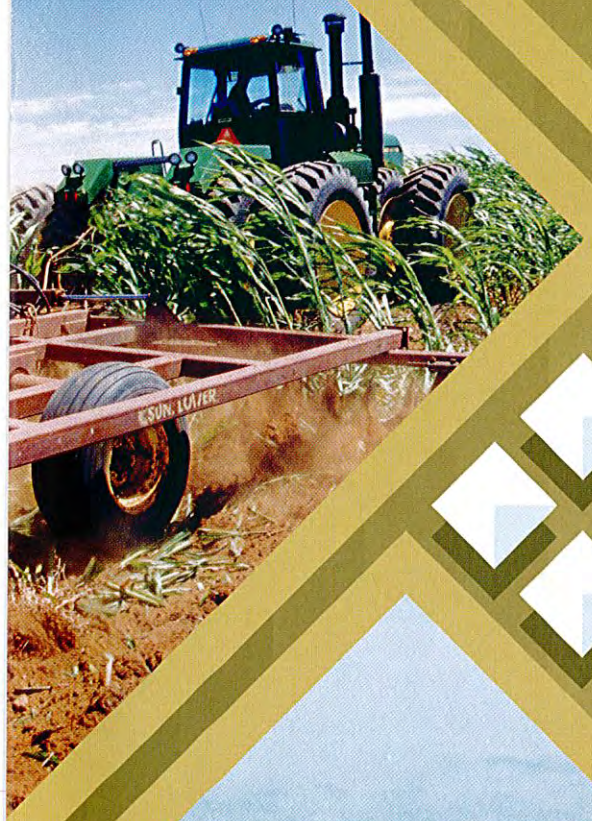
Natural Resource Management in Western Australia

Salinity:
A guide for land managers

March 2000

Government of
Western Australia



STATE
SALINITY
COUNCIL

A range of landcare treatments is being used on this Morbinning farm. Photo: Landcare Vision

Salinity: A guide for land managers

Introduction

Salinity is the greatest environmental threat facing Western Australia – 1.8 million hectares in the south-west agricultural region are affected by salinity to some extent. Projections show that without rapid, large-scale activity, including significant changes to current land use practices, about three million hectares will be affected by 2010-2015 and six million hectares, or 30 per cent of the region, will be affected by the time a new groundwater balance is reached.

The area of salt-affected land has already had a serious impact on biodiversity, current and future water supplies, agriculture and regional infrastructure, including roads, rail, public and private buildings, water and wastewater facilities. The impact is potentially enormous if the area at risk is allowed to become saline. Without large-scale activity, 450 plant species native to the region will become extinct; up to $400 million per year will be lost in agricultural production by 2050; and there will be increased flood risk in many areas.

Something can be done and should be done quickly. Combinations of higher water use farming systems have already been adopted, including a range of phase farming options and perennial tree and shrub crops. These are being complemented by catchment-scale surface water management options, while other engineering tools are addressing discharge techniques. Many land managers are also protecting and enhancing remnant native vegetation, and revegetating land for biodiversity conservation and commercial returns. Opportunities to use land and water affected by salinity are also developing, with some promising outcomes.

This guide provides an overview of the tools available for land managers to manage salinity at the farm and catchment scale, and is a component of the Western Australian Salinity Strategy. The Strategy emphasises the need for actions to be undertaken across a wider area, and more quickly, than anticipated in the 1996 Salinity Action Plan.

The guide should be used by land managers and groups as an initial reference point when considering the range of options available to address salinity – many more groups than can be listed here are involved in salinity management. Details on where to find further information on the tools available are provided.

None of the options listed here should be considered in isolation. Catchment groups and individuals will need to implement a combination of activities to manage salinity in their area effectively. The treatments listed in this document are directed at the landscape scale and across farm boundaries.

The agricultural region will not be affected uniformly, so the tools to address salinity will differ according to the catchment and the rainfall zone in which they are being implemented.

Alex Campbell
Chairman, State Salinity Council

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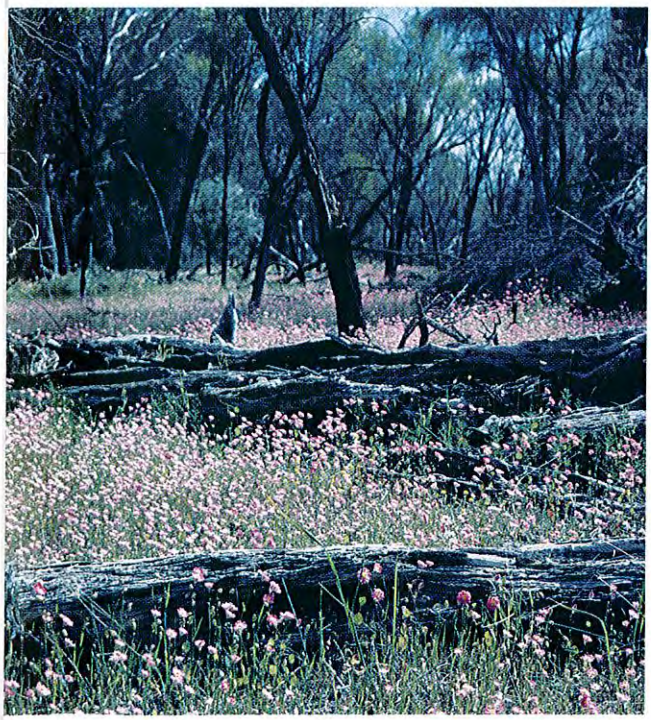

York gum and everlastings at Arthur River.
Photo: Department of Conservation and Land Management

These options are indicative only – for more detail, contact the relevant agency, production group or regional catchment group in your area. For maximum benefit and control of recharge and discharge, an integrated approach is advised.

Shading indicates the options currently under research or trial.

Changing agricultural practices

Cropping options

Lower recharge farming systems

Benefits

New farming systems that include a considerable area of deep-rooted perennial species use more groundwater than traditional annual cropping systems and are the best way of reducing recharge through cropping options.

There are also farm productivity benefits.

Requirements/Conditions

The effectiveness of high performance annual crops and pastures in reducing recharge varies with soil type and climate.

It is important to keep in mind that perennial pastures are relatively shallow rooted compared with native species and are less effective in controlling recharge from episodic events such as large storms and very wet winters. They may not balance recharge on areas of poor fertility or poor soil structure, such as deep white sands.

Technical resources
(and activities in progress)

Western Australian No-Tillage Farmers' Association (WANTFA) Newsletter
WANTFA field days and seminars

A current collaborative project between GRDC, UWA and AGWEST is investigating the use of perennial legumes as a means of controlling recharge and reducing watertables under crop/pasture rotations.

A joint GRDC and AGWEST project to develop cropping systems with lower recharge for the less than 600mm rainfall zones began in spring 1999. The project is looking at incorporating perennials, probably lucerne, into a phase cropping system. It will also develop simple best practice management guidelines for farmers targeting recharge.

WANTFA is also looking at phase farming.

Initial contacts

Western Australian Lucerne Growers' Inc
C/- Lisa-Jane Blacklow,
AGWEST, Katanning
Phone: 9821 3333

Bill Porter, Project Manager,
AGWEST, Northam
Phone: 9690 2000

Western Australian No-Tillage Farmers' Association (Inc)
Bill Crabtree (Scientific Officer)
Mobile: 0417 223 395 Phone/Fax: 9622 3395

Cropping options

Soil amelioration

Benefits

Addressing problems such as acid soils, poor soil structure and water repellence in non-wetting soils improves crop and pasture productivity and in turn increases water use and decreases recharge.

Soil amelioration has other benefits. For example, overcoming water repellence in non-wetting soils also increases moisture infiltration, allows even wetting of the soil and even weed germination, controls wind erosion, retains nutrients and increases microbial activity.

Requirements/Conditions

– *Acid soils*

Many soils in the agricultural regions of WA are becoming more acidic due to leaching of fixed or applied nitrogen from the root zone and removal of produce (grain, hay, grazing) from the paddock. Light textured soils acidify faster than heavier textured soils. Soil acidity is tested using a calcium chloride pH test on the soil.

Lime can be used to improve the pH of acid soils if topsoil or subsoil pH values are low. Recommended rates of lime application range from 1 to 2 tonnes per hectare every 7 to 10 years depending on the soil type, rainfall and production practices.

It is important when comparing lime sources to consider the neutralising value and particle size of the product. The higher the neutralising value and the smaller the particle size the more quickly the product will act to amend low soil pH.

– *Soil structure decline*

Cultivation and trampling by stock on heavy soils, especially under adverse moisture conditions, can cause aggregate breakdown and soil compaction. This results in reduced rainfall infiltration, poor soil aeration, reduced seedling emergence and root growth and increased run-off.

Soil structure may be improved by incorporating organic matter, such as using minimum/zero tillage and green manuring (still experimental in WA), and the application of gypsum. Additional nitrogen may also be required in order to get a yield response from gypsum application.

– *Water repellence in non-wetting soils*

Caused by waxes, alkanes and fatty acids left behind in the breakdown of organic matter. Generally only occurs in the top 100mm cultivated layer as soil below wets up easily due to the lack of organic matter. Most water repellent soils have a clay content of <1%.

Application of a clay subsoil to the non-wetting soil increases the ability of these soils to accept water. 100t/ha of subsoil with 30% clay content mixed into the top 100mm increases the clay content of the cultivated layer to 3 to 4%.

Technical resources
(and activities in progress)

AGWEST website: **www.agric.wa.gov.au**

Initial contacts

Acid soils
Amanda Miller
AGWEST, Lake Grace
Phone: 9865 1205

Soil structure
Greg Hamilton
AGWEST, South Perth
Phone: 9368 3276

Water repellence
Rob Hetherington
AGWEST, Albany
Phone: 9892 8444

Cropping options

Warm season crops

Benefits

Growing warm season crops increases water use beyond the traditional growing season. Combined with no till and full stubble retention, farmers are now seeing dramatic improvements in crop yields and crop water use efficiency from these wider-rotation cropping systems.

Requirements/Conditions

Rainfall zone does not appear to be important; the limiting factors are moisture availability and soil type. Potential will be particularly high in areas where winter crops have failed due to waterlogging and moisture availability over summer is still high.

Best planted before September – November. Later planting may not allow enough water availability and heat units for grain crops to mature properly.

Best results so far have been achieved in all areas of the State with sorghum, sunflowers and safflower. Fodder crops show greater promise than grain crops.

Avoid fallowing to reduce the risk of moisture draining past the root zone and into the deep groundwater system.

Initial contacts

Western Australian No-Tillage Farmers' Association (Inc)
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Western Australian Lucerne Growers' Inc
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AGWEST, Northam
Phone: 9690 2000

Tim Wiley, AGWEST, Jurien Bay
Phone: 9652 2225

Green manuring with sorghum. Photo: Agriculture Western Australia

Pasture options

Lucerne

Benefits

Lucerne is a perennial pasture with a deeper root system than that of annual pastures. This means it uses water year round and takes water from deeper in the soil profile, in turn increasing water use and decreasing recharge.

Lucerne also provides high quality and reliable fodder to replace supplementary feeding over the late summer to early winter period.

Requirements/Conditions

Lucerne grows in a wide range of soil types with the following criteria:

- annual rainfall greater than 250mm (10");
- pH greater than 4.8 (in $CaCl_2$), surface and subsurface;
- well-drained;
- low weed burden.

Lucerne is able to survive extended drought periods by becoming dormant in times of insufficient soil water and it also grows in marginally saline soils provided they are not waterlogged.

There are some establishment problems on non-wetting soils and it is not good in shallow soils.

Lucerne should be grown on large areas for existing stocking systems – small areas of lucerne require careful stock management. It requires rotational grazing and may be cut opportunistically for hay.

Technical resources
(and activities in progress)

Western Australian Lucerne Growers' Inc (WALG)
On-ground Assistance Package

WALG field days and seminars

AGWEST Farmnote 4/98 "Dry land lucerne – establishment and management"

Initial contacts

Western Australian Lucerne Growers' Inc
C/- Lisa-Jane Blacklow, AGWEST, Katanning, Phone: 9821 3333

Other perennial pastures

Benefits

As for lucerne.

Technical resources
(and activities in progress)

Fact sheet for rapid evaluation of perennial pasture options.

Various perennial pasture options are being trialed across the agricultural region. Best production has been on moisture gaining sites (specific niches), as perennial grasses are summer active and winter dormant.

AGWEST is working with West Midlands producers who are looking at forming a growers' group concentrating on summer crop and perennial grass options.

Initial contacts

AGWEST, Northam
Phone: 9690 2000

Tim Wiley, AGWEST, Jurien Bay
Phone: 9652 2225

Fodder shrub options

Tagasaste

Benefits

As for lucerne.

Planting deep-rooted and longer growing season species of annual pastures such as cadiz seradella in between rows of tagasaste, further increases water use and stock production on these sites. The profitability of beef cattle enterprises can be improved with areas of tagasaste.

Requirements/Conditions

Requires rainfall >300mm (>12") per year and deep, well-drained soils, with best results in soils with pH 4.8 to 6.0 ($CaCl_2$). Can also be suitable on more fertile, deep yellow sands.

Soil variation in a paddock of tagasaste results in uneven grazing with the lightly grazed areas becoming less productive and palatable in subsequent seasons.

Can be used for alleys with cropping in between. Block planting is most suitable on deep infertile soil and alley farming is best on stronger, yellow sands.

Tagasaste does not tolerate waterlogging and should not be planted in areas where the watertable is regularly <1m from the surface.

Can be planted as bare-rooted seedlings or seed. Pest (insects and rabbits) control is critical.

Technical resources
(and activities in progress)

AGWEST Bulletin 4291, "Tagasaste", June 1994

Initial contacts

Tim Wiley, AGWEST, Jurien Bay
Phone: 9695 2225

Emma Davies, AGWEST, Gingin
Phone: 9575 3014

Sheep grazing in a paddock of tagasaste. Photo: Agriculture Western Australia

Fodder shrub options

Acacia saligna

Benefits

On sites where saligna is successfully grown, it tends to find a niche as a windbreak and shelterbelt rather than a fodder shrub.

Requirements/Conditions

Establishment of *Acacia saligna* has been successful on similar sites to tagasaste.

Anecdotal evidence reveals mixed results with saligna, suggesting that there is wide variation in palatability and digestibility within the species. On-going management has not been compatible with tagasaste. In some cases saligna has been eaten out preferentially to tagasaste in mixed stands. In other cases, saligna has become woody and unpalatable with lower nutritional value than tagasaste. A consistent concern with *Acacia saligna* is its short life span (usually 8 to 10 years). If saligna is to be grown as a fodder shrub, it should be grown on separate sites to tagasaste to avoid incompatible management problems resulting from differing grazing pressures.

Saltbush

Benefits

Some land managers have success using saltbush species such as river saltbush on non-saline land to increase the variety of fodder shrubs being planted on these sites. See page 15 for benefits of saltbush on saline lands.

Requirements/Conditions

On non-saline sites, higher productivity is obtained from non salt-tolerant species.

Saltbush growing successfully on salt-affected land. Photo: Landcare Vision

Benefits Freshwater aquaculture allows productive use of excess water.

Yabbies (most proved species)

Requirements/Conditions Yabbies may be farmed in all areas north of Perth and in areas south of Perth to the east of an ecological boundary which is defined by the inland margin of State forest. Yabbies are not to be farmed in the south-west because of the risk to unique freshwater ecosystems and the biodiversity of the aquatic fauna found there.

Yabbies survive a temperature range of 1 to 30°C (optimum 24°C) with growth occurring in temperatures of 15 to 34°C. They require a water salinity level <8 parts per thousand (ppt) and may be farmed in existing farm dams or purpose built ponds.

Technical resources *(and activities in progress)* Fisheries Western Australia has an extensive website covering all aquaculture options in Western Australia at:
www.wa.gov.au/westfish/aqua/ index.html#AQWA

Initial contacts Craig Lawrence, Fisheries Western Australia
Phone: 9246 8415

Marron

Benefits Marron is the highest value freshwater crayfish in Australia.

Requirements/Conditions Marron grows best from Geraldton to Esperance along the coast where it is a bit cooler.

They tolerate salinities of 0 to 15ppt but optimum is 6 to 8 ppt. They survive in a temperature range of 1 to 30°C (optimum 24°C) and may be farmed in existing farm dams or purpose built ponds.

The biggest problem is increasing production enough to meet existing demand.

Technical resources *(and activities in progress)* Fisheries Western Australia has an extensive website covering all aquaculture options in Western Australia at:
www.wa.gov.au/westfish/aqua/ index.html#AQWA

Initial contacts Craig Lawrence, Fisheries Western Australia
Phone: 9246 8415

Benefits

Commercial farm forestry introduces deep-rooted perennial vegetation which not only uses water year round, but also accesses water from deeper in the soil profile. It is very successful at increasing water use and decreasing recharge. Commercial farm forestry also provides an opportunity to diversify farm income. The economic benefits available could include carbon credits.

Radiata pine (Pinus radiata)

Requirements/Conditions

Radiata requires a >600mm/year (24") rainfall and grows well on a wide range of sites. It prefers deep, well-drained soils with high water holding capacity. Saline areas should be avoided.

Fire should be excluded. Ground fuel loads can be managed by grazing once trees are above vulnerable height.

Radiata is suited to block plantings or agroforestry layouts. There are well developed markets for all products from thinning and final harvest (metro and south-west).

Thinnings (posts, chiplogs) can start at year 10 with final harvest at year 25 to 30.

Joint venture schemes to finance tree establishment are currently unavailable.

Technical resources
(and activities in progress)

TreeNotes (TreeNotes and other WA farm forestry information can be found at **www.agric.wa.gov.au/programs/srd/farmforestry/**)
Consultants
Expertise within CALM

Initial contacts

Farm Forestry Advisory Service (phone numbers) –

CALM Busselton:	9752 1677		
AGWEST Albany:	9892 8444	AGWEST Manjimup:	9771 1299
AGWEST Bunbury:	9780 6100	AGWEST Midland:	9274 5355

Maritime pine (Pinus pinaster)

Requirements/Conditions

Maritime pine is suitable for deep sands and deep sandy gravels in areas wetter than 400mm/year (16"). The species is more fire tolerant than radiata.

Existing markets are similar to those for radiata. Thinnings (posts, chiplogs) can start at year 15 and final harvest occurs at year 30 to 35. A joint venture scheme is available to finance tree establishment.

Technical resources
(and activities in progress)

TreeNotes (TreeNotes and other WA farm forestry information can be found at **www.agric.wa.gov.au/programs/srd/farmforestry/**)
Expertise within CALM
CALM Sharefarms joint venture

Initial contacts

CALM Sharefarms (phone numbers) –

Midwest:	9279 4088	South Coast:	9842 4530
Lower West:	9734 1688	Esperance:	9071 3733

Pinetec – Gary Hartnett, Phone: 9377 1006 Mobile: 0409 988 905

Tasmanian bluegum (Eucalyptus globulus) for pulpwood

Requirements/Conditions

Tasmanian bluegums are suitable for deep soils (but not deep sands), above 700mm (28") rainfall with low evaporation (lower south-west and Great Southern).

Soils should be deeper than 3.5m to an impenetrable layer. Drought deaths occur on sites with low effective rainfall and/or shallow soil.

Tasmanian bluegum is not tolerant of waterlogging or salinity.

Harvest occurs at age 8 to 12 years.

Several joint venture schemes are available to finance trees.

Pulpwood is exposed to international market prices.

Technical resources
(and activities in progress)

TreeNotes (TreeNotes and other WA farm forestry information can be found at **www.agric.wa.gov.au/programs/srd/farmforestry/**)
Farm forestry advisers
Consultants
Joint venture companies

Initial contacts

Farm Forestry Advisory Service (phone numbers) –

CALM Busselton:	9752 1677	AGWEST Bunbury:	9780 6100
AGWEST Albany:	9892 8444	AGWEST Manjimup:	9771 1299
AGWEST Midland:	9274 5355	AGWEST Gingin:	9575 3002

Joint venture companies – Bunnings Treefarms, Phone: 9771 7222
Integrated Tree Cropping, Phone: 9842 1389

CALM joint venture schemes – Lower West Sharefarms, Phone: 9734 1688
South Coast Sharefarms, Phone: 9842 4530

Maritime pine growing as a commercial crop on previously cleared farmland. Photo: Department of Conservation and Land Management

WA eucalypts for sawlogs (suitable for rainfall >450mm)

Benefits

Better management of remnant native forest and woodland improves regeneration and timber growth.

Requirements/Conditions

Management for multiple uses provides income and enhances biodiversity. Management and harvesting regimes for private native forest are not well developed for all forest and woodland types.

Requirements for harvest permission vary from shire to shire.

Technical resources
(and activities in progress)

Farm forestry advisers
Consultants

Initial contacts

Revegetation on Farms Project, AGWEST, Narrogin
Phone: 9881 0222

Eastern states eucalypts for sawlogs and other species

Suitable species depending on soil type and rainfall include:

Tasmanian bluegum *(E. globulus)*
Sydney bluegum *(E. saligna)*
Spotted gum *(Corymbia maculata)*
Flooded gum *(E. grandis)*
Southern mahogany *(E. botryoides)*
Sugar gum *(E. cladocalyx)*
Red ironbark *(E. sideroxylon)*
River red gum *(E. camaldulensis)*

Benefits

Deep-rooted perennial vegetation has the ability to increase water use and decrease recharge. It provides an opportunity to diversify farm income from products that may include carbon trading.

Requirements/Conditions

Eastern states eucalypts require a rainfall of >500mm (20") and have less demanding site requirements than for pulpwood plantations (grown at wider spacing). Some species have poor form on WA sites – careful selection is needed.

Thinnings for posts or pulpwood can start after 8 to 10 years, small sawlogs after 15 years, large sawlogs 20 to 40 years depending on site and management.

Some fast-grown timbers suffer from growth stresses and tension wood (which may reduce the recovery of high grade timber).

Markets are not yet well developed in WA for eastern states' timbers, but demand is expected to grow, as supply grows.

No joint venture schemes are currently available to finance trees.

Technical resources
(and activities in progress)

Farm Forestry Advisory Service (FFAS)

FFAS TreeNotes (TreeNotes and other WA farm forestry information can be found at **www.agric.wa.gov.au/programs/srd/farmforestry/**)

AGWEST Factsheets

Information kits are also available (for a fee) on species including oil mallee, olives, maritime pine, sandalwood and jojoba.

AGWEST website: **www.agric.wa.gov.au/programs/srd/farmforestry**

CALM website: **www.calm.wa.gov.au/projects/tree_crop.html**

Timber Advisory Notes (describing the wood properties of 39 types of timber on the Australian market)

Growing methods are still being refined (but 15-year-old demonstration sites are performing very well).

Studies indicate that the young eucalypt logs can be milled and seasoned satisfactorily.

A joint CALM and AGWEST project to examine the selection and development of multiple purpose species for large-scale revegetation is being funded by the NHT's Farm Forestry Program. The project will initially focus on the genera *Eucalyptus*, *Melaleuca*, *Acacia* and *Allocasuarina*. Species selection will include likely prospects from most of the seven categories for potential products (sawn timber, reconstituted wood, extractives, fibre, carbon, chemicals and energy).

Initial contacts

Farm Forestry Advisory Service (phone numbers) –

CALM Busselton:	9752 1677	AGWEST Bunbury:	9780 6100
AGWEST Albany:	9892 8444	AGWEST Manjimup:	9771 1299
AGWEST Midland:	9274 5355	AGWEST Gingin:	9575 3002

AGWEST Revegetation on Farms Project
Narrogin, Phone: 9881 0222

CALM Timber Technology Centre, Harvey, Phone: 9729 1913

CALM Farm Forestry Unit, Como, Phone: 9334 0322

Timber Advisory Centre, Wembley, Phone: 9380 4411

Oil mallees

Benefits

Oil mallees are being developed as a commercial tree crop for the Wheatbelt. Many species are being planted, most of them native to the Wheatbelt. They are tough, adaptable, fire and grazing tolerant. They can be planted in alley layout without fencing, but require some protection from grazing in the first two years.

Mallees are a short rotation crop and can be repeatedly harvested on a 2 to 3 year cycle. Regular harvest keeps them in a permanent coppicing mode of growth and they are surprisingly productive.

Oil mallee seedlings. Photo: Department of Conservation and Land Management

Oil mallees (continued)

Requirements/Conditions

There are oil mallee species suitable for all Wheatbelt soil types and rainfall up to 600mm (24"). The Oil Mallee Association has managers in most parts of the Wheatbelt to advise on site and species selection. Oil mallees can be integrated into the farming landscape as block plantings or tree belts.

Commercial potential is increased by concentrating plantings locally to reduce the overhead cost of harvest.

Commercial harvest has not yet begun. A feasibility study has shown that mallee feedstocks going into an "integrated mallee processing" factory could profitably produce eucalyptus oil, activated carbon and electricity while paying the farmer a wheat-competitive price for the mallee.

Technical resources
(and activities in progress)

Oil Mallee Association quarterly newsletter

AGWEST "Oil Mallees Information Kit"

AGWEST Trees in Agriculture website:
www.agric.wa.gov.au/progserv/natural/trees/

A $5 million pilot factory to test "integrated mallee processing" is being planned for Narrogin.

Initial contacts

Oil Mallee Association of WA (Inc) –
Ric Collins (Administrator), Chris Richardson, Jason Menzies
Phone: 9478 0330

CALM Farm Forestry Unit, Phone: 9334 0322

AGWEST Revegetation on Farms Project, Narrogin
Phone: 9881 0222

Carbon credit trading

Benefits

The potential for carbon credits and greenhouse emission trading could add extra returns to revegetation options.

Requirements/Conditions

Trees and other woody perennial vegetation absorb carbon dioxide from the atmosphere during photosynthesis, and the carbon is "sequestered" into the plant, creating what is known as a "carbon sink". Under the terms of the United Nations Framework Convention on Climate Change, and the associated Kyoto Protocol, growers may be able to obtain financial credit for increasing such sinks, particularly those established on agricultural land after 1990. However, until the protocol is ratified and the international and domestic rules for carbon trading are resolved (which may take many years), no guarantees can be given about the price (if any) for carbon credits.

Transaction costs would preclude small parcels of vegetation and favour cooperative or corporate bodies.

Technical resources
(and activities in progress)

"Farming carbon" – extract from CALM's LANDSCOPE magazine

Initial contacts

CALM's Plantation Group, Phone: 9334 0463

Productive use of saline lands

Saltland plants

Benefits

The most beneficial saltland pasture systems contain a mixture of perennial and annual species and become "functional mimics " of the original ecosystem. The major role of the perennial (saltbush, wattle or tall wheat grass) is to lower the watertable enabling the growth of less salt-tolerant species, such as balansa, which provide high quality fodder for grazing animals.

Requirements/Conditions

For WA, adapted salt and waterlogging tolerant species occur within the genera *Atriplex* (saltbushes), *Puccinellia*, *Elytrigia*, *Acacia*, *Melaleuca*, and *Casuarina*.

Saltbushes are best suited for areas receiving an average rainfall of 300 to 400 mm/year (12-16"). Wattle (*Acacia saligna*) and tall wheat grass (*Elytrigia elongata*) will be better suited to wetter areas (450 to 550 mm/year, or 18-22").

Choice of species will vary depending on rainfall and local levels of soil salinity and waterlogging and inundation risk. Grazing control is critical so that perennials can develop and maintain leafy canopies that transpire water in summer, and annuals are able to establish, flower and set seed. Grazing management will also determine the legume/grass ratio in the annual component.

Depending on the choice of "perennial groundwater pump", grazing may need to be forgone for a number of years to allow establishment. With fodder shrubs, grazing can commence within 2 years; with slower growing trees grazing may only be possible after 5 to 10 years.

Plant survival on saltland is affected by changes in salt accumulation in the root zone, waterlogging and inundation.

Production from annual legumes depends on soil fertility (especially phosphorus and potassium) and insect control. Plantings must be laid out so that the annuals can be fertilised and sprayed.

Technical resources
(and activities in progress)

"Saltland Pastures in Australia: A Practical Guide" by E.G. Barrett-Lennard and C.V. Malcolm, AgWA Bulletin 4312

"Saltland Pastures – Options and constraints" – Michael Lloyd, and "Saltland Pastures? They are feasible and sustainable – we need a new design" – E.G Barrett-Lennard and M. Ewing. Papers from the published proceedings of the 5th National PURSL Conference Tamworth NSW, Australia 9-13 March 1998.

Major products for some of these species are still to be developed. Potential uses are likely as pastures, in carbon trading, and in the production of biomass, speciality timbers, essential oils and other organic products.

Initial contacts

Dr Ed Barrett-Lennard, AGWEST
Phone: 9368 3278

Saltland Pastures Association
Michael Lloyd – Chairman
Phone: 9871 2041

Productive use of saline water

Saline aquaculture

Benefits

Saline aquaculture is a productive option for the safe storage of saline water.

The development of a viable saline aquaculture industry could also increase the potential for tourism in rural areas.

Rainbow trout

Requirements/Conditions

Trials have used existing water bodies such as soaks, ponds, dams and small lakes. The most suitable water bodies are likely to have:

- fairly shallow water (1 to 2m deep);
- salinity between 5ppt and 30ppt;
- maximum water temperature of 18°C during growing period (April/May to October/November);
- pH between 6 and 10;
- aquatic weed (such as ruppia) for shelter and food.

Technical resources
(and activities in progress)

Trials using rainbow trout as a lead species began in 1998. At this stage there is no existing industry or infrastructure and little or no experience in production, processing or marketing.

Fisheries WA and AGWEST are working together to develop commercial aquaculture in inland saltwater through the Outback Ocean Project. Landowners interested in participating in trials are invited to join the project.

Initial contacts

Jasper Trendall, Aquaculture Projects Officer
Fisheries WA, Phone: 9841 7766

Peter Lacey
AGWEST, Merredin
Phone: 9081 3111

Black bream

Benefits

Fishing pressure on natural populations of black bream could be reduced through aquaculture.

Requirements/Conditions

An initial study by Murdoch University shows that black bream is an excellent candidate for stocking saline inland water bodies with the following conditions:

- salinity in the water body >3ppt throughout the year;
- a water body that is not subject to eutrophication due to excessive nutrient runoff;
- there is protection from predation by cormorants.

Technical resources
(and activities in progress)

Fisheries WA "Aquaculture WA – Farming Black Bream" No.10 in a series

Trials are continuing to determine the suite of conditions, in inland water bodies, that are required for rearing black bream to a size that is suitable for angling and to be able to demonstrate to potential stockers of black bream that such fish can be readily caught on rod and line.

Initial contacts

Dr Gavin Sarre
Murdoch University
Phone: 9360 6335

Fisheries WA
Pearling and Aquaculture Program
Phone: 9482 7333

Native vegetation management

Benefits

Improving the health and diversity of remnant vegetation improves water use and lowers recharge. This also helps prevent other areas within the catchment from becoming saline. Protecting remnant vegetation also provides habitat for native fauna and maintains biodiversity.

Economic benefits are possible through such activities as wildflower picking.

Requirements/Conditions

Planning is important to minimise the threats to biodiversity and maximise economic benefits. Proper planning and implementation of appropriate native vegetation protection and management techniques (such as weed control) will protect and enhance native vegetation and habitats.

Fencing subsidies are available for remnant vegetation management through such schemes as the Remnant Vegetation Protection Scheme, State Revegetation Scheme and the Natural Heritage Trust (NHT funding for fencing is available only as part of a bigger project). Other management actions may be funded by organisations such as the Blackwood Basin Group.

Technical resources
(and activities in progress)

Bushcare, Land for Wildlife and Greening Australia (WA) can provide useful advice on managing remnant vegetation on private land. Many volunteer and community groups are also actively involved in native vegetation management.

CALM Wildlife Notes

"How to manage your granite outcrops" (CALM)

"How to manage your wandoo woodland" (CALM)

"Managing your bushland" (CALM)

Land for Wildlife's "Western Wildlife" quarterly magazine

"Managing Dieback in Bushland" (jointly produced by Shire of Kalamunda, Dieback Working Group, NHT, Bushcare and CALM)

Bushcare technical notes

Initial contacts

Regional Bushcare Facilitators
(phone numbers) –

Southwest:	9725 5909
Northern agricultural:	9921 5955
South Coast:	9842 4519
Swan:	9474 7052

Land for Wildlife officers (phone numbers) –

Coordinator, CALM Como:	9334 0530
Merredin:	9041 2488
Narrogin:	9881 9218
Bridgetown:	9761 2318
Mundaring:	9295 1955
Busselton:	9752 1677
Albany:	9842 4500
Newdegate:	9871 1791
Coorow:	9952 1074

Greening Australia (WA),
Phone: 9481 2144

Yellow eyebright.
Photo: Department of Conservation and Land Management

Native vegetation management

Protecting streamlines

Benefits

Riparian zone (any land which adjoins or directly influences a body of water) buffers are important salinity control zones in WA where groundwater of moderate salinity is at or close to the streambed.

Riparian buffer strips with deep rooted perennial vegetation help lower the watertable in conjunction with other landcare activities and reduce the flow of salt into streams from sub-surface flow.

Protecting streamlines and their riparian zones is also important to reduce bank erosion, decrease sedimentation, improve water quality and conserve in-stream ecology.

Requirements/Conditions

Management options include reduced clearing, revegetation, alteration of stocking rates and fencing off riparian areas.

Technical resources
(and activities in progress)

A series of Water Notes covering the identification, value and protection of riparian vegetation is currently under production by the Water and Rivers Commission. There are also plans to produce regionally specific guides to revegetation.

CALM Wildlife Notes

Initial contacts

Waterways WA Program Coordinator, Water and Rivers Commission
Phone: 9278 0300

Waterways WA Program Officers (phone numbers) –
Midwest/Gascoyne/South West: 9278 0370
Swan/Goldfields/Agricultural/South Coast: 9278 0379

Waterways WA Program Regional Rivercare Officers (phone numbers) –
Swan/Goldfields/Agricultural: 9220 5308 or 9220 5313
Midwest/Gascoyne: 9964 5978
South West, Bunbury: 9721 0646 or 9721 0631
South Coast, Albany: 9841 0118

Land for Wildlife officers (see page 17)

Planting to rehabilitate the headwaters of a stream. Photo: Simon Neville – Ecotones/Water and Rivers Commission

Native revegetation

Revegetation for nature conservation

Benefits

Revegetation to increase biodiversity can create a wildlife corridor linking areas of native fauna habitat, a buffer around existing remnants, or a habitat island within commercial revegetation.

Requirements/Conditions

Good planning is important to target recharge areas that will provide maximum benefits, as well as other strategic revegetation areas. Locally occurring native species, which are appropriate for soil type, should be used and the natural flora structure should be recreated.

Fencing subsidies are available to protect revegetation through such schemes as the Gordon Reid Foundation for Conservation, State Revegetation Scheme and NHT.

Technical resources
(and activities in progress)

Expertise within CALM

CALM Wildlife Notes and How to... books.

Initial contacts

Revegetation on Farms Project, AGWEST Narrogin
Phone: 9881 0222

Land for Wildlife Officers (see page 17)

Greening Australia (WA) provides information to groups to promote bush care
Phone: 9481 2144

State NHT Coordinator
Phone: 9325 0000, or 1800 198 231

State Revegetation Scheme
Executive Officer, Soil and Land Conservation Council
Phone: 9325 0000

Executive Officer, Gordon Reid Foundation for Conservation
Phone: 9340 5270, or 1800 655 270

Successful flooded gum regeneration after fencing to exclude stock. Photo: Water and Rivers Commission

Benefits

Excess surface water can be harvested to improve the reliability of on-farm water supplies. Increased water harvesting can be an effective way to create water resources for new farm enterprises such as aquaculture, horticulture or summer irrigation. Good design and planning of water management systems can reduce the incidence of seasonal waterlogging and inundation. Integrated water management designs can reduce the risk of flooding.

Requirements/Conditions

With any engineering works, the best methods to use will be very site specific and largely dependent on soil type and position in the landscape.

Engineering options should be used as just one component of an integrated catchment water management plan.

All engineering works must consider the following:

- safe disposal of water;
- potential off-site and downstream impacts;
- are your neighbours aware of and in agreement with your proposal?
- do you need to submit a Notice of Intent to drain?

Technical resources *(and activities in progress)*

AGWEST Technical Report 185: "Common Conservation Works Used in Western Australia" (Martyn Keen 1998)

"Avon Drainage Project" CD-Rom and website (under development)

Initial contacts

Land Conservation Officer at your local AGWEST office

AGWEST Catchment Hydrology Group, Phone: 9368 3333

Surface water management

Includes shallow drains, banks, waterways, floodways etc.

Requirements/Conditions

Surface water management usually consists of shallow interceptor drains or grade banks. It is mainly used for recharge management and soil degradation control. The earthworks are generally implemented on a whole of farm basis and should be integrated with catchment water management strategies.

The best design is shallow drains or banks built along grade lines channelling water into a series of dams or a stable, safe disposal point. Several rows of trees or shrubs planted on the lower side of the drains add to the resilience of the system.

Technical resources *(and activities in progress)*

AGWEST Technical Report 185: "Common Conservation Works Used in Western Australia" (Martyn Keen 1998)

"Avon Drainage Project" CD-Rom and website (under development)

Initial contacts

Dr Neil Coles, AGWEST
Phone: 9368 3333

John Ruprecht, Water and Rivers Commission
Phone: 9278 0300

Groundwater management

Deep drains

Deep drains are characterised as those >1.5m in depth and are notifiable under the Soil Conservation Act. Shallow drains and banks are not notifiable.

Requirements/Conditions

Deep drains are characterised by a focus on watertable and salinity management via drains constructed at depths of 1.5m or more.

Effective drainage design accounts for slope, soil type and hydrology and must reduce the risk of negative downstream impacts including flooding, waterlogging, erosion, sedimentation, salinity and eutrophication.

Deep drainage is most effective in limestone or stable sandy soils or in shallow clays over permeable formations i.e. saprolite grit (partly weathered material above the bedrock) and is normally placed at the break of slope in the landscape.

It is not effective in deep "tight" clay soils as they have low permeability and very low soil water transmission rates limiting the zone of influence around the drain.

Deep drains cost significantly more to build and maintain than grade banks. High net returns from crop improvements as a result of drainage are required to recoup construction costs.

Technical resources
(and activities in progress)

AGWEST Bulletin 4391 "An assessment of the Efficacy of Deep Drains Constructed in the Wheatbelt of Western Australia"

Initial contacts

Dr Neil Coles, AGWEST
Phone: 9368 3333

Contour bank to manage surface water. Photo: Landcare Vision

Groundwater pumping

Requirements/Conditions

Groundwater pumping refers to pumping from production bores drilled into deep saprolite grit (partly weathered material above the bedrock) or fractured bedrock or in some terrain, permeable sands.

The efficiency of production bores is highly dependent on the permeability of material at the screened depth (usually in the order of 20 to 30m deep).

Increasing the number of production bores within the system (optimum spacing calculated by hydrogeologist) will increase its effect in lowering watertables.

Technical resources
(and activities in progress)

"Reducing the Impacts of Salinity by Deep Groundwater Disposal in South Western Australia" (Alan Seymour 1999)

Initial contacts

Alan Seymour, AGWEST Katanning
Phone: 9821 3333

Relief wells

Requirements/Conditions

Relief wells involve groundwater flowing under pressure from a production well. The method requires knowledge of groundwater head conditions on site, which are best determined with a nest of piezometers.

The permeability of material at the screened depth (usually in the order of 20 to 30m) will determine the efficiency of relief wells.

The number of production bores within the system (optimum spacing calculated by hydrogeologist) will determine its efficiency in lowering water pressure.

Technical resources
(and activities in progress)

"Potential for Relief Wells to Reduce Secondary Salinity in the Southern Wheatbelt of Western Australia" (Alan Seymour 2000)

Initial contacts

Alan Seymour, AGWEST, Katanning
Phone: 9821 3333

Syphons

Requirements/Conditions

This system involves a self-priming syphon that "pumps" groundwater from a production or set of production bores.

A syphon production bore, or set thereof, is primed daily by a small groundwater pump and irrigation controller(s).

Efficient groundwater abstraction from syphon production bores is limited to bores with water levels less than approximately 4m below ground level located on topography gradients greater than approximately 3%.

Some groundwaters have a high level of dissolved gases that come out of solution when the pressure is released. This can quickly stop the syphon action.

Initial contacts

Alan Seymour, AGWEST, Katanning
Phone: 9821 3333

Monitoring and evaluation

Benefits

Monitoring the biophysical changes at a particular site or on an integrated catchment basis as a result of implementing a plan must be an integral part of the plan, so land managers can assess whether their activities are effective and make any necessary adjustments.

Requirements/Conditions

Monitoring requirements will be dictated by the objectives of the plan.

A minimal monitoring system should include watertable depths, change in percent cover and health of perennial vegetation, and change in farming practice. These measurements should complement the production/financial measurements taken for Crop Check, Paddock Action Planner and Business Check.

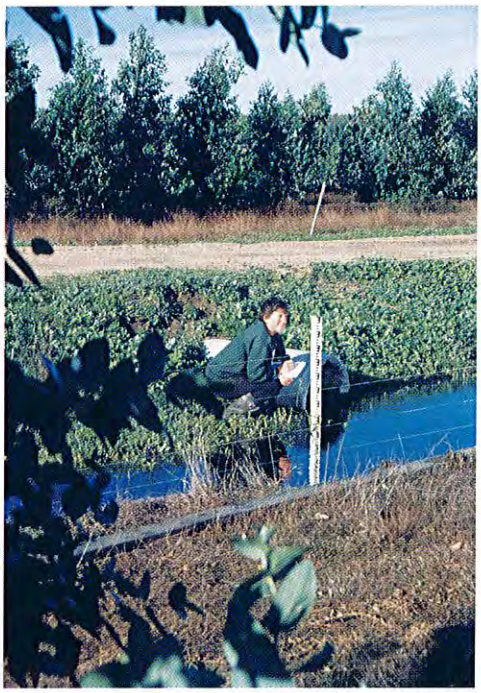
Technical resources
(and activities in progress)

Farm Monitoring Kit,
Land Management Society

Initial contacts

Land Management Society
Phone: 9450 6862

Department of
Environmental Protection
Phone: 9222 7000



Monitoring water levels on a property planted with bluegums. Photo: Department of Conservation and Land Management

Community and government partnerships

As well as the outstanding progress that individuals, landcare groups and grower groups have made towards salinity control in Western Australia, the State Government is also contributing in selected catchments through its priority catchment program.

Focus Catchments

Focus Catchments represent those catchments where productive agricultural land is the main asset at risk from salinity and where it is largely within the means of land managers to implement the changes to farm practices required to protect or restore the land. Further information on Focus Catchments, including how to apply for selection, can be obtained from your local AGWEST office.

Water Resource Recovery Catchments

Water Resource Recovery Catchments are aimed at ensuring drinking quality water is protected into the future. Further information about Water Resource Recovery Catchments can be obtained from the Water and Rivers Commission Regional Salinity Management Coordinators in the South West Region: Bunbury phone 9721 0666 or South Coast Region: phone 9842 5760.

Natural Diversity Recovery Catchments

The priority in these catchments is protecting key wetlands and natural diversity from salinity in agricultural areas. Further information about Natural Diversity Recovery Catchments can be obtained from your local CALM office.

Rural Towns Program

The Rural Towns Program was established to manage the impact of salinity on rural towns and their infrastructure. Towns may apply to join by submitting an expression of interest to the Program Manager, Mark Pridham, AGWEST, 9368 3919. Entrance to the program is assessed on the basis of certain environmental, economic and social criteria.

Rapid catchment assessment

In addition to the existing priority catchment program, all farms in the agricultural region need some assessment of their salinity risk, advice on the generic treatments that may be adopted and the impact of these treatments on groundwater levels.

Consequently, it is proposed that a rapid assessment of catchments throughout the south-west agricultural region will be undertaken. This will comprise of:

- a statewide assessment of the salinity risk to agricultural land, the environmental values and the infrastructure likely to be affected, to help in priority setting;
- advice on strategies available to avert the risk, delay the onset of salinity and thus buy time to develop new technologies, or adapt to increasing salinity;
- water management plans for each catchment which define the acceptable points into which water may be diverted, the impact of increasing salinity on flood peaks and the effect of earthworks on reducing those flood peaks; and
- identification of the potential social impacts and development of strategies to address them.

Regional groups

Regional natural resource management groups have evolved in recognition of the need for an integrated, coordinated and "systems" view of natural resource management issues. They provide an umbrella network for the smaller landcare, environmental and catchment groups within each region and provide an opportunity to develop and implement regional strategies to address a variety of natural resource management issues. These groups provide the opportunity to develop effective partnerships between the community, industry and government at the regional level.

There are five regional natural resource management groups in the south-west agricultural region:

Northern Agricultural Integrated Management Strategy (NAIMS)	Jenna Brooker, Executive Officer AGWEST, Geraldton Phone: 9956 8555
Avon Working Group (AWG)	Executive Officer AGWEST, Northam Phone: 9690 2000
South West Catchments Council (SWCC)	Sasha Taylor, Executive Officer Water and Rivers Commission, Bunbury Phone: 9721 0601
South Coast Regional Initiative Planning Team (SCRIPT)	Anne Brandenburg, Executive Officer c/- AGWEST, Albany Phone: 9892 8444
Swan Catchment Council (SCC)	Peter Nash, Executive Officer Swan Catchment Centre Phone: 9221 3840

Other useful contacts and resources

Land Management Society	PO Box 242, COMO WA 6152 Phone: 9450 6862 Website: **www.space.net.au/~lmsinfo**
Greening Australia (WA)	10-12 The Terrace, Fremantle WA 6160 Phone: 9335 8933
CSIRO Land and Water	Website: **www.clw.csiro.au/**
Australian Association of Agricultural Consultants WA (Inc)	Phone: 1800 644 855
Agriculture Western Australia	Website: **www.agric.wa.gov.au**
Department of Conservation and Land Management	Website: **www.calm.wa.gov.au**
Department of Environmental Protection	Website: **www.environ.wa.gov.au**
Water and Rivers Commission	Website: **www.wrc.wa.gov.au**
Regional Information Centres –	
Avon Catchment Network	PO Box 311, Northam WA 6401 Phone: 9622 7600
Swan Catchment Centre	108 Adelaide Terrace, East Perth WA 6004 Phone: 9221 3840
South Coast Regional Information Centre	444 Albany Highway, Albany WA 6330 Phone: 9892 8444
Yarra Yarra Catchment Management Group	PO Box 124, Perenjori WA 6620 Phone: 9973 1061
Northern Agricultural Regional Information Centre	Under development – a manager has been appointed and further details can be obtained from AGWEST Geraldton – Phone: 9956 8555

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