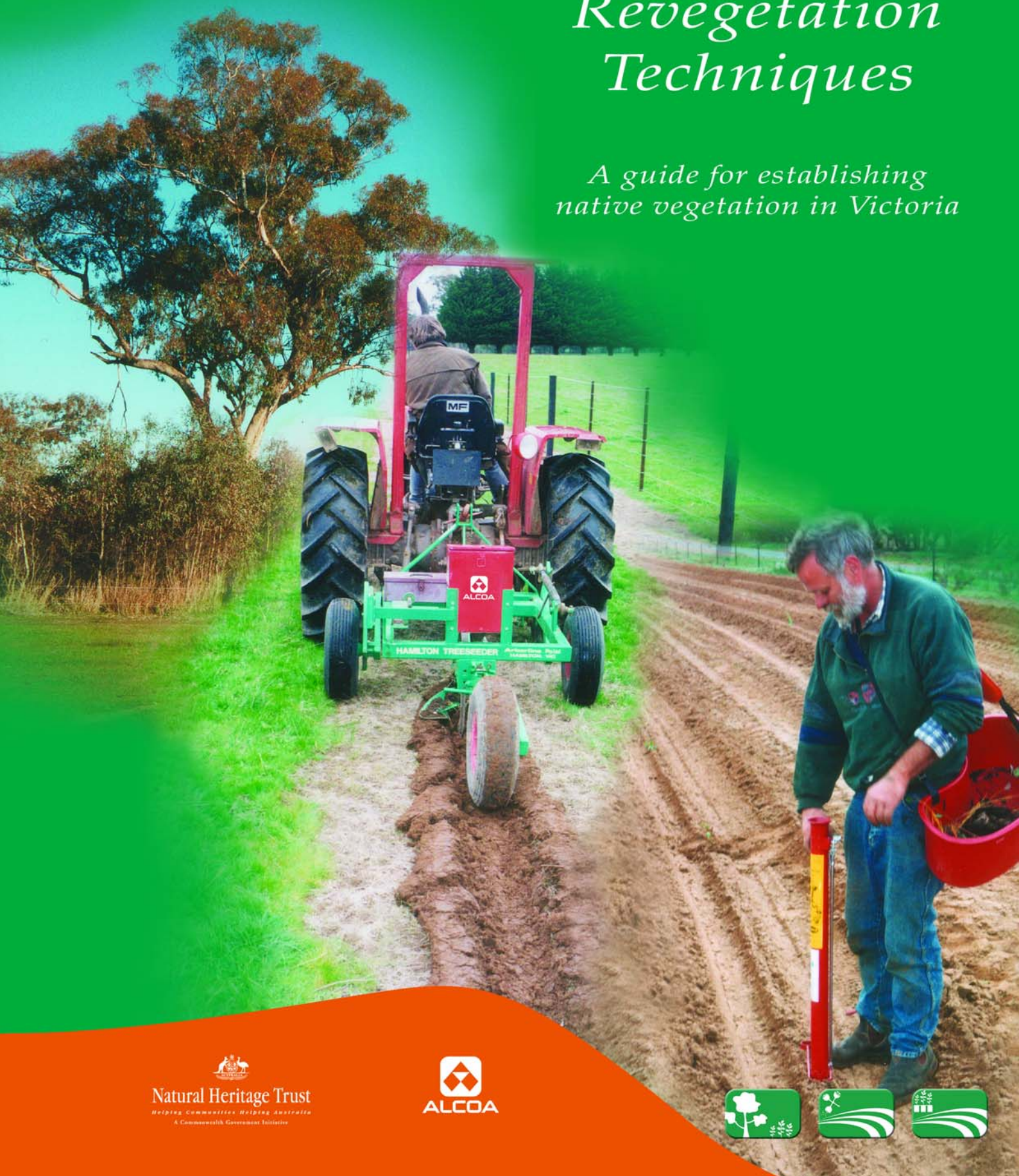
Greening Australia Victoria Inc.

growingthefuturetogether

Revegetation Techniques

A guide for establishing native vegetation in Victoria



Natural Heritage Trust
Helping Communities Helping Australia
A Commonwealth Government Initiative

ALCOA

Published by Greening Australia Victoria

With funding assistance from Alcoa World Alumina Australia and the Commonwealth Government's Natural Heritage Trust.

ISBN: 1-875345-67-1

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Layout: Design by Shelley Baker, Horsham
Printing: Shelton and Lane, Horsham
Photography: Katherine Corr, GAV (unless otherwise acknowledged)
Cover Photos: Middle and right, GAV

Foreword

Our capacity to conserve, enhance and re-establish native vegetation is vital to ensuring the health of Victoria's future landscape.

Native vegetation provides essential habitat for our wildlife, filters water, keeps erosion and salinity in check, has economic benefits for productivity and adds to the natural character of our environment.

Techniques to establish native vegetation have come a long way. Labour intensive and expensive means of raising trees and getting them in the ground have been replaced with highly efficient and cost effective options of direct seeding, plant propagation and planting.

Revegetation Techniques: a guide for establishing native vegetation in Victoria brings together these methods in the one publication and aims to provide the practical 'know how' to help carry out your revegetation from start to finish.

Most importantly, the information is built upon the innovations and experiences of landholders, community groups, land management agencies and our own staff at Greening Australia over many years. It's what has worked at a local level.

Underpinning these achievements is support from partner organisations. Alcoa World Alumina Australia is a major supporter of Landcare initiatives and Greening Australia Victoria acknowledges its contribution to the production of *Revegetation Techniques* and to the Alcoa Revegetation Assistance Scheme, through which much of the work highlighted in this publication has been made possible.

I am confident that you will find *Revegetation Techniques* to be a valued resource helping to guide and support on-ground action in both your catchment and across the broader landscape.

Rob Gell
President
Greening Australia Victoria

Alcoa World Alumina Australia

For more than 10 years Alcoa World Alumina Australia and Greening Australia Victoria have been partners in the Alcoa Landcare Program. The community links continue to strengthen and the knowledge learned has deepened with time.

Alcoa's Landcare program ethos is to share knowledge, to educate, and to help build stronger communities. The *Revegetation Techniques* guide is a perfect 'fit'.

Our partnership with Greening Australia Victoria has involved a number of projects that have had and are having significant effects on the landscape, including the Alcoa Revegetation Assistance Scheme in which we have built up the largest fleet of revegetation equipment in the State.

In 2002 Greening Australia Victoria calculated that the Alcoa Revegetation Assistance Scheme had contributed to the planting of more than 9,000,000 (nine million) trees and shrubs. These trees and shrubs will also lock up an estimated 2,000,000 (two million) tonnes of carbon dioxide over a 30-year period. That's an impressive outcome.

Throughout the years, members of the community and Greening Australia Victoria have worked together on revegetation projects, learning new things as they went along.

The result is this revegetation techniques guide. It contains the knowledge accumulated by thousands of people who have been our partners in revegetating this State.

Other long-term partnerships with Greening Australia Victoria include:

- the Alcoa Portland Seed Bank that services South Western Victoria's indigenous seed needs;
- the Alcoa Warrambeen Landcare Education Centre that has become a focus in the region for Landcare education and has expanded into areas such as farm safety; and,
- the pilot of Living Landscapes, a recent project that promises great things for biodiversity.

Building community links is critical to the success of projects such as these. The willingness of land managers to be our partners, for example, in the Alcoa Revegetation Assistance Scheme, has resulted in planning and action that has changed the landscape for the better.

We can now all share in the knowledge gained. We hope all who read this guide will find it invaluable for getting the best results in revegetating our State.

Joan McGovern
Community Affairs and Landcare Manager, Victorian Operations
Alcoa World Alumina Australia

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Acknowledgements

Revegetation Techniques: a guide for establishing native vegetation in Victoria is based largely on what has been learnt by landholders and others involved in revegetation at the ground level across Victoria. Thank you to the many landholders and others in giving their time and experience.

Alcoa World Alumina Australia is a major supporter of Landcare across the country. For more than a decade Alcoa has assisted a range of initiatives managed and operated by Greening Australia Victoria including the Alcoa Portland Regional Seedbank, the Alcoa Revegetation Assistance Scheme and the production of *Revegetation Techniques.*

The funding for on-ground works, from the Commonwealth Government's **Natural Heritage Trust** Bushcare Program, has enabled much of the recent work highlighted in this publication to be undertaken. The Bushcare Support Contract has enabled Greening Australia Victoria to develop and build on much of the expertise outlined in this guide. The Natural Heritage Trust's National Landcare Program, Farm Forestry Program, Coastcare and Rivercare programs have also supported revegetation work undertaken by Greening Australia.

Revegetation Techniques is based on the original direct seeding guides produced by Greening Australia in western Victoria and Greening Australia New South Wales. These guides were adapted for the North Central and the Wimmera regions of Victoria and to cover the growing and planting of cell-tray seedlings and the use of mechanical planting machines. Greening Australia Victoria also produced *The Port Phillip Guide to a Successful Community Planting Day* that provided background information. Support for these publications has come from Federal and State government departments as well as Alcoa World Alumina Australia.

Revegetation Techniques has been compiled by Katherine Corr, Project Officer, Greening Australia Victoria. The following staff of Greening Australia Victoria have assisted in the production of this guide and accompanying Footprints Fact Sheet series: Jim Robinson, Ron Dodds, Jason Horlock, Glen Terry, David Millsom, Claire Dennis, Dave Warne, Kate Walsh, David Lockwood, David Curry, Ashley Burns, Karl Dickson, James Scholfield, Doug Phillips, Rae Talbot, Kathryn Schaefer, Daryl Walters, Christine Gartlan, Andrew Pearson, Denis Martin, Vince Andreana, Bronwyn Teesdale, Nadine Slade, Jon Theobald, Glenn Mansfield, David Simondson, David Hill, Brett Spicer and Natalie Moxham. Thank you to Andrew Bennett, Senior Lecturer, School of Ecology and Environment, Deakin University, for his comments.

Thank you to the staff of the Department of Sustainability and Environment, the Department of Primary Industries, the Bushcare Facilitator network and Catchment Management Authorities for their comments. Thank you to the Victorian Indigenous Nurseries Cooperative for allowing photographs to be taken of nursery plant stock and to The Kondinin Group that provided permission for the use of diagrams from its publication *Tree Tops* and to Neville Bonney for providing permission to base the seed pre-treatment table on *Germination Pathways.*

Introduction

There are many benefits to be gained from re-establishing native vegetation in our rural and urban areas. Whether providing shelter for livestock, pastures and crops, creating habitat for native wildlife, improving our water quality, producing commercial opportunities, or improving our quality of life and natural heritage, protecting and re-establishing native vegetation is an important part of the process for achieving sustainable land management.

But there is more to it than picking out a seedling, digging a hole and putting it in the ground. Successful revegetation relies on proper planning and preparation to produce the best results, first time round, ensuring that in each location or situation the right plant goes in the right place, using the right site preparation and revegetation technique at the right time!

Revegetation need not be limited to one technique. There is a range of options available to suit establishment from seed or seedling; these will often be combined, producing a better result. Similarly, revegetation techniques will vary depending on the scale of works, the labour available and the site conditions and needs.

Often, the cheapest form of revegetation will be encouraging **natural regeneration** (germination of self-sown seedlings from existing or nearby vegetation) and should be considered as the first option for re-establishing native vegetation.

Direct seeding is a cost-effective and highly efficient technique, particularly for large-scale projects. Carried out by machine or by hand, direct seeding has many applications and advantages for plant establishment.

Planting of seedlings is another option. Today seedlings can be grown in a variety of containers, to suit the scale and purposes of works and can be planted by machine or by hand.

Retaining the existing native vegetation is of critical importance to restoring degraded landscapes. If lost, it is an expensive, lengthy process to replace many of the components of our native ecosystems. Revegetation builds on, supplements and connects these existing areas.

The selection of species for revegetation should aim to maximise opportunities to provide environmental, economic and social benefits. Local native (indigenous) species, grown from local seeds or plant material are generally the preferred choice for revegetation. They provide the greatest range of long-term benefits because they:

- are best suited to the local conditions and can still fulfill all of the functional roles required of farm trees and shrubs;
- maximise biodiversity in the local area;
- provide the best habitat for local wildlife;
- benefit the health of existing remnants;
- are well suited to regenerating without assistance;
- benefit farm productivity;
- will maintain the natural character of the local landscape.

Where indigenous species are not available, do not meet the project needs, or if the environment at the site has been so modified that local native species cannot survive, for example, highly salt affected sites, other native species may be appropriate.

A strategic approach to revegetation that results in multiple benefits and the creation of a healthy and productive environment into the future is recommended.

Revegetation action in Victoria

Much progress has been made on the ground with the development of revegetation techniques and in raising awareness of the importance of our native vegetation, particularly through programs, such as, the Commonwealth Government's Natural Heritage Trust and the National Action Plan for Salinity and Water Quality.

However, as outlined in *Victoria's Native Vegetation - A Framework for Action* and in the Draft Regional Native Vegetation Plans, more work is needed to help increase our capacity to undertake vegetation protection and revegetation. This guide is a tool to further assist and enable rural and urban communities to achieve on-ground change. By promoting the protection of existing native vegetation, its importance and priority, and the use of indigenous vegetation, this guide supports the goals and guiding principles of the above mentioned plans and policies for the long term survival of our native vegetation.

About this Guide

Revegetation Techniques is a 'how to' guide for establishing native plants from seed or seedlings. The information is based on what has worked at a practical level for landholders, project managers and research organisations.

Section A covers the steps involved in a revegetation program, from planning and preparation to monitoring.

Section B outlines the different techniques available to direct seed or plant seedlings. Natural regeneration, mechanical and hand methods are covered. Section B will also assist you to choose the technique or techniques most suitable for your site and purposes.

Section C provides contacts and resources for further advice and support.

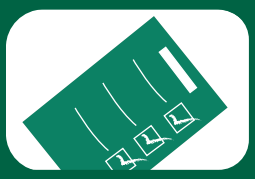
Footprints Fact Sheets is a series of case studies that describe landholder experiences with revegetation and provides on-ground examples of many of the techniques outlined in this guide. Contact Greening Australia Victoria for a copy or download the sheets from our website: http://www.greeningaustralia.org.au

Revegetation Techniques aims to complement regional guides that identify the local species and vegetation communities that should be replaced in your area. This publication should be regarded as a living document that will be updated when new information arises.

We hope you find *Revegetation Techniques* to be a helpful and practical resource.

Footprints Fact Sheet Series

SECTION A:
A revegetation program



1. PLANNING

2. PREPARING THE GROUND

3. PEST ANIMAL MANAGEMENT

4. SEEDS AND SEEDLINGS

5. REVEGETATION

6. SITE MAINTENANCE

7. MONITORING

1. Planning

Projects are successful because of good planning. Projects that involve establishing native vegetation are no exception. Careful planning helps to set objectives, identify tasks to be done, ensures that the resources are available and that activities are undertaken when needed. Planning ensures that the best possible results can be achieved.

Proper planning prevents poor performance!

Levels of planning: site, local and landscape

Planning for revegetation occurs at a number of levels:

- the **site level**, where the seeds or plants are going into the ground;
- the **local level**, for example, when revegetation is integrated into the property or farm planning and activities;
- the **landscape level** which may encompass neighbouring farms, parklands, roadsides, rivers and catchments.

Photo: GAV

Site level

Local level

Landscape level

While the focus of this Guide is on techniques for establishing vegetation at the site level, to gain the most benefit, you need to first step back and plan your revegetation from the whole farm or property level and the landscape level.

Local level

Forward planning on a local level, such as the whole farm or property area basis, is a worthwhile undertaking. Whole farm plans or property management plans look at how land uses, such as agriculture, can best come together with infrastructure, such as buildings and fences, and the natural aspects of the land.

Local native (indigenous) vegetation, both existing remnant and planned revegetation, are an important element in planning. Strategically integrating them into the property planning process will help ensure that the time and effort involved will be most beneficial.

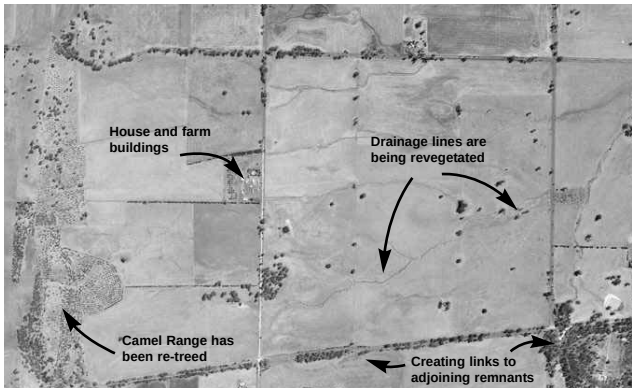


Photo: Permission of T. Hamilton

Above: Aerial view of the Hamiltons' property in the Goulburn Broken region. The family has incorporated revegetation into the planning and operation of their vineyard enterprise. Drainage lines have been fenced and are being revegetated and Camel Range has been re-treed to control salinity and improve production.

More recently Environmental Management Systems are being incorporated into farms to help improve biodiversity conservation and support clean and green production (Section C).

Landscape level

There are many benefits to be gained from linking your revegetation with the activities of others in the broader landscape. Most land management issues are not confined to property boundaries, so a cooperative approach with neighbouring landholders, community groups or other agencies will help to better target efforts and manage issues such as weeds, salinity, water quality decline and habitat loss and achieve greater gains for you and the area.

Aligning your works with the priorities outlined for revegetation in your region will increase opportunities to link to other initiatives and funding assistance.

Further information

The publication *Biodiversity Action Planning*, published by the Department of Natural Resources and Environment, is a good starting point when planning revegetation across different levels. *Biodiversity Action Planning* will help you to locate the most important biodiversity assets of your area and as a planning tool it can direct your actions for maintaining and restoring these areas.

The Native Vegetation Plan and Regional Catchment Strategy for your region is also worth referring to. Refer to Section C for full referencing and availability on the web.

Seek local advice before you begin

Before you start, talk to as many people as possible. The list of resources throughout this guide provide a great start; other sources of information include your local Landcare Groups, field days, training sessions, neighbouring landowners and advisory organisations. Refer to Section C for contacts.

Why do I want to revegetate?

Revegetation is undertaken for a variety of purposes including:

- for shade and shelter, for example, for livestock, pasture and crops;
- for fodder production;
- for timber production;
- for native products, such as cut flowers and foliage, bushfoods, biomass production and medicines;
- to control weeds, for example, Serrated Tussock;
- to stabilise soil;
- to reduce or control salinity;
- to manage pests, for example, attracting native birds to control insects;
- as habitat for native wildlife;
- to enhance rare or threatened species or plant communities;
- to enhance existing native vegetation;
- to reverse tree decline;
- to act as a sink for greenhouse gases;
- to maintain landscapes, for example, Red Gums at Dunkeld and Bulokes in the North West;
- for seed orchards or seed production areas to ensure future seed resources;
- to improve water quality;
- to improve the amenity around homes and buildings;
- for aesthetic reasons, for example, screening unwanted views;
- to create a pleasant living and working environment;
- for social and educational purposes.

An integrated approach to revegetation can achieve many of these objectives, such as, a viable farming enterprise, healthy land and water resources, social benefits and improved biodiversity outcomes.

For shade

To protect and enhance existing native vegetation

Photos: J. Robinson

For fodder, such as saltbush, for livestock

Where do I want to revegetate first?

Once the purpose of your revegetation is identified, you can then select the site where revegetation is most needed. As the examples below show, the purpose will affect site selection.

Purpose: Shelter for livestock

Locate the revegetation at right angles to the severest winds against which protection is required. Often this is along the paddock boundary in a north-south location, to provide the greatest protection from northwesterly summer and southwesterly winter winds, however, this will depend on the landscape. To maximise the benefits from the trees seek local knowledge when siting windbreaks.

Photo: J. Robinson

Stock seeking shelter on the farm

Purpose: To bring back native wildlife

Consider the specific habitat requirements of the wildlife, including the size of habitat and area in which a population needs to live, and food, shelter, nesting and breeding requirements.

You should first protect existing habitats and locate your revegetation to buffer, enhance and enlarge these areas. By viewing things at the farm and landscape level, the revegetation can be used to increase connectivity of habitats both on the property and beyond, to public and private land.

For a farmer in north-west Victoria, encouraging the return of the Mallee Fowl to the farm was one motivation. Read about his story in **Footprints Fact Sheet 30.**

Purpose: Farm forestry for profitability and biodiversity

You can readily integrate farm forestry into revegetation projects on your property. This can provide multiple benefits including biodiversity and profitability, for example, by buffering existing remnants with harvestable timber or planting productive shelterbelts across a property.

Purpose: Control water erosion

Use revegetation projects to treat the source of the problem not the symptom, that is, use water where it falls. Re-establishing trees, shrubs, grasses and sedges will help stabilise erosion sites, such as active gully heads.

Purpose: Control wind erosion

Shelterbelts, particularly those in a regular sequence across farms will help control wind erosion, such as that which occurs with lighter soils in cropping areas.

Purpose: Control salinity

Interception and prevention is better than treatment. Strategically locate revegetation to achieve the greatest outcome in combating salinity, that is, in high recharge areas, for example, Camel Range in the Goulburn Broken area (pictured below). Plan revegetation works in conjunction with neighbours to gain catchment benefits beyond the farm. Revegetation of discharge sites or areas with rapidly rising watertables will require salt tolerant species.

Purpose: Aesthetics

Revegetation should be sited to screen unwanted views or to maintain an outlook. Our wonderful native flora and fauna can be used to create a pleasant living environment for ourselves and for future generations.

Look beyond your boundaries, two projects linked together can be more effective than one!

Camel Range revegetation

What should I know about the site?

No two revegetation sites are the same. The features of each site will determine the species and revegetation techniques required. The best way to get a good understanding of what is occurring at your site and to plan the works effectively is to get out into the field and undertake a **site assessment**. The table below provides a checklist of things to note when conducting your site assessment.

Site assessment checklist

Flora and fauna	✓ Native vegetation	✓ Native wildlife (or evidence of)
	✓ Weeds	✓ Introduced animals and birds (or evidence of)
Soils	✓ Type of soil/s, structure and health	
Other features	✓ Topography and contours (especially steepness and ability to use machinery. Hand revegetation methods may be exhausting).	✓ Aspect ✓ Wetlands, creeks, drainage lines, ridges, escarpments etc.
Land and water issues	✓ For example, erosion by wind or water; salinity	
Infrastructure - above and below ground	✓ Dams, bores, buildings, roads, easements, powerlines, underground cables/pipes etc.	
Access	✓ People, vehicles and machinery. The level of access available will influence the revegetation techniques chosen and the transport of materials, such as plants, across the site.	
Surrounding landscape	✓ What is surrounding the site that will have positive and negative effects on the revegetation?	
Also find out about:		
Cultural, historical and conservation values	✓ Aboriginal ✓ Historical ✓ Rare or threatened species or communities of native plants or animals	
Management of the area	✓ Past and present land uses and management practices ✓ Ownership, planning controls, boundaries etc.	

Site assessment checklist cont.

Beginning your monitoring program

An important component of revegetation is monitoring the site over time and the information collected during the site assessment provides a great starting point or baseline of information for comparison over the years (refer to the end of Section A for greater detail on monitoring).

A part of monitoring is taking photos of the site from a fixed point **(photopoint)**. Take photos at the site assessment stage - over time it will provide a great visual record and a great deal of satisfaction!

Photos: Miller/Munford

These photographs of the Archies Creek Reafforestation Group's Wildlife Corridor project show the value of taking photos over time. The top photo was taken in 1977 and the photo above in 2000, twenty-three years after the revegetation.

Further information

A useful website for information on the natural resource features of Victoria is the Victorian Resources Online website:
http://www.nre.vic.gov.au/vro

Aboriginal cultural heritage

Contacts for more information on traditional Aboriginal Owners and people responsible for cultural heritage include the Mirimbiak Nations Aboriginal Corporation, the National Native Title Tribunal, Aboriginal cultural and heritage organisations and Aboriginal Affairs Victoria. There are also numerous Aboriginal co-operatives and land management businesses based in regional locations throughout Victoria.

Aboriginal Affairs Victoria can arrange site inspections for those planning to undertake large areas of soil disturbance or those wishing to report a possible Aboriginal Heritage Site. Further details and reporting forms are available on the Aboriginal Affairs Victoria (Department for Victorian Communities) website
http://www.dvc.vic.gov.au/aav.htm
Refer to Section C for contact information.

Designing revegetation

The design of the revegetation, including the species chosen, their placement, densities, the shape and size of the works should reflect the objectives of the revegetation.

If multiple outcomes are intended, there are likely to be different requirements to consider in the design of the works. For example, if the primary goal is to create shelter in a paddock for livestock, the plant species, their arrangement and the width and length of the revegetation will be quite different to establishing a block of timber for harvesting or creating habitat for a particular species of bird.

Revegetation design for biodiversity is the focus of the following section. Recommended reading for the design of revegetation for commercial activities, such as farm forestry can be found in Section C.

Designing revegetation for biodiversity

Biodiversity is the variety of life - the different plants, animals and micro-organisms, the genes they contain and the ecosystems of which they form a part. Where all the components are able to interact and function, a healthy environment - from the soil below, to the land and water and air above - can be achieved.

Tips for maximising biodiversity in revegetation

Before considering what to seed or plant, first protect and enhance the existing remnant native vegetation

When it comes to recreating a 'natural' biodiverse landscape, the protection, enhancement and management of existing remnant native vegetation is the highest priority.

Remnant vegetation on properties will contain the remaining biodiversity and the elements of functioning ecosystems that are often the hardest to recreate through revegetation: the fungi and soil microorganisms, lichens, mosses, herbs and ground covers.

Remnants, whether in good condition or degraded, are in most cases much easier and cheaper to restore than recreating new areas from scratch. Even a single dead tree or a patch of native grasses provides some 'building blocks'. So take a closer look at what is left and protect and enhance that first. Remember, the visible vegetation is probably just the tip of the iceberg!

River Red Gums, such as this one north - west of Melbourne, are a rare find and are a priority for protection.

Protect hollow-bearing trees and include these species in your revegetation

Many paddock trees may be 200 years old or even older. Their hollows, crevices, twisted bark and branches attract a great diversity of wildlife; they are particularly important for hollow-dependent animals. It can take about 100 years for hollows to form in Eucalypts to a stage where they are useful for wildlife (Ambrose 1982, Land for Wildlife 1990; Mackowskil as in Robinson 1992). Protecting paddock trees and others so that they can mature and bear hollows is vital. Including species that will form hollows in the future should also be part of revegetation activities.

Hollows provide valuable habitat

Select indigenous species - they offer multiple benefits

The basic criteria for the selection of species are that the plants:

- are suitable for the site conditions;
- will achieve the objectives of the planting;
- will last on the site.

The use of **indigenous** species which are native to the local area and that are grown from local seed or cuttings are recommended as the first choice for revegetation. Indigenous plants, rather than species from other areas, regions, states or countries have many advantages for the landholder and environment.

These advantages include that they:

- are best suited to the local conditions, for example, they are adapted to the soils, rainfall patterns and frosts and can survive droughts, flood and fire whilst still performing the functional roles of farm trees and shrubs;
- maximise biodiversity of the local area;
- provide the best habitat for local wildlife;
- benefit the health of existing remnants;
- are well suited to regenerating without assistance;
- benefit farm productivity by, for example, providing shade and shelter for stock, habitat for insect eating birds for pest control, and filtering runoff;
- will maintain the natural character of the local landscape.

Protecting and enhancing our existing native vegetation and supplementing these areas with indigenous species in revegetation is important. Our native vegetation plays a vital role in the sustainable use of land and water including: preventing erosion and filtering runoff, supporting our economy and providing benefits for agricultural enterprises, and assisting the survival of our native flora and fauna.

Other considerations

Some local native species will be better suited than others in helping you meet your revegetation objectives. On some sites, where conditions have been substantially modified, for example, by salinisation or waterlogging, the benefits of indigenous plants may be reduced and non-local native plants may be preferable.

Refer to Section C for a listing of information notes for further information.

Developing a species list for your site

There are a number of avenues that may assist you in the development of a species list.

- Identifying the existing native vegetation (remnant) that is growing on or near a site is a good starting point. Seek assistance from your regional Greening Australia officer to help identify what is growing on your property.
- Vegetation mapping across the state has been undertaken by the Department of Sustainability and Environment and has produced what are known as **Ecological Vegetation Classes**. This information can point you in the right direction for finding out what species may naturally occur in your area. Contact your local Department of Primary Industries or Catchment Management Authority office for help in identifying the vegetation types that occur (or were likely to have occurred) on your property and their constituent species suitable for revegetation.
- Consulting local species guides for your area is recommended. In most catchment management regions of Victoria, indigenous plant guides have been produced that can assist with the selection of species. These usually list plants by locality and land system or soil type as well as by their location in the landscape, for example, along creeks or gullies or on dry ridge tops. Local publications are listed in Section C.

Photo: J. Robinson

This photo illustrates the value of using local plants from local material. The background vegetation is regenerating Swamp Paperbark (*Melaleuca ericifolia*), near Foster (South Gippsland).
The small tree in the foreground is a planted Swamp Paperbark from a NSW source. Same age, very different performance!

Establish the right species in the right place for the best results

Aim to put species where they would have naturally grown. This means matching species with soil type, aspect and where they occur in the landscape. For example, plant local species that favour wet sites in gullies or along creeks; plant species that tolerate dry conditions on slopes and ridge tops. Regional revegetation guides are helpful references for this, as is the Ecological Vegetation Class information for your area.

Consider the ratio and densities of different plants being established

The ratio of trees to shrubs and ground cover plants, and their densities will depend on the type of vegetation community being created. As a general rule, for what were originally forest environments, a 20% overstorey of trees and an 80% understorey of shrubs and ground covers is suggested. For grasslands or grassy woodlands, the ground layer would be an even greater percentage.

It is best to seek local advice to determine the most appropriate spacing of plants for the vegetation community that you are creating. The Department of Sustainability and Environment is developing guidelines for revegetation. These will provide a guide to the minimum plant density and structural diversity required for revegetation proposals based on a defined Ecological Vegetation Class benchmark. More information can be obtained from the Department of Sustainability and Environment website, http://www.dse.vic.gov.au or by contacting your local Department of Primary Industries or Catchment Management Authority office.

Find out the ratio of trees to shrubs and grasses for the vegetation community you are establishing - a grassland will be very different to a forest.

Maximise the diversity of your revegetation

Structural diversity

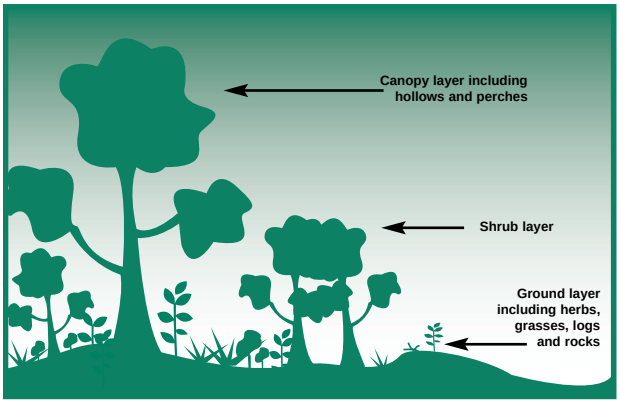
To achieve structural diversity use vegetation of different heights (canopy, shrubs and ground layer), growth forms (bushes, trees, climbers, grasses) and foliage (for example, prickly species) **that would have once occurred at the site**, including those that provide nesting opportunities and future hollows for wildlife.

Species diversity

To achieve species diversity include as broad a range as possible of the original species **(Ecological Vegetation Class)** that would have occurred on the site. This should maximise the diversity of fauna habitats created.

Include non-living elements

Leave existing rocks, logs, fallen fence posts and leaf litter for wildlife to forage in, and dead trees to provide hollows and perches.



Structural diversity in revegetation

Maximise the structure and foliage diversity and include the non-living elements such as fallen branches and logs.

Maximise vegetation connectivity

Many of the remaining patches of bush, now occur as fragments across the landscape. As a result, many species of native wildlife are unable to travel between remnants. Healthy ecosystems are more likely to exist where there are effective linkages to other areas of vegetation allowing the movement of birds and other animals and facilitating the pollination of native plants.

Revegetation efforts which seek to provide connectivity need to consider the requirements of different fauna. Different animals will prefer different levels of connectivity, from unbroken links (corridors) to scattered trees (mosaics) (Bennett, Kimber & Ryan 2000). A single line of trees will have little benefit as a corridor for most species, however, a linear corridor at least 20 to 50 metres wide will have greater benefits (Bennett, Kimber & Ryan 2000).

Connectivity should be considered at the property and landscape level. Creating links to remnants on neighbouring properties, roadsides, grasslands, streams or public land greatly enhances the network of habitat.

Photo: GAV

This landholder in Victoria's Wimmera is using direct seeding and hand planting to link Black Box (*Eucalyptus largiflorens*), Buloke (*Allocasuarina leuhmannii)* and Yellow Gum (*Eucalyptus leucoxylon)* remnants within the property and to road reserves beyond his boundary. **Read Footprints Fact Sheet 26 for the full story.**

Consider the size and shape of the revegetated area

Protecting and creating larger vegetation blocks and areas should support more of an individual species and often a greater diversity of species too (Johnson & Don 1990). Alternatively, a combination of smaller, different habitat types, such as a creek gully and nearby rocky rises will support a greater range of species than a single type of habitat (Johnson & Don 1990).

Focal Species Approach

The Focal Species Approach is a tool for landscape planning in rural areas. This approach, developed by Rob Lambeck from the CSIRO, identifies the needs of the most sensitive species of native animals in a local area in terms of habitat and space requirements: the focal species. It then identifies what needs to be done to ensure their long term survival, for example, the minimum habitat size required. By meeting the needs of the most sensitive species, the requirements of many others will be met at the same time. This helps ensure that revegetation efforts are strategic and beneficial to biodiversity (Collis 2002; Bennett, Kimber & Ryan 2000).

Further information

Further information on the Focal Species Approach in action can be obtained through Greening Australia staff based in south-west Victoria. Also refer to the references in Section C.

Biodiversity Action Planning and Landscape Plans, that identify fauna species with more demanding requirements, thereby making good focal species, are helpful references. Refer to Section C.

Promote a patchy design

If the purpose of the revegetation does not require ordered rows or spacings of plants, create a natural effect with clumps of vegetation, small clearings, different heights and ages of vegetation. This will provide greater opportunities for wildlife (Bennett, Kimber & Ryan 2000).

Consider staged revegetation and succession

Rather than reinstating a wide range of overstorey and understorey species at once, revegetation projects may opt for staged revegetation. Staged revegetation may be the best way to outcompete weeds. For example, it may be preferable to get the overstorey established first to shade out an exotic understorey and then come back and in-fill with understorey species. With a grassy woodland, efforts might concentrate on weed control to encourage the native grass understorey to return and then follow up with overstorey planting later.

Pioneer or **colonising species** play an important role early on in the development of vegetation communities and ecosystems. Wattles (*Acacia* spp.), Cassinias (*Cassinia* spp.), Fireweeds (*Senecio* spp.) and Kangaroo Apples (*Solanum* spp.) are all colonisers useful in the early stages of succession of vegetation. They establish easily after disturbance, for example, fire, and grow quickly under sunny conditions, often providing the ideal protection and environment to aid the establishment of longer-lived, slower-growing species.

Further information

Revegetation and Wildlife - A guide to enhancing revegetated habitats for wildlife conservation in rural environments by Bennett, Kimber and Ryan is recommended.

Pioneer species include Kangaroo Apple (*Solanum laciniatum*) above and Golden Wattle (*Acacia pycnantha*) below

Golden Wattle (*Acacia pycnantha*)

Value of wetlands and grasslands

Wetlands

A wetland refers to areas of marsh or water that are permanently or temporarily inundated, fresh, brackish or salt and can be artificial or natural (Ramsar Convention in Cameron 1994). On a farm, wetlands may include the farm dam, a swamp, bog, lake or billabong.

From both a conservation and economic point of view, wetlands have many benefits. They attract and support a wide variety of wildlife including birds, frogs, fish and invertebrates as well as water plants and some trees. They help with water filtration and improve water quality, improve water flow and support many birds, including insect eaters, that feed on crop pests.

Wetlands have numerous benefits - for wildlife, water filtration, water quality and aesthetics

Further information

To create or enhance an existing wetland, refer to the contact points and further information listed in Section C. Find out how a farmer recreated a wetland habitat on his property, in south-west Victoria in **Footprints Fact Sheet 17.**

Grasslands

Native grasslands and grassy woodlands are our most threatened vegetation communities. Landholders are encouraged to appropriately manage what is remaining to protect and enhance their conservation values.

Apart from providing habitat for native plants and wildlife, grasslands also have economic benefits. They are drought-resistant, they can be incorporated into farm production systems as native pasture, they are able to cope with low-nutrient, acidic and saline soils, they provide cover to prevent erosion and they provide habitat for pest controlling wildlife.

If reasonably intact grassland plants or ground flora are still present, any revegetation should ideally involve minimal disturbance. Techniques are still developing to re-establish native grasses on a broad scale. Methods for successful sowing that can apply to particular species are still needed.

Photo: J. Robinson

Grasslands are a precious resource

Further information

For further information on native grasslands, their protection and re-establishment, refer to the contact points and information listed in Section C. *Grassy Guidelines: How to manage native grasslands and grassy woodlands on your property* by Tim Barlow is recommended.

Also, read about the re-establishment of native grasses on a Corangamite property in **Footprints Fact Sheet 15.**

When is the best time?

Timing is a key consideration throughout the whole process of establishing vegetation. Identifying the appropriate timing in your area for seed collection, site preparation, seeding and planting for the species and site conditions involved is essential.

The timing of seeding and planting is site specific and heavily dependent on thorough weed control and soil moisture conservation. Ideally, seeding or planting is undertaken when the ground is still moist and soil temperatures are starting to rise. Thorough weed control will often widen the 'window-of-opportunity' for planting or seeding. The general principle to follow, given good weed control, is the lower the rainfall, the earlier the direct seeding or planting. As seasons can be variable, having preparation completed well in advance enables revegetation to occur when the conditions are most favourable.

Individual species may also have their own requirements for germination, for example Sweet Bursaria (*Bursaria spinosa*), Prickly Currant Bush (*Coprosma quadrifida*), Tree Violet (*Hymenanthera dentata*) and Cypress-pine (*Callitris* spp.) amongst others are known to germinate during the short, cold days of winter and therefore should be sown in early winter, not spring, to be certain they receive the required environmental triggers for germination.

The following table is a guide for the timing of activities in areas of medium to high rainfall and semi-arid environments. The timing of the activities should still be tailored to the local environmental conditions. At the site level, it is recommended that planning, and in some cases preparatory on-ground works, such as seed collection, plant orders and weed control, begin more than a year before seeding or planting.

Guide to timing of revegetation activities

Activity	Spring	Summer	Autumn	Winter	Spring	Summer	Autumn	Winter	Spring
1. Planning*									
2. Preparing the ground									
Soil preparation									
Weed control*									
3. Pest animal management									
Pest control									
Fencing									
4. Seeds and seedlings									
Seed collection, cleaning and ordering*									
Plant orders and propagation*									
5. Revegetation									
Natural regeneration									
Direct seeding and planting									
6. Maintenance									
7. Monitoring									

Refers to the timing of activities for both semi-arid and medium to high rainfall environments

Refers to medium to high rainfall (500mm plus p.a.) areas only

Refers to semi-arid (250-500mm rainfall p.a.) areas only

*These activities should commence in advance of the seasons shown. Ideally:
- begin planning two or more years ahead of seeding or planting;
- start weed control at least twelve months prior to seeding or planting or earlier depending on the site;
- order seed two years before seeding or planting;
- order plants at least twelve months prior to planting.

What resources are needed?

An important part of planning your revegetation is determining what resources are required, how you can source them and their cost.

Factors will include:

- **time** - planning, preparation, revegetation, follow up maintenance and recording;
- **budget**;
- **materials** - seedlings, seed, stakes and guards and fencing;
- **equipment** - seeding or planting machinery and planting tools;
- **knowledge and skills** - fencing, seed collection, plant identification, site preparation, direct seeding and weed control;
- **labour** - fencing, seed collection, site preparation, direct seeding and planting.

There is help available!

There are a number of avenues that you can explore that may assist with resourcing your revegetation.

Funding initiatives, grants and incentives are available to assist landholders and groups with revegetation. Contact your local Catchment Management Authority.

Regular **training** days are run by organisations in regional and urban areas, including Greening Australia Victoria and Landcare, and cover a wide range of topics from native plant identification to planning your revegetation project to seed collection and direct seeding. Contact Greening Australia Victoria for details.

Linking in with local Green Corps activities (teams of young people participating in environmental and cultural heritage projects across the country) may assist you with **labour support** for your project. Also, community events that attract volunteer support from the local area, such as the Spring Planting Festival in Greater Melbourne and planting weekends in rural Victoria, may also be able to facilitate community support for your planting.

Equipment and machinery can be sourced through the Alcoa Revegetation Assistance Scheme and Community Equipment Support Scheme managed by Greening Australia Victoria.

Further information

Refer to Section C for contact information and resources to support your project.

2. Preparing the ground

The successful establishment of vegetation is dependent on two key activities:

- site preparation leading up to seeding or planting;
- site maintenance following seed germination or planting.

A well prepared site will provide the best conditions for plant germination, survival and growth. This means early weed control and choosing the type of soil preparation which best suits the site and revegetation technique.

Ideally, site preparation should begin at least twelve months before seeding or planting, even earlier depending on the condition of the site. It is worth the effort to get the preparation right because the degree of site maintenance afterwards will largely reflect how good the site preparation was at the start.

Options for weed control, including chemical and mechanical methods, and soil preparation methods such as ripping and mounding are outlined below. The appropriateness of each method will depend on the site itself and the ground preparation required for each revegetation technique.

An important consideration will also be the level of invasiveness or disturbance created by the preparation. For example, in a sensitive area such as a site with some relatively intact native ground covers/grasses, the lowest form of disturbance should be chosen if revegetation is necessary.

Note: The techniques promoted in this guide are those that are the most efficient and cost effective to achieve success. The aim is to make revegetation as cost effective and easy as possible for landholders and to stretch any funding dollars as far as possible.

Photo: K. Walsh

A well prepared site ready for mouldboard ploughing in South Gippsland (above) and for mechanical planting in Corangamite (below)

Photo: J. Robinson

Weed control

Weed control is usually the most important factor for the successful establishment of vegetation. Weeds compete for and use up the soil moisture and nutrients that would otherwise be available to the native seedlings. The survival of plants can be expected to increase from nothing to 100% and growth rates to increase by 70% with adequate weed control. All weed control must be approached professionally and be timely.

Step by step guide to weed control

Step 1: Assess the problem

In order to target the control effectively, it is vital to:

- identify the weeds present;
- understand their habits and life cycles, for example, when do they grow, flower and seed? Are they annuals or perennials, grasses or broad-leaved weeds? How do they spread?;
- determine the scale of the problem (Dreher & McPhee 1994).

Step 2: Consider the control options

There is a range of weed control options available for small and large-scale revegetation, including chemical, mechanical, manual and biological methods. Reviewing land management practices and using them as part of your weed control strategy is a very effective, cost effective option, for example, grazing to reduce weed seed set. Similarly, the process of revegetation itself can also be effective in controlling weeds, for example, using competitive indigenous species to outcompete the weeds following initial weed control.

This guide does not recommend one treatment over another but does advocate taking the 'softest' approach possible, that is, use chemicals only if other treatments are less practical or effective for the job.

Photo: J. Horlock

Scalping as part of the direct seeding operation (below left), hand cultivation (above) and chemical use (below) are three methods of weed control

Handheld Rope Wick Applicator being used to target weeds in an urban revegetation bed comprised of Spiny-headed Mat Rush (*Lomandra longifolia*)

Step 3: Undertake the weed control

Whatever treatment or treatments chosen, the long-term success of weed management relies upon:

- timeliness (control prior to weed seed set);
- minimising disturbance during the weed treatment;
- replacing the space occupied by weed species with desirable plants;
- follow up monitoring and treatments (Horlock 1998).

Ideally:

- a minimum of two weed control activities should be undertaken prior to vegetation establishment and weed control should be continued until the desirable plants can adequately compete against the weeds;
- weed control should commence at least twelve months prior to sowing or planting or even earlier depending on the weeds present, for example, Phalaris (*Phalaris aquatica*), Fog Grass (*Holcus lanatus*), Blackberry (*Rubus fruticosus*) and Gorse (*Ulex europaeus*).

The importance of thorough weed control prior to seeding or planting can not be over stressed.

Chemical control

One of the main reasons why herbicides are used for the preparation of large-scale revegetation areas is that they are a cost-effective and efficient option compared with mechanical or manual methods. Herbicides can also be used selectively, with precision, in difficult topography and are often the only effective method for weeds that are difficult to control.

There are a range of chemicals, formulations and equipment available to match different, specific requirements of weed control. For example, low volumes can be applied in droplet applications, small areas can be sprayed using a knapsack sprayer and in larger accessible areas, a boom or hose line can be used.

The most commonly used herbicides for pre-planting weed control are **translocated (systemic) knockdown herbicides**, such as glyphosate (the active constituent in products such as RoundUp®). These control a broad spectrum of plants (including seedlings) and are readily absorbed and circulated throughout the plant.

Knapsack (above) and shielded boom spraying behind a four-wheel motorbike (below)

Photo: GAV

Contact herbicides are another type and are effective on those parts of the plant they touch, while **selective herbicides** will only target certain plants, for example, some will only control narrow-leaved plants such as grasses, while others will control broad-leaf weeds.

Residual or pre-emergent herbicides are absorbed by seeds and/or via the root system or leaves of young plants and prevent their establishment. Residual herbicides persist in an active form in the soil following application and can extend the period of weed control and prevent seed germination. **However, they can cause long term detrimental impacts if used inappropriately**. Experienced operators and a high level of caution are essential.

Note: Residual herbicides will affect the choice of direct seeding method chosen, for example, residuals cannot be applied as a site preparation with the mouldboard ploughing technique. The layer of soil contaminated by the residual or pre-emergent herbicide will need to be removed or scalped prior to direct seeding. However, this will not guarantee that the residual herbicide will not move through the soil bank into the scalped seedbed. Seek advice about your soil type and environment before applying residuals.

Take the softest approach possible

The use of chemicals for weed control should be approached with care and should aim to produce acceptable levels of control with the minimum use of herbicides. Similarly, it is suggested that they be used only if other forms of treatment are less practical or effective for the job.

Handle chemicals safely

- Always comply with Occupational Health and Safety Standards
- Seek expert advice
- Obtain the required permits before undertaking any works

It is strongly recommended that a Farm Chemicals Users Course be undertaken prior to chemical handling. An Agricultural Chemicals Users Permit (ACUP) is needed to use restricted chemicals, for example, dangerous poisons (Schedule 7 poisons).

Refer to Section C for more information. Contact your Regional Chemical Standards Officer from the Department of Primary Industries for chemical advice in your region.

An example of an ideal chemical weed control program using a knockdown herbicide in a spring seeding or planting program*

Spray	Timing	Purpose
Spray 1	Spring in the year before seeding or planting	Prevent seed set in the existing weeds. This may also weaken hard to manage perennials such as Phalaris.
Spray 2	Ideally after the autumn break or the first rains of the season (if there are any!)	Control seedlings that germinate after the break. Be aware that knocking out the first pasture weeds will create ideal conditions for seeds of the broadleafs to germinate.
Spray 3	6-12 weeks after spray 2	May be worth considering controlling any new seedlings that have emerged or are emerging.
Final spray at seeding or planting	A final spray may be able to take place immediately before seeding or planting, however, always adhere to the label recommendations. Also, if the revegetation technique is manual, wait for the recommended time after spraying before allowing people onto the site (adhere to the label instruction). The final spray at seeding or planting may include an insecticide, for example, for Red-legged Earth Mites; again, always adhere to label recommendations.	

*Adjust the timing to suit local conditions. The example is only a guide and will not be appropriate or practical for every situation. What it does highlight however, is the forward planning needed to control weeds prior to seeding or planting.

For spot spraying, spray circles one to two metres in diameter and for strip spraying, spray one to two metre widths.

If incorporating a residual or pre-emergent herbicide, the second spray after the autumn break is the usual timing. It is important to observe the '25 25' rule. Either 25 days or 25 millimetres of rain should intervene between spraying the residual and planting or seeding. Again, seek advice from your supplier and adhere to label recommendations.

Prevention of seed set

For annual weeds, the prevention of seed set can assist weed control. Some chemical and non-chemical methods include:

- spray topping - treating the seed heads with herbicide at low rates before seed maturity;
- pasture topping - removing seed heads mechanically before seed maturity;
- strategic grazing - stocking the area (if appropriate) heavily before seed set.

For perennial weeds, chemical control is more likely to be necessary (Dreher & McPhee 1994).

Mechanical and manual control

Do you know what's below the surface?
DIAL BEFORE YOU DIG
PHONE 1100
This service provides details of the pipes and cables for gas, water, electricity and phone lines at your site (allow at least 2 - 3 days for the information to be forwarded to you).

There are a range of mechanical and manual weed control options available and there will be one to suit the scale of weed control required and the needs of the site. A number of the options are described below.

Scalping

Scalping involves the removal of the weed seedbank in the top soil by machine or hand.

For this technique to be effective the soil must be scalped to a sufficient depth to get below the weed seedbank. The precision direct seeding machines undertake this form of weed control as part of the seeding operation. Grader blades and bulldozer blades have also been used (refer to Section B, Deep scalping of steep slopes). Scalping for spot sowing can be undertaken by hand using a rake hoe.

While an effective method of weed control, scalping is not recommended on hilly terrain that may erode. It is also important to be aware that everything is being taken away (good seeds and soil microorganisms, along with the bad). It is essential, however, if sowing and using residual or pre-emergent herbicide.

Photo: GAV

Photo: GAV

Scalping being undertaken as part of a direct seeding operation (above) and manually with a rake hoe in readiness for spot sowing (bottom left)

Cultivation

The use of a spring-tyned harrow (not a plough) can be used to maintain a weed free site. A mattock or hoe, for small scale sites may be effective to dig out weeds.

Photo: J. Horlock

Cultivation

Cultivation

Revegetation techniques that require a 'bed' situation may benefit from cultivation. However, this cultivation is not normally recommended prior to direct seeding. Cultivation will mix weed seeds through the soil profile and hence limit the benefits of the shallow scalping undertaken by precision direct seeding machines, namely, removal of the weed seed bank in the top soil.

In any event, direct seeding is an ideal technique for large-scale works. Minimising the number of passes necessary with machinery is fundamental to its usefulness, particularly if that activity, such as cultivation, is counter-productive!

Slashing

The use of a slasher or mower can be used to cut weed growth following flowering and prior to seed set.

Photo: J. Horlock

Slashing

Heat

Flame or steam weeders use high temperatures to 'cook' the top growth. The plants have no defence against the heat. Contact your local agricultural or horticultural supplier.

Smothering/Mulching

Covering weeds with mulch, newspaper or other materials. This is best suited to small-scale projects. The material must effectively block out light and/or smother the growth of weeds.

Mulching at planting can have the added benefit of assisting seedling growth by conserving soil moisture by reducing evaporation and improving water infiltration. Organic mulches, such as leaf litter, prunings, wood chips and organic jute mattings can also improve soil structure and modify soil temperatures which lead to improved plant growth.

Tips for mulching

- Ensure that the material is weed free and that the product will not cause any harm to the seedlings (aging or composting prior to use is recommended for freshly-chipped mulches that may otherwise cause nutrient deficiencies in the soil or that contain toxic phenols or resins that could harm seedlings).
- Keep the mulch clear of the seedling stem to prevent collar rot.
- Obtain good coverage and thickness (this will depend on the mulch type, however, it should last for at least a year).
- Anchor any weed mats or newspaper mulches.

Note that thick mulches will limit opportunities for natural regeneration from seed fall from revegetated plants.

Photo: J. Horlock

Smothering to control weeds

Hand removal

Weeding by hand can be a simple and effective method for small-scale projects, if carried out regularly. Care should be taken to create minimal disturbance and to remove all plant parts capable of re-growth.

This technique does not prevent growth of new weed seedlings and should be undertaken prior to the weeds flowering and producing seed (Horlock 1998). Use of gloves is recommended for poisonous or irritating plants, for example, nettles.

For more information on hand removal refer to *Bringing Back the Bush: The Bradley method of bush regeneration* by Bradley (see Section C).

Biological control

Biological control is the use of organisms to control weeds or pests. Find out if biological control options have been trialled in your area. Contact your local Department of Primary Industries Office (See Section C).

Land management and revegetation options

A change in land management may be an option to control weeds. For example, ceasing fertiliser application in a particular area may, over time, change the balance from a nutrient-rich to a nutrient-poor environment, favouring the return of indigenous species over exotic species.

Another option is suppressing weed growth with dense plantings that enable the indigenous species to outcompete exotics for sunlight, moisture and nutrients. This can link into a staged revegetation program where short-lived colonising species that grow quickly can be strategically planted to help control weeds and establish the optimum conditions for other longer-lived, slower-growing indigenous species, for example, direct seeding, at high rates, of leguminous Wattles and Pea shrub species. Similarly, in South Gippsland, Cassinia species have been used as colonisers to out-compete weeds such as Ragwort (*Senecio jacobaea*) between planted-sown rows of indigenous seedlings. In northern Victoria, timely grazing of grassy weeds has allowed the return of native pasture systems that, in turn, have outcompeted annual, broad-leaved weeds such as Paterson's Curse (*Echium plantaginuem*).

Soil preparation

In some areas, soil preparation will be required to produce loose, well drained and aerated soil ready for plant establishment. Various soil preparation techniques are described below.

Deep ripping

Ripping is recommended to assist root development by re-aerating clay-loams, clay soils, hardpans, or compacted soils. It aims to shatter dry subsoils, allowing easy and rapid root growth laterally and to depth, and to improve infiltration. Doing so, will increase plant survival, vigour and stability.

The loosened and friable soil conditions provided by ripping are also often required for the efficient use of manual planting tools and mechanical planters.

In order to optimise the shattering effect, ripping should be undertaken when the soil is relatively dry (summer or after the autumn break). Ripping in the autumn, some months prior to a spring planting will allow time for rain events and soil settling thereby minimising any large air pockets between soil clods. Similarly, driving a tractor wheel over the ripped lines is also recommended to reduce surface disturbance and help break up soil clods and produce soil 'fines'.

Proposed seeding or planting lines should be ripped to a depth of 30 to 60 centimetres where possible. Broad width and depth of soil shatter can usually be achieved with a winged, single tyne ripper. However, it may be preferred to double rip two lines 50 centimetres apart and plant-seed between the rip lines.

Equipment

Ripping is usually done with a bulldozer or three-point linkage, tractor-mounted, ripping tyne(s). For the correct use of winged ripper-tynes that produce broad width of subsoil shatter at 30 to 60 centimetres deep it is essential to have adequate horsepower. When ripping, try to avoid bringing infertile subsoil to the surface as this can inhibit seed germination.

Soil type and environment

Ripping is **not recommended** in the following soils or environments:

- waterlogged areas or wet soils;
- deep soils;
- streamsides/streambanks;
- cracking clays;
- sites where there is a high level of intact native ground flora.

In clay or sodic soils, it is best to use gypsum and chisel plough these sites. In self-mulching, cracking soils, ripping is not sufficient and can in fact be deleterious leading to subsequent problems (refer to mounding). Ripping is generally of no benefit with deep sands, however, in non-wetting sands ripping may be beneficial due to the mixing of the soils during the operation. Ripping along contours is recommended for hilly sites, particularly for highly erodible soils. It is recommended that you trial an area first to determine the worth of ripping, particularly on different soil types.

Level of disturbance

Deep ripping produces a high level of soil disturbance which may make it an inappropriate method for soil preparation on some sites.

Photo: GAV

Deep ripping using a single tyne ripper to achieve loosened and friable soil conditions

Mounding

Mounding is a soil preparation commonly used for heavy soils, waterlogged or saline soils or for farm forestry. Mounding is critical for moderate to highly saline soils.

There are four main reasons for mounding:

- to improve drainage and soil aeration, for example in waterlogged sites;
- to build up a friable soil bed to allow rapid root growth, for example, in farm forestry sites;
- to combat cracking soils - this is done by developing a rip line, mounding soil over the line and planting into the mound;
- to combat saline soils using an **m-profile** - to date in Victoria, m-profiling has mainly been used in some salinity-affected areas in North Central Victoria (refer to Section B Specialist direct seeding techniques).

Mounding does tend to facilitate faster seedling establishment and growth and therefore reduce ongoing maintenance, particularly weed control. When undertaking direct seeding ensure the mound is well formed.

Equipment

There are several specialised mounding ploughs available, for example, the Rippa Mounder and the Merbein Plough. The Rippa Mounder has a shallow ripper at the front and discs behind and the Merbein Plough has three parallel sets of discs. When using the Merbein Plough, rip then plough. Offset disc attachments on some of the direct seeding/mechanical planting machinery can also create mounds.

It is best to spray, rip and then mound. Mounds should be created at least six months in advance of any seeding or planting to enable the mound to settle and, in saline areas, to allow salts to flush out of the m-profile. Cultivation*, prior to mounding, facilitates the creation of well-formed mounds.

*Refer to note on cultivation on page 35.

Soil type and environment

Mounding is undertaken in an area where a greater volume of friable soil is required to facilitate early plant growth, for example in saline and waterlogged areas.

Level of disturbance

Mounding produces a high level of soil disturbance which may make it an inappropriate method for soil preparation on some sites.

Read about landholder experiences with ripping and mounding as methods of site preparation in Footprints Fact Sheets 1 and 18.

Photo: GAV

Merbein Plough (above) and Rippa Mounder (below) in action

Photo: C. Dennis

High pressure water injectors

An alternative to ripping is the use of high-pressure water injectors. Powered by a fire-fighter pump and water tank, this hand held injector is charged with water and blows holes into the soil, ready for planting. It also has the added benefit of loading up the soil profile with water. Once the holes are created, they can then be planted.

This method is particularly useful in hard to access sites, for planting 'long stem' seedlings in river beds or for use in dry areas. As an establishment technique it is slower than planting with manual tools (Pottiputkis or Hamilton Treeplanters) and greater time should be allowed or smaller scale works planned if this technique is to be used.

Soil type and environment and level of disturbance

High-pressure water injectors can be utilised in a wide variety of environments, from sandy to clay soils. This technique provides the benefits of ripping with a low level of disturbance.

Read about landholder experiences with high pressure water injectors in Footprints Fact Sheets 30 and 34.

Photo: GAV

High pressure water injector being used for planting along a rip line to load up the soil profile with water

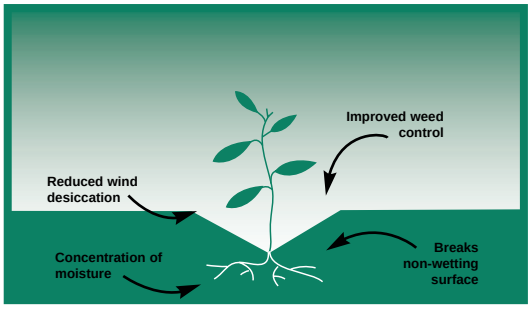
Water harvesting

In low rainfall areas, water can be harvested to enhance plant establishment. Grading the surface of the soil at an angle along the contour and pushing it into a low embankment enables water to pool behind the bank. As shown in the diagram (below), the seedlings are planted into the rip lines on the slope, at the edge of the pooled water (Casey & Chalmers 1993).

Water harvesting in low rainfall areas may be beneficial

Furrow lining

In non-wetting sands, furrow lining is a technique which can be used. The process involves deep ripping and then creating a furrow which can be 300 millimetres deep and up to one metre across. With the non-wetting sands removed from the soil surface, the rainfall can penetrate into the wettable soil below, where the seedling has been planted. To reduce erosion, create the furrow line across the direction of any potential damaging winds (Casey & Chalmers 1993).



Furrow lining in non-wetting sands may be beneficial

Diagrams reprinted from *Tree Tops: the tree planting book for farmers*, with kind permission of the publisher Kondinin Group. Phone 1800 677 761 for further information on Kondinin Group products and services.

3. Pest animal management

Have you got any of these animals on your property?

- Rabbits and hares
- Red-legged Earth Mites
- Slugs and White Snails
- Wingless Grasshoppers
- Crickets
- Ants
- Wallabies
- Kangaroos
- Deer
- Goats
- Livestock

If yes, then read on! They are likely to affect the success of your revegetation.

Control of pest animals is as important as weed control. Whether they are grazing animals or insects, revegetation efforts can be a total failure if there is inadequate pest management. The most effective pest management measures will treat the source of the problem prior to establishing vegetation.

The following advice is a guide only. Contact your local supplier and pest animal officer from the Department of Primary Industries for advice on the most appropriate pest control for your situation (see Section C).

Rabbits and hares

All rabbits and hares need to be eradicated from an area prior to seeding and planting. They have the potential to damage and destroy emerging seedlings and planted trees. Guarding will offer some protection to trees, however, seedlings from direct seeding are generally not guarded.

There are a number of control options, including harbour destruction, shooting, baiting, fumigating and warren ripping. All rabbit warrens within 300 to 400 metres of the revegetation area need to be destroyed. Hares should be constantly monitored as they have a large range; they can be very damaging as they tend to browse rather than graze.

Direct seeded plants will not be associated with fresh soil disturbance (which attracts rabbits and hares) and the plants may be tougher and less palatable than planted ones. However, they will be prone to browsing, particularly over summer-autumn when there is no other green feed available.

Contact the pest plant and animal officer of your local Department of Primary Industries office to obtain site specific advice. To be effective, co-ordinated rabbit-hare control measures with adjoining neighbours/Landcare Group members is recommended.

For some landholders, the use of car tyres as guards has been an effective method of deterring browsing by hares. Just remember to remove them when the seedlings are large enough!

Insects

Red-legged Earth Mite

Red-legged Earth Mites (RLEM) are widespread and major pests of newly emerged seedlings at the two leaf stage. Heavy infestations can rapidly destroy seedlings. If the area where the revegetation is to occur is prone to heavy infestations of RLEM, control is vital.

Approximately one millimetre in size with dark bodies and distinctive red-orange legs, RLEM hatch in autumn after cold and wet conditions and attack and suck the fluids from emerging seedlings. Signs that RLEM are feeding on plants are white spotting on the foliage.

'Chemical control is an important management strategy for RLEM' (Ground Cover 2002). Carefully timed mite control in the spring, using the appropriate insecticide prior to sowing prevents the mites producing eggs over summer and hatching swarms of mites onto emerging seedlings in the autumn. Seedlings will be susceptible, probably until they reach the four to six leaf stage so it is important to inspect plants one week after sowing and regularly thereafter.

Contact The Kondinin Group (Ph 1800 677 761) and ask for the TIMERITE™ date for RLEM control in your area to spray in spring the year before seeding.

Slugs and White Snails

Be on the lookout for slug attack if prolonged wet weather sets in. They hide under the turned over soil and then come out quickly and destroy the emerging trees. White snails are also a potential hazard on some sites.

Baits can be laid along seeding lines, or if using milk cartons in the revegetation program, place baits inside the cartons (cartons may attract snails). Non-toxic products are available.

Be aware of the possible effects on non-target species wherever chemical control measures are used.

Wingless Grasshoppers

Damage to native plants by Wingless Grasshoppers is common; recently established vegetation is particularly susceptible. Wingless Grasshoppers are smaller than a match head and almost black in colour. They have one hatching a year on bare ground when the ground becomes warmer, for example, where Capeweed (*Arctotheca calendula*) has dried off.

Early detection and control is the key. Control by insecticide sprays or baits are an option. You may have to spray a couple of times depending on the season. Even though they are called Wingless Grasshoppers, they can re-infest by coming in with the next strong wind. Before planting trees in known Wingless Grasshopper infected areas, the use of insecticides may be necessary to reduce the likelihood and extent of infestations.

Crickets

Crickets can be a problem in cracking clay areas and insecticides may need to be a control option.

Ants

In some areas ants can be a problem by taking away the seed sown in direct seeding, particularly if sowing into dry soil. If possible, time the seeding for a rapid germination so the seed is not available to be harvested by the ants.

Ant treatments, such as Magnesium Carbonate or the poison Coopex are products that can be added to the seed mix when direct seeding. Again, seek local advice.

Native animals

In some areas, native wildlife, such as wombats, wallabies, kangaroos and possums may cause damage to revegetation. However, native wildlife are protected and their destruction is prohibited without a permit.

Exclusion fencing and deterrents may be options for your area. Where native animals are damaging seedlings, one form of deterrent, for small-scale works, can be to place branches, especially of prickly species, over the revegetation area.

The use of prickly species in the seed mix used in niche seeding can be another effective deterrent to browsing animals. For example, the very prickly species, Hedge Wattle (*Acacia paradoxa*) has been sown in niches with palatable She-oaks (*Allocasuarina* spp.) and been successful at discouraging browsing.

One effective, short-term repellent for wallabies is an egg-based product developed by the Victorian Institute of Animal Science, called WR-1. An adhesive liquid, WR-1 is sprayed onto seedlings, then a calcium carbide grit is sprinkled onto them and allowed to dry overnight before planting the next day. However, the protection given by this product is limited to six to eight weeks.

The use of prickly species, such as Hedge Wattle, in niche sowing has been effective in protecting more palatable species such as She-oak.

Further information

Other ideas on wallaby control are suggested in 'What can we do about Wallabies' by Matt Armstrong, *Agroforestry News*, Autumn 2000, pg. 10.

Another good reference is *A guide to living with wildlife. How to prevent and control wildlife damage in Victoria* by Ian Temby.

Talk to your local Flora and Fauna Officer at the Department of Primary Industries for advice.

Fencing

For the vast majority of revegetation, fencing is the most cost-effective way of protecting plants from livestock and from native animals such as kangaroos.

Designs vary from prefabricated wire fencing, electric fencing and traditional post and wire fencing and will range in cost per hectare. Sloping electric fence designs have been used successfully for kangaroos, for example, at Telangatuk East. Blocking any gaps beneath the bottom wires may be needed to prevent digging under the fencelines.

Fencing can also be tailored to protect plants from the wind in exposed environments, for example, in coastal areas and are a good way to deter vehicle and pedestrian access.

Vermin proof fencing can be constructed, but is usually a very expensive option. For feral animals, it is preferable to tackle the source of the problem and use fencing as a last resort.

On the Red Gum Plains in East Gippsland, trials by the Department of Primary Industries have used fenced plots located within already fenced remnants, to exclude introduced and exotic grazers. While a more expensive option, the trials have shown promising results for the introduction of understorey species in areas where the pressure from grazing is intense.

Refer to the references on fencing listed in Section C for more information on fencing.

Rabbit proof fencing has assisted with the exclusion of rabbits from this direct seeding site in Wooragee, north-east Victoria. **Read more in Footprints Fact Sheet 20**

Tree guards

The two main functions of tree guards are to protect plants from grazing animals and to provide a beneficial microenvironment for the plant's early establishment by providing protection from drying winds and extreme temperatures. In some areas, the visual impact of tree guards can also serve the purpose of raising awareness of the revegetation activity.

However, it is important to consider:

- the cost associated with purchasing guards and stakes;
- the time and labour involved and transport of materials to the site;
- that not all guards are biodegradable and will require follow up removal;
- that tree guards are no substitute for adequate pest control;
- that some guards suit certain site conditions better than others.

If tree guards are required, choose the most cost and labour effective option for the project. A wide range of guards are available including:

- cardboard drink/milk cartons with slits cut in two opposite corners for either bamboo or bent metal wire stakes;
- rigid plastic guards (if light is a limiting factor, use a clear guard);
- plastic sleeves;
- mesh guards, either plastic or galvanised netting wire.

Choosing the guard to suit the site conditions is also important. In parts of the Wimmera for example, milk cartons are preferred to plastic sleeves not only because they are cost effective, but because they do not tend to lift in strong winds which can expose the plant stem to being burnt or killed. Also, the cartons do not tend to 'cook' the trees as the plastic sleeves can in the high temperatures of this region.

Photo: J. Horlock

Photo: J. Robinson

Photo: GAV

Cartons (top), plastic sleeves (middle) and plastic mesh guards are three types of guards available to protect seedlings

Tips for guarding

- Always ensure the guards are held securely in place with stakes or pegs as needed.
- Milk Cartons: Once the seedling is planted, place the guard over the seedling and stake. Then, heap the soil back around the base of the milk carton. This helps to keep the carton in place, channel water down and trap water in the carton for the plant rather than allowing it to escape for weed growth outside the guard.
- Order stakes and guards a minimum of two months before the planting day to allow time for delivery!

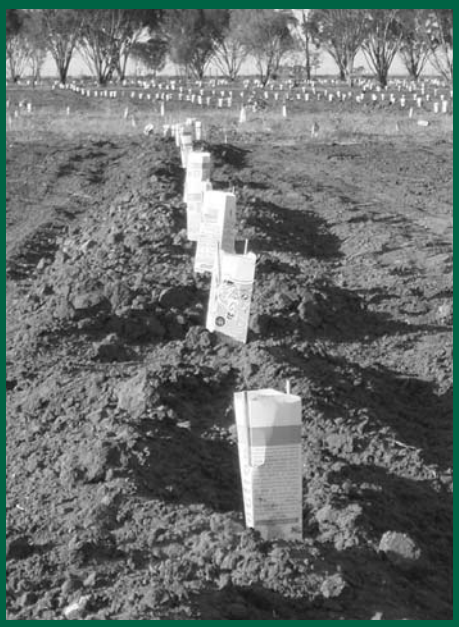


Photo: GAV

The site preparation used here was ripping and mounding. The soil was then heaped back around the milk cartons after planting.

4. Seeds and seedlings

Seed

Seed is a fundamental resource for any revegetation project and the use of locally sourced seed is recommended. This will achieve the best possible outcomes when biodiversity is an objective of the revegetation.

Whether using seed for direct seeding purposes or for raising seedlings, forward planning is critical.

- Place orders for seed preferably two years before undertaking the seeding or planting (the minimum is September in the year before a spring revegetation).
- If the seed is for propagation by nurseries allow the same amount of time to enable collection and sowing.

It is essential to provide enough lead time for collectors to obtain the quantity and diversity of desired species and allow for the fact that some species do not seed each year. It will also enable the nursery to have the plants grown, to the right stage, if you are planting seedlings.

Purchasing seed

When purchasing seed, always check its origin, its age and its viability (if known). Indigenous seed can often be purchased from local seed collectors or seedbanks. Greening Australia Victoria can provide you with a copy of the 'Seedbanks and Seed Collectors in Rural Victoria' listing.

'FloraBank Guidelines' have been developed to provide recommended standards for different aspects of collecting, extraction and storage of seed, such as keeping records and storage of seed for revegetation. A number of regional community seedbanks in Victoria have adopted these Guidelines which helps to ensure that high quality seed is available (refer to Section C). If your regional seedbank does not have suitable seed for your project, collectors will need time to plan and collect the appropriate seed.

Place orders well in advance to allow collectors time to plan and collect the seed.

Photo: GAV

Buloke seed

Collecting seed

Seed collection is an easy and often enjoyable activity. However, practitioners do need some knowledge and skills plus some basic equipment to successfully collect viable seed. To assist in gaining these skills and knowledge, you could attend a local training day; Greening Australia Victoria regularly runs seed collection training.

If collecting your own seed or propagation material you should consider the following points.

- Get to know the indigenous species that grow in your area. The key parts of plants for species identification are generally, flowers and fruits, for example, pods.

- Become familiar with the annual reproductive cycle of plants (buds, flowers, immature and ripe fruits) to ensure that collection is undertaken when fruits contain viable seeds.

  Generally, seed collection is a summer activity (80 to 90% of native plant fruits ripen over summer).

- If possible, match the environmental conditions at the planting site with those of the collection location, and work out which areas you can collect from.

- **Obtain permission** from the landowner or manager first when collecting seed whether from public or private land. The Department of Sustainability and Environment and the Department of Primary Industries manages most public land. However, other public land managers such as Vic Roads, the Public Transport Corporation and local councils should be contacted where appropriate.

- If collecting on public land you need to obtain a **permit** from the Department of Sustainability and Environment. Permits from the Department of Sustainability and Environment are free; telephone 13 61 86 to obtain the appropriate permit. In some instances a permit is also needed for collection on private land, for example, if the area is declared critical habitat.

  You should comply with all the conditions of the permit, for example, how much can be collected, from what material it can and cannot be collected and how the material can be collected. Collection from some species is restricted or not permitted at all. As a general guide, with remnant plant populations, take small amounts of seed (no more than 10% from any one plant) from a large number of plants of the same species in an area to help maintain genetic diversity and reduce inbreeding 'depression'.

- Collection from cultivated seed orchards or revegetation sites are an exception, as most or all of the seed can be removed.

- When collecting seed, collect responsibly (minimise pruning damage to plants and ideally pick fruits only), watch where you walk (minimise damage to ground flora) and generally create minimal disturbance to the collection site.

- Thoroughly dry the fruits and seed; extract seeds from fruits; label the storage container with the date of collection, collector, species and location of collection for future reference; and store seed in a cool, dry, dark place that has even temperatures throughout the year.

Further information

The seed collection permit information above was based on the Department of Primary Industries Landcare Note LC0110 *What permit do you need to collect local seed?* Further information from this note and on seed collection can be obtained from the references listed under Seeds in Section C, including the FloraBank Guidelines, website and information notes series from the Department's website.

Photo: D. Walters

Seed storage at the Mallee Seedbank, Mildura

Seed data management

The Seed Supply System is a database designed by Greening Australia Victoria to help manage the records of seedlots. A standard 'Seed Collectors Record Book' which is consistent with the Seed Supply System is also available. For further information, contact Greening Australia Victoria.

Seed collection equipment

Equipment needed for seed collection can include high pruners, secateurs, drop sheets or tarpaulins, collecting bags or containers with neck straps (for example, fruit collecting equipment, kidney trays), wool bales, buckets, envelopes and gloves (pictured on page 47).

Seed collection is generally undertaken in summer. Take appropriate precautions to minimise the potential hazards of working outdoors in the heat, for example, sunburn block-out, hat and water and watch for snakes, spiders and ants.

Photo: GAV

Seed collecting equipment

Native grass seed collection

There is a range of equipment to assist with the efficient collection of native grass seed. The Bandicoot Native Grass Seed Harvester, now available in a number of regions in Victoria, is a portable, easy-to-use brush harvester drawn behind a 4WD motor bike or utility. This harvester is a very efficient collector of clean seed and is suitable for most native grass species. Other equipment used for native grass seed harvesting includes brush harvesters mounted on 4WDs, whipper-snipper brush harvesters, sickle-bar mowers and the use of portable vacuum cleaners.

Contact Greening Australia Victoria for advice on equipment available in your region.

Photo: GAV

Harvesting native grass seed using the Bandicoot Harvester in the Wimmera (above) and vacuums to collect seed in the Mallee (below)

Photo: D. Walters

Pre-treating seed before sowing

The seed of many Australian plants needs to be treated before it will germinate to break dormancy.

To maximise the germination of species sown in revegetation, we need to understand the biology of the seed and know what pre-treatment(s) is required (if any) for each species and apply it before or at the time of sowing.

Examples of treatments that overcome seed dormancy by mimicking environmental conditions are briefly outlined below. As research into seed biology is ongoing, obtain the latest advice for the species in your area prior to revegetation.

Eight of the treatments available to overcome seed dormancy

Seed Treatment	Purpose	Method	Examples
Light exposure	Sunrays help to weaken the outside covering of the seed.	Sow seed close to or on the soil surface and lightly press in to create good seed to soil contact.	Myrtaceae family, for example, Eucalypts, Bottlebrushes (*Callistemon* spp.) and Paperbarks (*Melaleuca* spp.) and native grasses such as Kangaroo Grass (*Themeda triandra*).
Darkness	Darkness (short day lengths) and cold triggers germination for some species.	Sow seed a little deeper; sow in early to mid-winter.	Liliaceae family, for example, Flax-lilies (*Dianella* spp.).
Stratification	Cold conditions trigger germination.	Subject seed to a given period of low temperature, usually in a refrigerator.	Cypress-pines, high altitude Eucalypts and Bursaria species (*Bursaria* spp.).
Maturation or after-ripening	Allow seed to mature before sowing.	Store seed for a given period of time.	Saw-sedge (*Gahnia* spp.).
Hot water treatment	Crack or soften the outer seed skin to allow moisture into the seed's food storage and embryo.	Check for the correct temperature and duration for the given species.	Hard coated seeds, such as, Wattles, Senna (*Cassia spp.*) and Eutaxia (*Eutaxia* spp.).
Scarification	Rubbing or nicking the seed or completely removing the seed coat.	Note: pay careful attention to scarification as it can easily damage the seed's embryo. If nicking, do not nick the seed at the end with the fleshy aril attachment.	Used for hard coated seeds.
Leaching	Overcome salts, tannins etc. contained in the seed.	Place seed in running water.	The leaching of salt has been one of the major developments in being able to direct seed many varieties of Chenopod seed (small shrubs and herbs, particularly well adapted to saline areas).
Smoke	Helpful in releasing dormancy factors.	See below points for the different methods of applying smoke.	Leguminosae family (such as Wattles), Proteaceae (such as Banksia) and Myrtaceae (such as Eucalypts).

The above treatments and examples were based on *Germination Pathways* a presentation given by Neville Bonney at Greening Australia Victoria's 'Smart Seed' Native Seed Forum, 2002 and are presented with permission. The complete *Germination Pathway* chart developed by Bonney is recommended for more detailed information.

Methods for applying smoke as a pre-treatment

- Spraying the seed with smoke water as it leaves the direct seeding machine.
- Soaking the seed in diluted smoke water prior to direct seeding.
- Lightly spraying smoked water onto the seed prior to seeding. The addition of a wetting agent can also be useful to combat seed hairs that repel water.
- Broadacre spraying of smoked water onto sites where a seedbed of native species is likely to be present in the soil. This should encourage germination.

Further information

Refer to Section C for additional references on seed and refer to the latest advice and trials being facilitated by Greening Australia Victoria and the *Seed Germination Data Sheet Series*.

Priming seed

Some direct seeding techniques, mechanical and hand, such as niche sowing, use pre-germinated or 'primed' seed. Priming starts the process of germination, that is it takes the seed into the germination phase. This differs from pre-treating the seed which only effects the dormancy mechanisms of seeds.

With priming, the seed is brought to the point just before root emergence, and then sown; this encourages rapid germination of seedlings after sowing. The plant has the chance to exploit the available resources, such as moisture, before the weeds. Its chance of being eaten is also reduced!

A number of direct seeding practitioners, who use direct seeding machines, are priming seeds for twelve to twenty-four hours, then drying them to enable good seed flow through the seed box, and finally sowing. The brief drying, for a short time immediately prior to sowing, does not kill the seed.

Hints for priming seed

- Only sow primed seed into wet soil conditions as the seed will continue the germinating process after sowing but will die if there is no moisture available. Do not prime seeds if sowing 'dry', for example, in the Mallee.
- If the seed has gone 'too far', that is, fully germinated with root emerging, seedling development may be physically damaged or will risk shock when sown.
- The seed may die if the site suddenly dries out or there is an extreme event such as heat, cold or a rain downpour.

Further information

Refer to Niche sowing in Section B.

Seed quality: germination testing

Germination testing is a service that many seedbanks can offer, usually on a fee for service basis.

Germination testing of individual seedlots is useful:

- to determine the percentage of viable seeds per gram;
- to assist with understanding reasons for low germination success in the field, for example, low seed viability versus site factors.

Seed orchards

More recently, revegetation sites are being established specifically as seed orchards where plants are grown for seed harvesting. Seed orchards provide a number of benefits including:

- reducing the pressure on remnant plant populations in the wild as sources of seed;
- helping to meet the demand for seed for revegetation;
- helping to provide the quantity of seed needed (Seabrook 1994);
- providing a financial return.

Well-documented revegetation sites are playing an increasingly important role in the supply of seed as seed orchards. However, documentation of the origin of seed used in these sites is required before they can be confidently used as seed sources for future projects, particularly if biodiversity (genetic variability *within* a species) is an objective. Where the seed origin cannot be tracked from collection to revegetation, it is not recommended for use in biodiversity-focussed projects. Keeping records of the seed source also helps to ensure certain areas are not exploited.

Photo: D. Warne

Weeping Grass (*Microlaena stipoides*) being planted at Five Ways Seed Orchard, Dunkeld. The site also contains Bristly Wallaby Grass (*Danthonia setacea*) and Redleg Grass (*Bothriocloa macra*).

Photo: P. Curucan

Pallister's Reserve Understorey Seed Orchard, western Victoria.

Track the seed in your revegetation program from collection to planting to ensure that sites are useful as future seed reserves.

Further information

For more information, refer to the FloraBank Guidelines and **Footprints Fact Sheet 4**

Seedlings

A range of containers can be used to grow seedlings including:

- **Cells** - multi-celled containers arranged in trays. Cell plants can be grown in a variety of sizes and in containers with and without lateral air pruning of the roots.
- **Individual containers**, for example, forestry tubes and bare rooted seedlings.

Cell grown seedlings

Forestry tubes

Tips for working with plant stock

- Choose plant material of a high quality. A high quality plant will:
  - -have healthy foliage;
  - -have a robust root system (if a legume, check that is has nodules present);
  - -be actively growing;
  - -be well proportioned, that is, a good balance of roots to shoots;
  - -be free from pests and diseases;
  - -be clearly labelled to identify the species;
  - -not be supplied 'soft' from an igloo or shade house but will have been well hardened-up outside.

- Check with the nursery that they can guarantee the origin of the seed or alternatively provide the nursery with seed that you have collected.

- If placing a large order consider spreading the 'risk' over a number of nurseries; nursery 'disasters' can happen, for example, frost events and poor or no germination.

- Consider the length of time the plants are left in the container - too long and they may be pot bound.

- Choose plants that have been grown in conditions that help to prevent root circling or that reduce the damage to the root, for example, air pruning and ribbed pots.

- Place plant orders well in advance - a minimum of twelve months before planting. This will allow nurseries to obtain the right seed and have plants grown to the right stage.

Choosing the container

Choose the right container for the job and for the revegetation equipment that you are proposing to use. Your indigenous nursery will be able to advise you on the most appropriate container for the species that you are having grown (for example, the smallest cell sizes are unsuitable for tree seedling root development) and the type of site where they will be planted (for example, native grasses that will be planted into bare ground can be grown in the smallest sizes of cells; a larger cell is more appropriate if the grasses are to be planted into a mulched site).

Features of plants grown in cell propagation systems

For most revegetation, cell grown plants will be the most efficient and cost effective type of seedling. The reasons for this include that:

- they are low in cost (10 to 60% of the price of a forestry tube);
- they require less space, less growing medium and water compared to tubestock;
- they are efficient for planting in terms of time, transporting, effort and water use;
- their smaller size and less mature root systems increase their chance of survival (providing the site conditions are right);
- they are easy to remove from the container;
- they make possible the efficient large-scale propagation of species that are not economic when grown in individual pot systems, for example, Saltbush and native grasses and farm forestry seedlings.

Note: The potting media used in cells should have smaller size particles and greater moisture holding capacity than that used in tubestock. If the correct potting media is used cells should not dry out significantly quicker than tubes.

Cell grown seedlings

Further information

The following reference provides more information on cell propagation systems: Millsom, D (et. al). (1999). *Growing and Planting 'Cell' or 'Plug' Tray Seedlings.* (Greening Australia Victoria: Heidelberg).

Features of plants grown as tubestock

Tubestock seedlings:

- are best suited to smaller-scale projects;
- enable small quantities and a high species diversity to be grown;
- are more resilient than cell grown stock, particularly if there is going to be a considerable delay until planting;
- can be used in some mechanical planters;
- are preferred in some regions, for example, in South Gippsland where there is very strong exotic grass competition the depth of the tube can be an advantage for plant establishment.

Forestry tubes

5. Revegetation

Up to this point much time and effort has gone into the planning, preparation of the site and resourcing materials for the project. The next step is getting the seeds or seedlings in the ground at the right time and with the right method to suit the site and project size.

Natural regeneration, direct seeding and planting are the three main techniques of establishing native vegetation. In many cases, a combination of these methods may be used and a variety of equipment and machinery is available to suit the job. The choice of technique will depend on the objectives of the project, the site conditions, resources available and project size.

Revegetation techniques, their uses, advantages and factors to consider and the equipment and machinery options are followed up in detail in Section B.

However, two general issues associated with the revegetation stage of any project are watering and the use of fertiliser.

Watering

There are differing opinions on watering at the time of planting and post-planting watering. Watering at the time of planting is advantageous to help overcome any transplant shock, to help remove air pockets from the roots and establish good root to soil contact. Follow up watering after the day of planting is not usually necessary if good quality, hardened-up, indigenous plant stock, adapted to local conditions, has been planted correctly (no potting media exposed) into a well-prepared, weed free site at the appropriate time (particularly if there is a reasonable expectation of rainfall).

Direct seeding operations rely upon the build-up of moisture within the soil that results from weed control activities to support the germination and establishment of seedlings. Therefore direct seeding should be timed to coincide with predictable, follow-up rainfall. The planting of seedlings should also be timed for these conditions.

Particularly dry areas

To help guarantee success in particularly dry areas, for example, north-west Victoria, a follow-up watering may be necessary five to seven days after planting. The use of water injectors for planting in these areas can also help provide moisture to depth (refer to Section B).

Particularly wet areas

In high rainfall areas, when the timing of planting is correct, watering is not usually necessary at all.

Fertiliser

As indigenous plants are generally adapted to low nutrient soils, fertilisers are not usually necessary in revegetation programs. Fertilisers are more likely to benefit weed growth! However, for farm forestry sites where maximum growth rates are essential, fertilisers are commonly applied.

Further information

A good reference for the use of fertiliser in farm forestry is Agnote AG0788 *The use of fertiliser in farm forestry* by Bruce Sonogan, available from the Department of Sustainability and Environment's website: http://www.dse.vic.gov.au/notes (search for fertiliser)

6. Site maintenance

The table below provides some general tips for maintaining a revegetation site. The information to follow outlines the importance of plant identification when it comes to maintenance of revegetation sites and finally, weed management options for the second season are discussed. However, it is always best to seek advice about appropriate follow-up strategies for revegetation sites in your area.

Tips for maintenance of a revegetation site

Patience!	• Plants that have been direct seeded will take time to establish and the site is likely to look untidy at first (depending on how thorough your weed control was). • Don't be too impatient - even in moderate seasonal conditions the key to success is good site preparation before seeding or planting.
Inspect germination of direct seeded areas	• After direct seeding the first inspection is not usually needed for four to six weeks (depending on the season). • Different species will germinate at different times. Some will germinate many months after sowing, and others may come up more than a year later. • Identify what has germinated and keep records. It is good to be able to identify both the indigenous and exotic species coming up. The photos on pages 55 to 57 provide a guide for identifying nine indigenous species.
Pest animals	• Check the site when seedlings are at the two-leaf stage for large numbers of pest animals, particularly RLEM and, in wet years, slugs. • Implement pest control as required. • Check the seedlings for evidence of grazing/browsing and apply appropriate management if required, for example, protection from wallabies.
Post weed control	• Post-planting/seeding weed infestations will be reduced if the site preparation has been carried out thoroughly.
Fencelines	• Check, when convenient, that fencelines are stock proof, and, for electric fencing, not shorting out (ensure you include a gate to get the stock out!).
Plant losses	• If required, replace any plant losses as soon as conditions permit (except if it is a farm forestry planting that will be thinned).
Thinning	• Thinning is likely if it is a farm forestry site. However, if the purpose is to achieve a natural effect, generally leave the seedlings to sort themselves out.
Tree guards	• If tree guards have been used, maintain them and remove as needed.
Watering	• Watering at the time of planting establishes good root to soil contact and helps overcome transplant shock. Follow-up watering may be necessary if plants have been established in very dry seasons (refer to detail on watering on page 53).

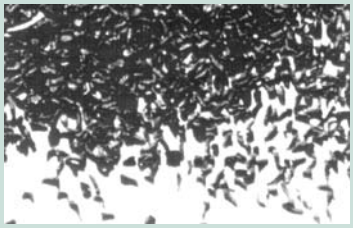
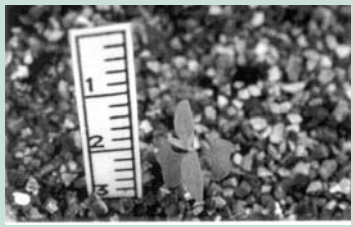
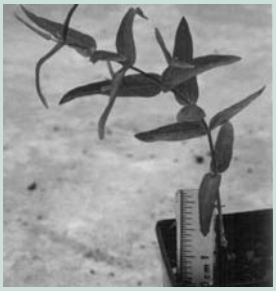
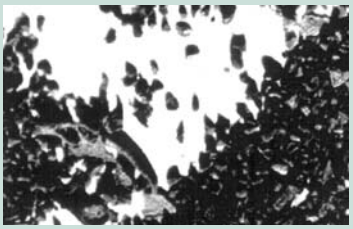
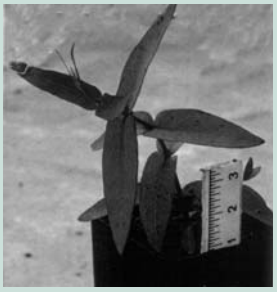
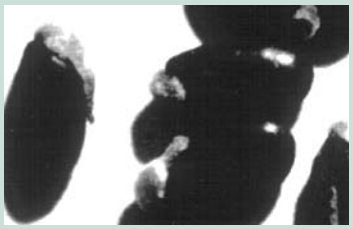
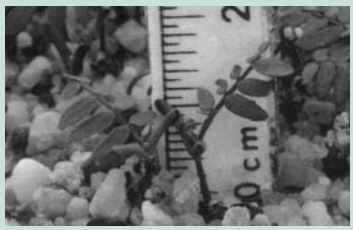
Plant identification

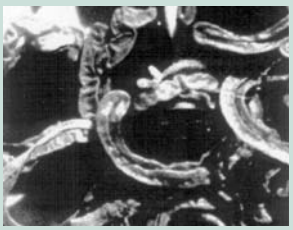
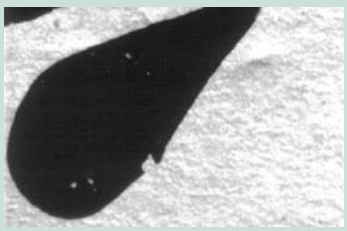
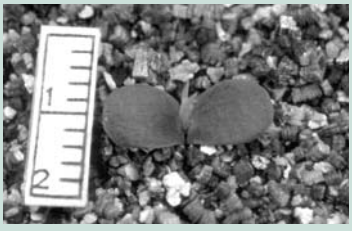
Plant identification is a very useful skill for revegetation. Knowing which are the plants to keep and which are the plants to eradicate is important. However, this does not mean you have to be a botanist. Finding out the names and main features of some of the key species that you have planted or sown will be very helpful, particularly when it comes to follow-up maintenance. Knowing what the native seedlings look like during their early stages of growth will make it much easier to identify what will need to be controlled.

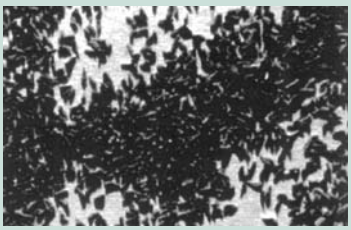
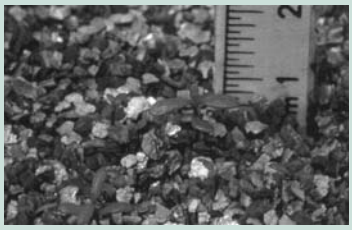
There are many colour plant guides available, for indigenous plants and weeds. Refer to Section C for some of the titles. Once you get your eye in, you will quickly remember the species.

The following table provides a photograph of nine common indigenous plants from seed to different seedling stages.

Guide to the identification of nine indigenous seedlings

Seed	Early seedling stage	Late seedling stage
1. Manna Gum (*Eucalyptus viminalis*)			
2. Narrow-leaved Peppermint (*Eucalyptus radiata*)			
3. Golden Wattle (*Acacia pycnantha*)			

Seed	Early seedling stage	Late seedling stage
4. Blackwood Wattle (*Acacia melanoxylon*)			
5. Silver Wattle (*Acacia dealbata*)			
6. Coast Banksia (*Banksia integrifolia*)			
7. Yellow Hakea (*Hakea nodosa*)			

	Seed	Early seedling stage	Late seedling stage
8. Moonah (*Melaleuca lanceolata*)			
9. Prickly Tea-tree (*Leptospermum continentale*)			

Photos: Greening Australia Victoria's Melbourne Indigenous Seedbank

Weed management options for the second season

Weed management options following seeding or planting should aim to minimise weed competition for one year (ideally two years for farm forestry) and be tailored to the site conditions. In some cases, a compromise between plant growth and weed control may be necessary. For example, in saline soils where the reduction in the water table is the goal, bare ground should be avoided.

If the site has been prepared well in advance, weed infestation problems should be largely reduced. The following information outlines some of the weed management options available.

Manual weed control

Pulling weeds out by hand or digging them out with a hoe, along or beside the seeding or planting line may be an option for small scale projects. Always try to avoid disturbing the roots of the sown or planted seedlings.

Overspraying

Selective herbicides that target, for example, grassy weeds, may be used as an overspray over the seeding or planting line, particularly after summer-early autumn rain events. Overspraying is a method regularly used in direct seeding. Take due care and ensure the sprayer is accurately calibrated.

Shielded or directed spray

An alternative to overspraying is the use of a shielded or directed spray mounted on a ute, motorbike or a backpack. This technique will eliminate any natural regeneration of desirable species between the seeding and planting lines. Care must be taken to avoid spray drift. Success will depend on the accuracy of the driver and the effectiveness of the shield.

Photo: M.Dodds

Handheld shielded spray applicator (above) and a shielded spray unit mounted on a utility

Photo: R.Dodds

Rope wick weeding

A Rope Wick Applicator is one method to selectively control weeds where the weeds are considerably taller than the planted seedlings. The Applicator brushes against the tall weeds, wiping them with herbicide, while passing above the lower-growing indigenous seedlings. It can only be undertaken where the weeds are considerably taller than the indigenous seedlings (Department of Agriculture 1995). This will probably be too time consuming and tedious if you have kilometres of revegetation.

Photo: R.Dodds

Rope Wick Applicator being used for selective weed control

7. Monitoring

Why monitor?

Monitoring of revegetation sites is important. It helps to keep track of what is happening at the site and the impact of the revegetation works. It provides information that will help to improve the project at hand and improve future activities. To be of most use, monitoring should be set up from the beginning of the project, at the time of the site assessment, to provide a baseline of data with which to compare progress over time.

Inspecting the success of a mouldboard ploughed shelterbelt in the Corangamite region

Examples of monitoring activities

Taking regular photos of the site and activities from a fixed location (photopoint).

While this is often a requirement of publicly funded projects, it is worth doing for your own satisfaction. You quickly forget what the site looked like and photos provide a great visual record of what you have achieved!

When setting up a photopoint, mark it so that you know where to come back to. Also consider what the site will look like in future years and take the photo at the appropriate distance. Too close to the revegetation area and the shot will soon be blocked out by the trees. Picking a high position and a landmark to line up with can also be helpful.

Read about a monitoring program set up by a landholder in Footprints Fact Sheet 6.

Monitoring of a mouldboard ploughed site in West Gippsland

October 1997 and ready for mouldboarding

May 1998

Photos: K. Walsh

November 1999

Recording the establishment and survival of different species.

For direct seeding, if time allows, undertake basic counts of seedling establishment by species, using for example, ten metre transects every 100 to 200 metres along each seeding line. This information will help refine (and hopefully reduce) future seeding rates for different species and pinpoint species that require more research into their biology-germination requirements.

Photo: GAV

Recording vegetation establishment and survival

Keeping a list of the birds and animals observed.

Expect dramatic increases in bird species once trees and shrubs are four to five years old and have enough structure to provide some habitat. (See *Birds on Farms* report by Barrett listed under Wildlife in Section C)

Photo: R. Dodds

The use of this revegetation site by small mammals and reptiles is being monitored with pitfall lines

Read about the return of native birds to a revegetation site in Footprints Fact Sheet 17.

Checking for pest plants and animals.

Testing the water quality in creeks, dams and wetlands and monitor depth and quality of water from any bores adjoining your revegetation sites.

Contact the Waterwatch program for advice and information (refer to Section C).

Spatial and database recording of information.

Global Positioning Systems (GPS) equipment can be used to spatially record where revegetation activities take place and project information can be recorded onto databases, such as the Catchment Activity Management System (CAMS). This is a web based system that provides a spatially linked register of activities and includes information such as details of on-ground works and location of activities. For further information on CAMS phone the Department of Sustainability and Environment on 03 5833 5297.

Photo: GAV

Hand held GPS unit