NSW GOVERNMENT | Biodiversity Conservation Trust

Biodiversity Conservation Trust

Restoring Native Vegetation

Guidelines for assisted regeneration and revegetation

August 2019

Contents

Objective

Restoring vegetation cover on your property can help to improve your site's overall condition, connect habitat for animals and increase resilience to climate change. This is particularly important in agricultural landscapes where ecosystems are under significant pressure from a history of clearing and fragmentation.

The NSW Biodiversity Conservation Trust (BCT) partners with landholders to conserve and manage biodiversity on private land by establishing conservation and biodiversity stewardship agreements. You may already have an agreement on your property, or you may be looking to apply for one. If you are looking to restore the native vegetation on your property as part of this agreement, this guide will help take you through six key stages to ensure your project has a high chance of success and provides optimal biodiversity benefits.

Figure 1 - Planting wattle species using tubestock at a revegetation site

Introduction

The restoration of native vegetation, in combination with the protection and rehabilitation of remnant vegetation, can reverse the negative effects of clearing and habitat fragmentation. This can occur through either natural regeneration, assisted regeneration or revegetation (see Figure 2). These are defined as:

Natural regeneration: plants are able to grow back unassisted from seed in the soil seed bank, or from a nearby canopy. This occurs in highly resilient sites where the seed stock is intact, and there are very few, if any, existing threats present.

Assisted Regeneration: the practice of fostering natural regeneration by actively removing threats and/or providing a trigger (e.g. soil disturbance or fire) to enable this to occur. It is appropriate for sites with moderate to high resilience where the seed stock is still largely intact.

Revegetation: the introduction of plant propagules (either seedlings/tubestock or direct seeding) into sites with depleted or low resilience. In these sites, seed stocks have been depleted or are absent, and/or competition from introduced pasture plants or weeds are preventing natural regeneration.

The BCT uses assisted regeneration and revegetation as management approaches to actively restore vegetation in its agreements.

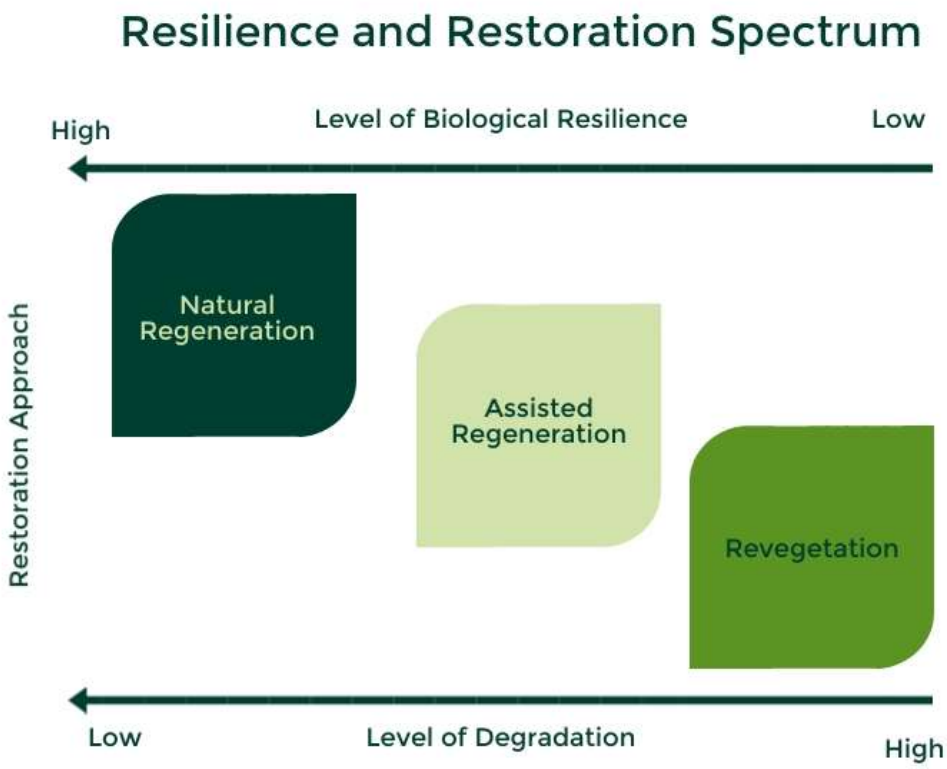


Figure 2 – Approaches to restoring native vegetation depending on the level of resilience/degradation

Principles

To ensure vegetation restoration activities are effective, the BCT recommends that your project is guided by the following principles[1]:

1. First address and mitigate the threats on site that are causing degradation.
2. Base management decisions on the level of resilience and degradation at the site. Where conditions are appropriate, assisted regeneration is preferred over revegetation.
3. Facilitate recovery by identifying clear objectives that aim to achieve ecological integrity.
4. Exclude (or strategically manage)[2] livestock in restoration areas.
5. Use locally indigenous (and/or climate-ready) plant species.
6. Aim to achieve complexity in vegetation structure using a diversity of species.
7. Base decisions on the best available science and seek advice from a professional restoration practitioner where appropriate.
8. Manage risk of failure through careful planning, clear objectives, measurable targets, adequate site preparation, ongoing maintenance and monitoring.

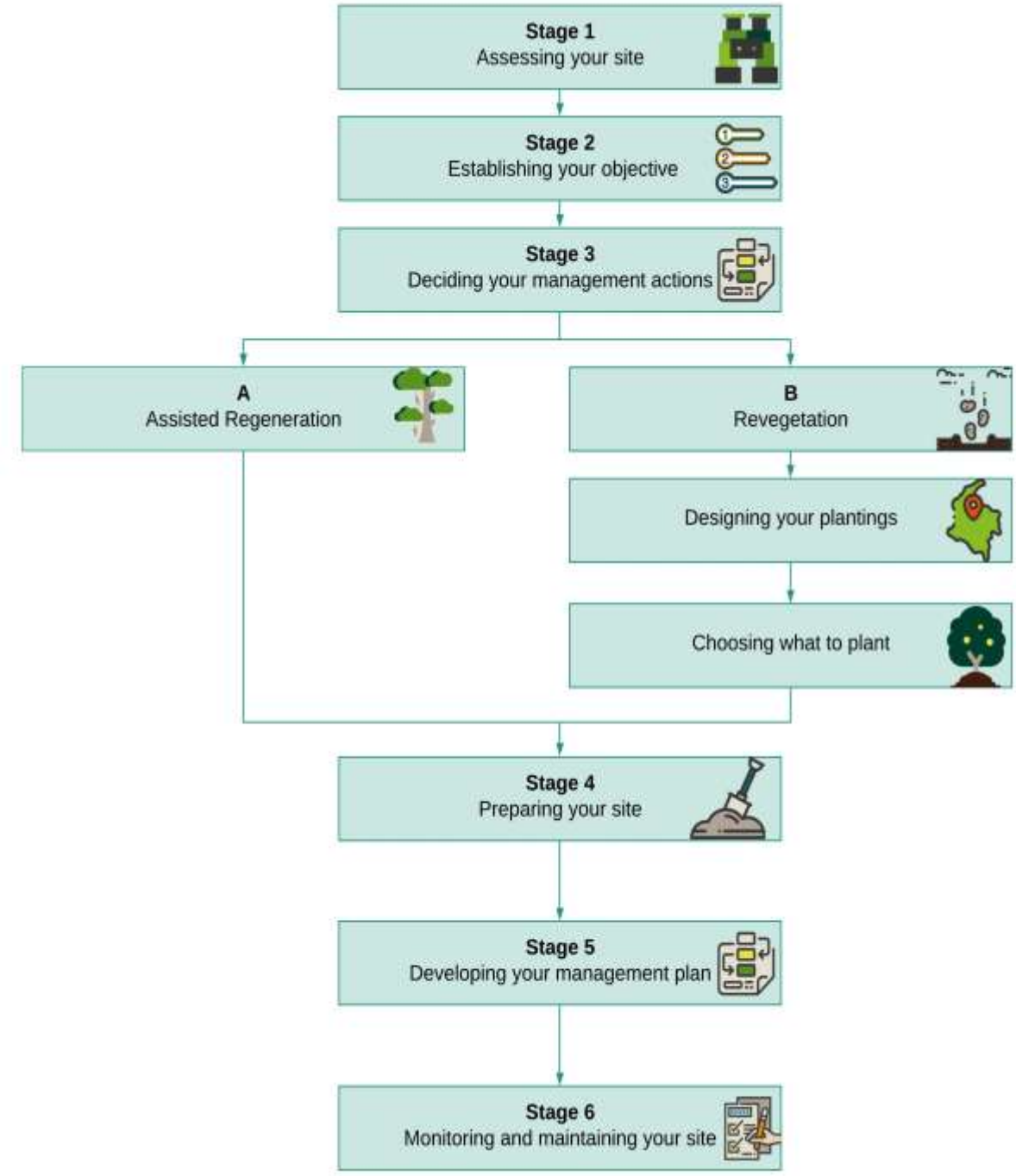
Figure 3 – Revegetation project underway in southern NSW. Photo by Nigel Jones

[1] Adapted from SERA's principles

[2] See the BCT Conservation Grazing Guidelines for further details.

Framework

This is an overarching framework to step you through the stages of planning an assisted regeneration or revegetation project. BCT staff can support you in working through this framework and if required, link you with professional restoration experts. Advice from an expert is encouraged, especially where proposed management will require a high level of capacity, capability or investment. More detailed information about each stage is provided in the sections below.



Stage 1 – Assessing your site

As part of your agreement, BCT staff will assess your site to determine the vegetation types present and their current condition. Vegetation condition will be influenced by the site's management history, for example, fertiliser use, addition of pasture species and grazing intensity. BCT staff will help identify any major threats existing on the site, including any threats that may change over time. Where possible, these threats will first need to be addressed before undertaking a restoration project.

This stage also involves assessing the inherent resilience of the site.

- Signs of a resilient site include the dominance of native grasses and ground-cover plants in the ground layer, and relatively low weed cover. Other signs of resilience can include the presence of old remnant trees, either in or adjacent to the site. Resilient sites may also have tree or shrub re-growth (e.g. young native saplings).

- Signs of depleted resilience include a high presence of weeds, or the dominance of introduced pasture grasses in the ground layer. There will commonly be minimal regrowth and few living trees, although some paddock trees may be present. There may also be other issues such as land degradation, soil erosion, and high rainfall runoff.

Figure 4 - Assessing the vegetation condition and resilience of a conservation site in Boorowa, NSW © Petaurus Education Pty Ltd

Stage 2 – Establishing the objective

The ideal objective for any native vegetation restoration project is to recreate the native vegetation believed to have occurred before it was degraded. This involves understanding what good condition looks like for the vegetation on your property and determining where, on the scale of degradation and resilience, your current vegetation condition sits in comparison.

One way to think about this is through a State and Transition model (see Box 1). This is based on the idea that an ecosystem is generally in a relatively stable state until a threat (such as a grazing event) causes a transition to another relatively stable state. A threshold is reached if vegetation changes are so significant that, even if the threat is removed, it cannot revert to a previous state without a management intervention.

BCT staff can assist you in determining what good condition looks like for the vegetation on your property and in identifying your current vegetation condition state and level of resilience. This is done using available benchmarks for the vegetation type present or by identifying appropriate local reference sites. It is often an iterative process which begins with understanding the past, current and possible future conditions of vegetation on your site. Determining the current state of your site will help determine what is a realistically achievable objective. This information will also help inform what management intervention, revegetation, or assisted regeneration is most appropriate (see Stage 3).

Achieving full restoration using assisted regeneration may be a realistic objective if, for example, your site has a high level of inherent resilience. In very degraded sites however, simply getting one or two species of trees or shrubs to survive can be a major achievement. This is often because the soil composition is so altered (i.e. threshold passed) that it no longer supports the original understorey. Rather than achieving full restoration, an appropriate objective for such a site would be to establish the pioneer and canopy species that help create the conditions for natural regeneration of understorey species to occur.

The decision about what objective to set should be based on an understanding of the current condition of your vegetation, a cost versus benefit analysis, the ability to manage current threats and the purpose of your agreement. If the main purpose for your site is to restore connectivity for a threatened species for example, achieving full restoration may not be appropriate and/or too costly.

Box 1 - State and Transition Model

This concept is based on the idea that an ecosystem is in a relatively stable state until a high impact disturbance (such as a fire or prolonged grazing event) causes a transition to another relatively stable state. A threshold is reached if vegetation changes are so significant that, even if the disturbance is removed, it cannot revert to a previous state unless a management intervention (such as a replanting) is introduced.

Many grassy woodlands for example, may not have recovered to their desired goal state even after the main threat of inappropriate grazing was removed through fencing and stock exclusion. It is likely that a long history of grazing and clearing in these landscapes has diminished the seed bank and allowed exotic plants to compete to such an extent that sites have crossed a threshold – meaning that they are unable to recover naturally without management intervention.

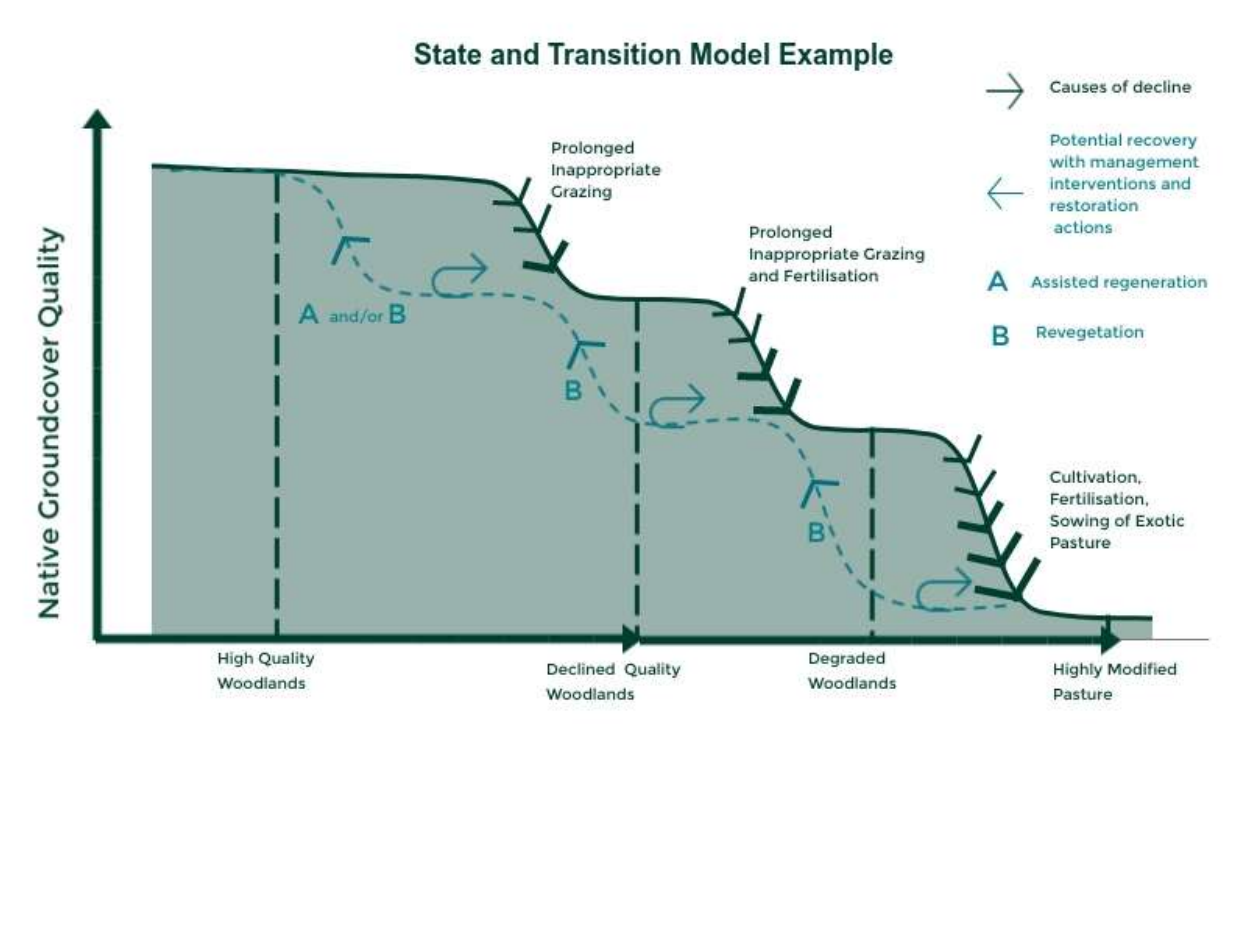


Table 5 – State and Transition model

Stage 3 – Deciding on your management actions

Establishing the status of vegetation condition on your site and its inherent resilience will help inform what management actions, assisted regeneration or revegetation, are most appropriate. The more degraded and less resilient the site, the less likely natural regeneration can occur (Table 1).

Assisted regeneration of remnant vegetation is most likely to be an appropriate management action at sites that have low to moderate levels of degradation with capacity for recovery within an acceptable timeframe. For highly degraded sites, where managing threats is not enough to allow regeneration within a short-term timeframe, revegetation may be required. Where remnant trees still exist but specific species or a layer of vegetation are missing, supplementary planting may be more appropriate.

Always consider if it is worth investing the resources to successfully undertake a revegetation project. Fencing of remnant areas or excluding grazing may be enough for regeneration to occur naturally. Assisted regeneration, where conditions are appropriate, is a preferred management action as it is cost effective, has lower labour inputs and results in vegetation communities that are locally appropriate and contain more diverse plant species (see Table 2). The best strategy for a site may combine multiple approaches.

Figure 6 – Revegetation is most suitable for moderately-highly degraded sites which have lost ability for successful natural regeneration of important structural layers, such as trees and shrubs.

Table 1 - Level of degradation/resilience and appropriate management actions

Level of degradation	Level of resilience	Example	Restoration approach	Actions
Low ↓	High ↑	- Near natural or little disturbed - Old remnant trees - Young native saplings - Native grasses and leaf litter	- Natural regeneration and/or assisted regeneration	- Protect and manage threats - Provide a regeneration trigger
Moderate ↓	Moderate ↑	- Modified, subject to prolonged disturbance - Some remnant trees - Understorey or certain species missing - Bare patches - Weeds present	- Assisted regeneration - Potential supplementary planting	- Increase protection - Remove cause of degradation - Provide a regeneration trigger - Reintroduce understorey or plants
High	Low	- Most of the original biodiversity missing - Few, if any, living trees - High presence of weeds and pasture grasses - Soil erosion	- Assisted regeneration for some species - Revegetation	- Increase protection - Remove causes of degradation - Provide a regeneration trigger - Reintroduce plant materials

Table 2 - Summary of costs and benefits of different methods of restoring vegetation cover

	Direct seeding	Tubestock planting	Assisted regeneration
What	- Sowing seed directly into the ground	- Direct planting of seedlings propagated in nurseries from seed or cuttings	- Create condition to allow regeneration to occur naturally - Manage threats (e.g. limit grazing) and provide trigger (e.g. soil disturbance)
When	- Large sites with limited capacity for natural regeneration - For sites where some species have lost the ability to regenerate naturally	- Small sites as well as difficult sites that may not be viable for other approaches	- In sites that are only lightly to moderately degraded with capacity for recovery
Benefits	- Lower establishment costs, unless small sites - Regenerate large amounts of vegetation across large areas in a relatively quick timeframe - Ability to customise seed mix - Can produce a staggered germination response to site conditions, resulting in a less evenly aged stand	- Higher success and survival rate of plantings - Uses small quantities of seed, so is more suitable for plants where seed resource is scarce	- Most cost effective - Establishes healthiest plants and maintains complexity of local ecosystem
Costs	- Uncertainty in outcomes - Long establishment times leading to more maintenance - Direct seeding machines are limited in rough or steep terrain	- High establishment costs particularly as size of the revegetation increases - Seedlings are more obvious targets for damage by herbivore browsing	- Long establishment times - Requires a nearby seed source

A. Assisted regeneration techniques

Natural regeneration means plants can grow back unassisted from seed in the soil seed bank, or from a nearby canopy. Assisted regeneration involves undertaking management actions to create the right conditions for this to occur. Inappropriate grazing is often a limiting factor inhibiting natural regeneration. Once grazing is excluded or strategically managed (refer to BCT grazing guidelines), degraded areas can often recover with little or no further assistance. In some circumstances, however, fencing alone may not be enough and a regeneration trigger (e.g. fire or soil disturbance) may need to be applied. The main factors that will enable natural regeneration to occur are outlined below:

A source of healthy seed	Prioritise sites adjacent or nearby to good quality remnant vegetation, near paddock trees, and where there is a relatively higher native species groundcover as these areas are more likely to have a soil seed bank.
Protection from browsing and grazing	Fence off designated regeneration areas to avoid excessive disturbance, and control pest animals.
Reduced competition from other plants	Native vegetation often regenerates strongly once weeds are removed and more space and light are available. Follow-up weed control is usually required and may need to be continued for years, until the weed seedbank eventually diminishes.
Some bare ground to germinate successfully	Some level of soil disturbance may be required to create gaps in the ground layer to trigger regeneration and reduce competition. Methods are summarised in Table 3.
Favourable climatic conditions	Time your management to coincide with the presence of ripe seed in the canopy and optimal climatic conditions (e.g. seeds often require warm, wet conditions).

Figure 7 - Natural regeneration occurring around a paddock tree following 15 years of stock exclusion at Wandiyali-Environa Wildlife Sanctuary, NSW. Photo by Daniela Binder

Table 3 - Disturbance techniques to assist natural regeneration

Method	Action	Desired outcome	Considerations
Strategic grazing	Strategic grazing can reduce biomass and weeds to encourage regeneration.	The disturbance or removal of competing grass biomass can create germination niches for seed falling onto the ground.	Grazing must not be continuous, targeted toward times of the year when introduced pasture grasses are dominant (late winter or early spring), occur only in grassy ecosystems and should comply with the BCT Grazing Guidelines.
Spot weeding	Used to create patches of bare ground where tree and shrub seeds can more readily germinate. This can be done using herbicides or manually with a mattock or dense mulch mats.	Competition from pasture and weeds is temporarily removed increasing the capacity of locally native plants to establish and grow.	This option may not be suitable/practical in large sites.
Cool burns	Burning patches to encourage seed germination, provide a fertile seedbed and eliminate competition. Cool to moderate burning is normally carried out in autumn through to early spring.	Competition from pasture and weeds is temporarily removed increasing the capacity of locally native plants to establish and grow.	The whole woodland patch should not be burnt in one go. Burn a mosaic of small patches joined by large unburnt patches. Weed control is particularly important in the first year after burning.
Smokewater	In patches not suitable for burns, smokewater products can replicate the effects of fire and can be sprayed onto the ground using a backpack or tank spray rig.	The chemicals in smoke trigger the germination of many Australian species, including some that lie dormant in the soil.	This action must incorporate weed and biomass control and only be used when soil moisture and temperatures are suitable for germination. Generally this is late winter and early spring in temperate regions or spring and early summer in sub-tropical regions.

B. Revegetation techniques

There are several techniques that can be used to revegetate your site, including transferring leaf litter or plugs of topsoil and transplanting brush matting. The most commonly used methods, planting and direct seeding, are described below. The choice of method will depend on the size and nature of the site, the time and money available, and the purpose of the revegetation. We recommend seeking advice from a local professional restoration practitioner as it can take trial and error to work out the most effective methods for each site.

Tubestock planting

This method involves the direct planting of seedlings propagated in nurseries from seed or cuttings. The benefits of tubestock planting include: the ability to revegetate small sites as well as difficult (e.g. steep, rocky, wet) sites where other approaches may not be cost-effective or viable; and greater likelihood of success than direct-seeding. In riparian areas, survival and growth rates can be increased by planting tubestock deep into the soil and burying around 1/3 of the foliage of the young plant. The limitations of tubestock planting primarily relate to cost. As a labour and input intensive method, it is typically much more costly than other revegetation methods, particularly as size of the revegetation increases.

Figure 8 – Revegetation project using tubestock plantings © Petaruarus Education Pty Ltd

Direct seeding

This method involves sowing seed directly into the ground rather than transplanting already established seedlings. It can be undertaken by mechanical means or manually. The benefits of direct seeding include its ability to generate large amounts of vegetation across large areas in a relatively short timeframe. It is also easy to customise the seed mix to suit local conditions and conservation outcomes. When undertaken with appropriate machinery, direct-seeding is also a much more cost-effective method for revegetating large areas. The limitations of direct-seeding include uncertain outcomes and limited application in difficult sites.

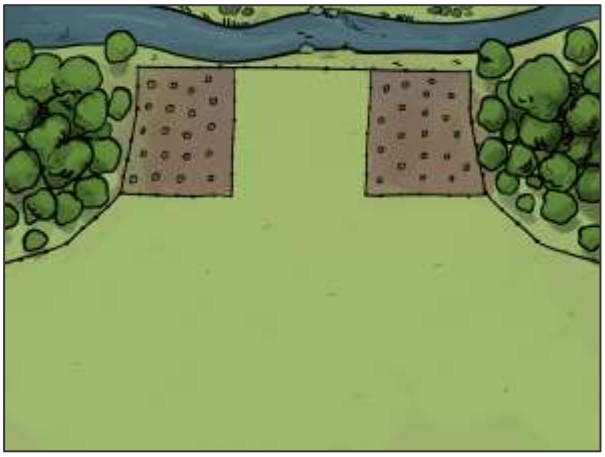
Figure 9 – Mechanical direct-seeding occurring at Woomargama (Photo by Nigel Jones)

Designing your planting

Deciding where and how to undertake your planting can greatly influence the success of the project and biodiversity benefits that your planting can provide. It is important to understand the local conditions and existing habitat. Tips for designing your planting are outlined below (see Figure 10).

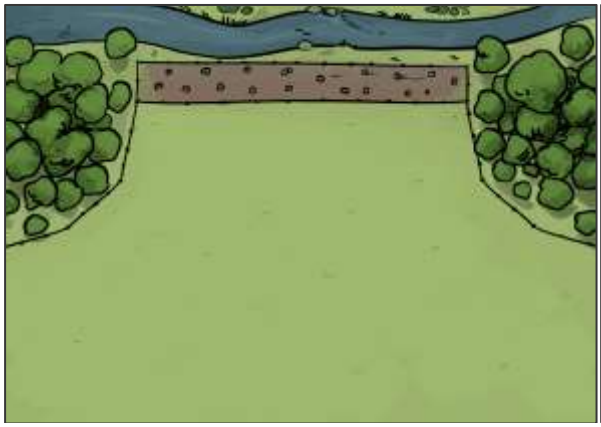
Plant near existing plantings, remnant vegetation or habitat features	Establish revegetation sites as close as possible to existing remnant vegetation, previous plantings or important habitat features including creek lines, riparian area, or existing large old paddock trees and rocky areas.
Connect habitats	Restore large connected patches as a priority over small isolated patches.
Aim for larger areas	There is a well-established link between the size of a patch of habitat and its conservation value, so the larger the revegetation site, the better. This does not necessarily mean there are not benefits in planting smaller sites, particularly when strategically placed.
Use block-shaped areas rather than narrow strips	Use less linear, or more block-shaped plantings as long, narrow plantings are more susceptible to edge effects that can negatively impact biodiversity values (e.g. through weed invasion). Where narrow plantings are required, for example when establishing connectivity between patches of remnant vegetation, attempt to maximise the width of these plantings. BCT recommends a minimum width of 30 metres for such plantings.
Plant in gullies or flat areas	Factors such as slope, elevation and soil type can impact germination of seed and survival of plantings. Plant in sites that receive useful surface water run-off during summer rainfall events.
Plant when optimal conditions occur	The time that plantings occur will have a great impact on survival rates. While the optimal time for planting will vary across NSW, it should generally occur from autumn through to spring. This needs to consider seasonality to ensure adequate soil moisture. An advantage of direct-seeding is that if seasonal rains fail, seed can be stored until seasonal conditions improve. A disadvantage of tubestock planting is that once delivered from the nursery they need to be planted within days, and without rainfall may need to be waterered in, so it is advisable to keep track of weather forecasts.
Plant using densities appropriate to the vegetation type, site characteristics and planting method	The optimal density of plantings will depend on the species being used, the planting method, as well as site characteristics such as rainfall, elevation, topography and soil capability of the site. A general rule of thumb would be to base it on the existing vegetation community in the landscape. You may need to over-plant to account for seedling losses, but ensure that even after anticipated losses, seedling density does not exceed the “natural” stem density of any species planted.

1. Plant near existing remnants or plantings,



2. or near existing habitat, like paddock trees

3. Connect remnants or existing plantings



4. Plant in large, block shapes

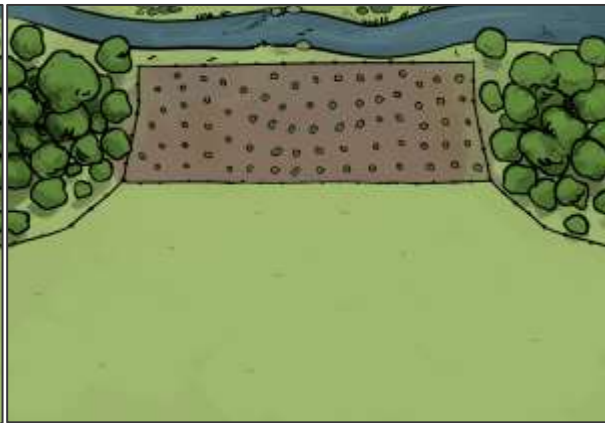


Figure 10 – Tips for deciding where and how to undertake your planting

Choosing what to plant

Selecting the right species for your site is crucial for plant survival and maximising the biodiversity benefit of your planting. When deciding what species of plant to include, ensure that you:

Use locally native plants	Species suited to local conditions are most likely to survive and are also important habitat for locally native fauna. The BCT recommends finding a local specialist nursery that propagates local native plants. There may be cases where it is appropriate to establish native but non-local plants, such as specific food source trees for threatened fauna species or climate-ready species (see below).
Consider climate-ready species	Given the fragmented nature of agricultural landscapes, it is important to consider the suitability of species for revegetation projects given climate projections. For example, species that have a wide range and large population size are more likely to adapt to a changing climate. Separate guidelines (climate ready vegetation) are available to help select climate ready species.
Focus on a diversity of species	Use a mix of native species to add different structural and age components to the planting. A greater variety of plant species will also create more opportunities for other species to forage, nest and seek shelter. This increases the survival of plantings by spreading the risk of environmental conditions such as frost, drought and pest attack, and ensures that there is a range of resources available for a diversity of native fauna.
Consider site specific requirements	Sheltered gullies, exposed ridges and low-lying moist areas will greatly influence the types of species that should be chosen. Salt tolerant species will need to be considered for areas that have become unnaturally saline. Similarly, appropriate species should be selected for frost-prone sites.
Source seeds locally	Seed for the chosen plants should come from healthy populations growing on similar sites within the same bioregion so they are adapted to the environment of the planting site. Securing a supply of seed must be considered early in the planning for revegetation. Seed suppliers need plenty of notice to collect quality seed and process it appropriately. Contact your local Landcare network to find out what nurseries occur in your area.

Stage 4 – Preparing the site

A well-prepared site will enable you to better manage newly established vegetation and ensure the greatest chance of seedling survival. Steps identified below will vary depending on local conditions and the revegetation method used. To increase the chance of your replanting's survival:

- Establish or maintain fences to ensure stock exclusion. Ideally, revegetation sites should be fenced before the plants go in, but you might need to consider providing adequate access for machinery if direct seeding.

- Undertake weed control well in advance, at least six months prior to planting. All plants are competing for space, light, water and nutrients, so if you wish to add locally native species to the competition, then you need to give your desired plants the advantage. This may involve boom spraying, spot spraying, scalping, mulching, use of weed mats and sometimes intensive grazing[1].

- Prepare the soil. For heavy clay soils which may be compacted, or for large-scale projects, this may be done by deep-ripping to enable easier planting and increase water availability at planting. However, be careful not to rip soil under or close to existing trees, especially when supplementary planting. Do not rip in areas that have established biodiversity values such as patches of native grass, as this can enhance colonisation by weeds. Ripping may not be required or should be carried out carefully in sandy or loamy soils, as it can damage highly erodible sites such as river banks.

[1]Any chemical use should be undertaken consistent with appropriate regulatory requirements and safety procedures and seek minimal impact on existing native vegetation at the site.

Stage 5 – Developing a management plan

You have now assessed your site and identified the current vegetation condition, present threats and inherent resilience (Stage 1), established an appropriate management objective (Stage 2) and determined an appropriate management approach (Stage 3), including the optimal methods to achieve it (Stage 4).

This information will help develop your management plan. This will involve planning and prioritising your management actions and setting realistic targets within clear timeframes to reach your objective. The following steps outline what needs to be included in your management plan. BCT staff will assist you in this process.

1) Identify and map the locations and extent of areas proposed for management

BCT staff will create a map of your site, identifying the different vegetation types and their condition, including any sensitive areas and watercourses. The map will also identify what areas have depleted resilience and require a 'revegetation' approach, and what areas have moderate to high resilience where 'assisted natural regeneration' is appropriate (see Figure 11).

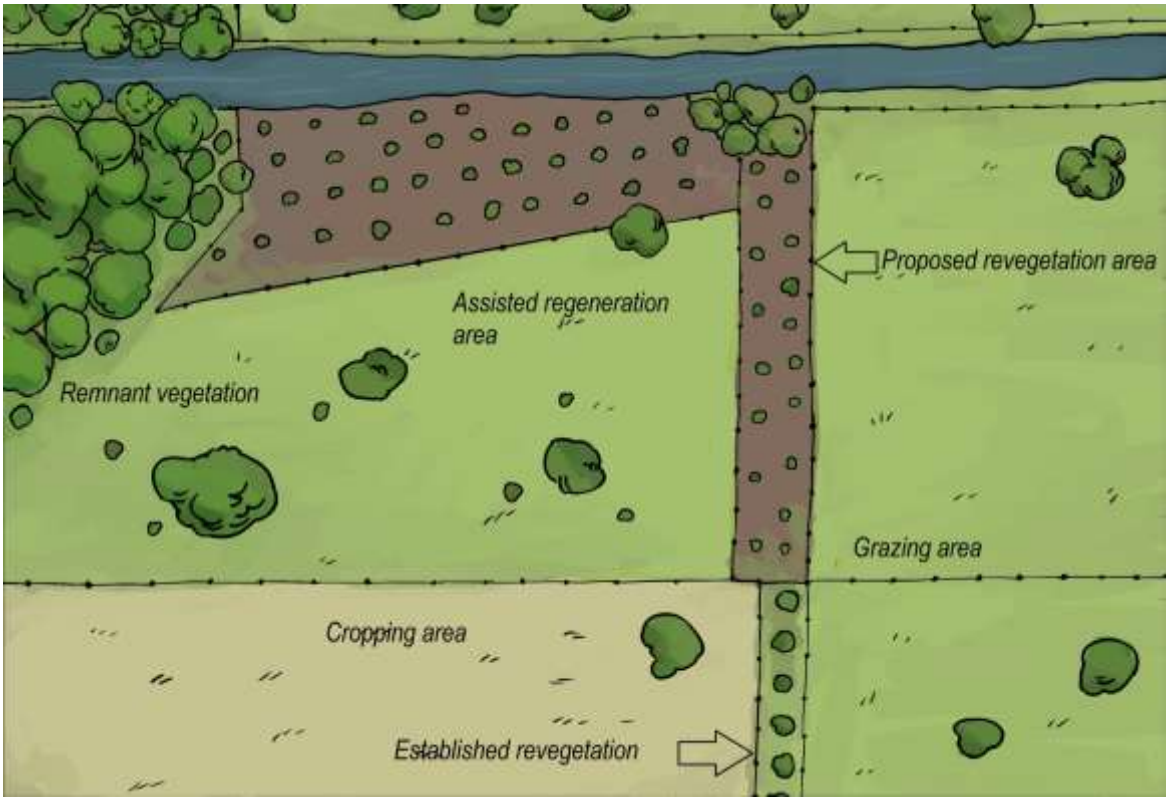


Figure 11 - Paddock plan flagged for native vegetation restoration project

2) Set out clear objectives, with timeframes, for each management zone

Beginning with a clear objective is a fundamental part of the planning process and will allow the future success of the project to be measured. Simply putting trees in the ground is unlikely to provide conservation benefits in the long-term. These objectives will be informed by Stage 2. When setting timeframes for objectives, be realistic in what can be achieved given the site's initial condition, the available funding, the size of the project and the length of time it will take to achieve those objectives. Set long-term objectives first and use short-term targets as stepping stones to help reach them.

3) Establish a schedule of events

Assisted regeneration and revegetation projects can require as much planning as any high-value agricultural crop. How to timetable which planting to establish when, is best guided by a whole-of-farm plan. Much of the groundwork for planning has already been undertaken in Stages 1-4. It is now time to fill in the details of the actions to be undertaken and set a clear timeline for when they will occur. This involves making decisions about what actions to prioritise first.

This is particularly important for revegetation projects as you will need to consider optimal planting times, how much ground preparation is required and how long it will take to gather the materials and plants required. If planting is to be established using tubestock, then shrubs and trees need to be ordered early to guarantee supply and allow planting to occur at the appropriate time of year. It can be useful to access long-range climate forecasts to assist in assessing the timing of planting to help reduce the rate of tree mortality. See Figure 12 for an example timeline for a revegetation project.

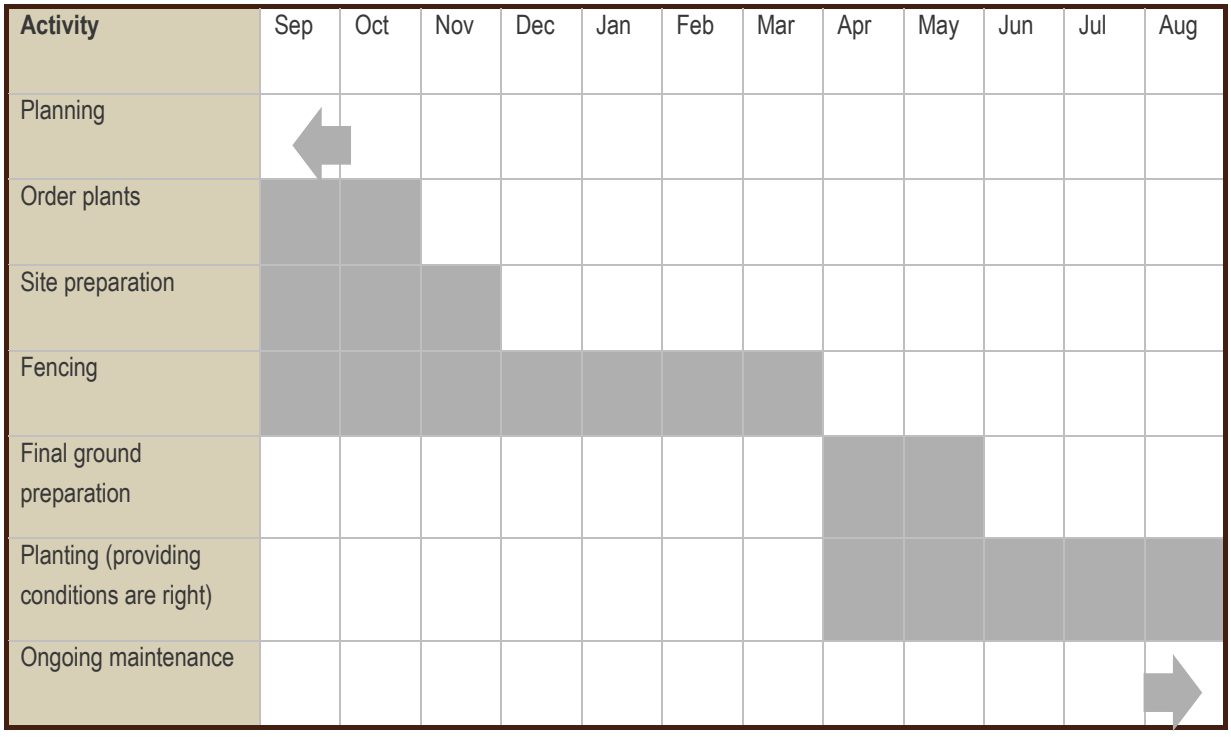


Figure 12 - Sample activity timeline for revegetation project

4) Detail the requirements for management

For both revegetation and assisted regeneration projects, the management plan should detail:

- the appropriate site preparation of each management area
- ongoing management required (see Stage 9 for more details)
- measures of success and monitoring requirements (see Stage 9 for more details)
- contingencies in the event of failure.

For revegetation projects, the management plan should also provide detailed prescriptions, including:

- species list per Management Zone
- planting method – (e.g. tubestock, direct seeding or another method)
- number of plants per area – for tubestock, the number of plants should be rounded to the nearest 100 if there are more than 1,000 plants, or to the nearest 10 if there are 1,000 plants or fewer
- timing – described as the number of months for completion of planting.

Stage 6 – Ongoing maintenance and monitoring

Maintenance

Plantings require ongoing management to succeed. Sites are likely to require follow-up activities and maintenance, including fence maintenance, weed control, control of exotic animals and over-abundant native herbivores. If the weeds are not causing any threat it is best to leave them alone as your efforts can result in other weeds colonising the area, an increase in grazing pressure, or increased exposure to climatic elements. Follow-up watering should not be necessary if ground preparation and soil moisture at planting was correct. Use your judgement, as watering often promotes weed growth and may not be necessary for native plants.

Monitoring

The only way to identify whether your revegetation or assisted regeneration project is working as expected, or whether it needs to be modified, is by monitoring your progress. As part of your agreement, you will be required to monitor and report on progress on an annual basis. This requires you to develop performance measures specific to your management plan to monitor against.

Performance measures should adhere to the SMART principles (specific, measurable, achievable, realistic, timebound). It is important to set a quantifiable target for each management action, for example, reduction of X% of the extent of weeds in the management zone by 2025; survival rate of 80% of X species in 3 years etc.

Record keeping

- **Planting -** you will be required to keep a record of the type and timing of ground preparation, weed control methods, climatic conditions leading up to and just after planting, when planting occurred, what methods were used and the number of individuals of each species planted.

- **Ongoing monitoring and maintenance** - following planting, undertake survivorship counts for each species. The height of the best performing species can be checked in the first six months after planting and should be measured at 2-3 years after planting. Keep a record of the date and type of any maintenance such as weeding, rabbit control, or watering of seedlings and record any replacement plantings.

- **Take photos** - plantings can change very quickly and photos can be a useful way to illustrate changes that occur with revegetation efforts. Set up permanent photo points and take photos at regular intervals to be submitted as part of your annual report.

Note: if you have a funded Conservation Agreement or a Biodiversity Stewardship Agreement, you need to read your agreement for minimal requirements you are contractually required to undertake regarding monitoring.

BCT monitoring

The BCT is developing a program-wide monitoring protocol designed to evaluate the response of an ecosystem to restoration actions, to gauge whether overall program goals are being achieved. BCT staff will be undertaking monitoring in accordance with the BCT's Ecological Monitoring Module. This will include baseline and ongoing monitoring of structural and functional attributes, species composition and secondary responses by fauna. The data you submit in your annual report (e.g. number of tubestock planted, number survived) will feed into this broader monitoring program. This information will assist the BCT in detecting how management on a larger scale is influencing conservation outcomes and will be important to use as the basis for adapting revegetation projects into the future.

Glossary

Term	Meaning
Assisted regeneration	The practice of fostering natural regeneration and recolonization after actively removing ecological impediments (e.g. invasive species, grazing pressure) and reinstating appropriate abiotic and biotic states (e.g. environmental flows, fire regimes).
Benchmark	A standard vegetation-quality reference point relevant to the vegetation type. Represents the average characteristics of a mature and apparently long-undisturbed state of the same vegetation type. NSW Vegetation benchmarks are available at https://www.environment.nsw.gov.au/research/Visclassification.htm
Conservation agreement	A joint agreement between the landholder and the BCT to conserve and manage biodiversity on an area of land.
Conservation area	An area of land covered by the conservation agreement.
Direct seeding	A replanting/revegetation approach most commonly involving the use of machinery, though also possible by hand, to sow seed of selected species into restoration sites.
Ecological restoration	The process of assisting the recovery of an ecosystem that has been degraded, damaged or destroyed.
Natural regeneration	Recovery or recruitment of species from a germination or re-sprouting event. A 'natural regeneration' approach to restoration relies on spontaneous or unassisted natural regeneration as distinct from an 'assisted natural regeneration' approach that depends upon active intervention.
Remnant	Existing patch of native vegetation.
Replanting	Reintroduction of plants on sites by mechanical or manual means (e.g. direct-seeding, tubestock planting etc.).
Resilience	A capacity to recover naturally from external stresses or shocks if those stresses are similar in type and degree to those previously experienced during the evolution of the species.
Revegetation	Introduction of plant materials by tubestock, direct seeding or other means.
Scalping	Removal and disposal of the top layer of soil to remove the weed seed bank.

Supplementary planting	Targeted replanting within remnant vegetation, often aiming to reinstate strata (e.g. understorey) or species.
Tubestock planting	A replanting/revegetation approach involving planting of seedlings raised in a nursery.

Further information

Below is a list of online resources to help provide you with further information in specific areas related to vegetation restoration. The NSW BCT does not necessarily endorse all opinions or ideas contained within these resources.

Topic	Category	Online information resource
Vegetation types	*Eucalypt woodlands*	Greening Australia Revegetation Guide for Eucalypt woodlands Rawlings, K., Freudenberger, D., Carr, D. (2010). A Guide to Managing Box Gum Grassy Woodlands. Canberra, ACT: Department of Environment, Water, Heritage and the Arts. Recovering Bushland on the Cumberland Plain – best practice guide for management and restoration of bushland
	Grasslands	Greening Australia Revegetation Guide for Temperate grasslands ACT Government 2017 ACT native grassland conservation strategy and action plans (Environment, Planning and Sustainable Development, Canberra).
	Subtropical forests	Greening Australia Revegetation Guide for Subtropical forests
	Riparian systems	Sustainable Farms ANU – Riparian restoration Greening Australia Revegetation Guide for Temperate riparian lands Hunter LLS Hunter river estuary riparian revegetation guide
	Mallee Woodlands	Greening Australia Revegetation Guide for Mallee woodlands
NSW regions	*South West Slopes*	South West Slopes Revegetation Guide – From little things big things grow

Topic	Category	Online information resource
	Central West	Central West LLS - Planting your patch – a guide to revegetation on your property
	Northern Tablelands	Northern Tablelands LLS – Native revegetation establishment guidelines
	North east	Coffs Harbour City Council – A guide to species selection for revegetation projects in the Coffs Harbour Local Government Area
Restoration techniques	*Assisted regeneration*	Australian Association of Bush Regenerators NSW Planting in bushland OEH Conservation management notes – Natural regeneration Illawarra Bush Regeneration Handbook – A Guide for Local Volunteer Groups
	Revegetation	OEH Conservation management notes – Revegetation Sustainable Farms ANU – Revegetation for birds Greening Australia Victoria 2003. Revegetation techniques - A guide for establishing native vegetation in Victoria. Australian Government Dept of Environment and Heritage 2000 Revegetation and wildlife: a guide to enhancing revegetated habitats for wildlife conservation in rural environments Greening Australia (2014) Whole of Paddock Rehabilitation – A new approach to regreening the farm.
National standards		The Society for Ecological Restoration Australasia (SERA) National Standards for the practice of ecological restoration in Australia – plain English version Climate ready revegetation guide

List of relevant literature

These guidelines rely on an extensive list of published material. This information has been used to identify, support and highlight the current understanding of best practice management in Australia. The NSW BCT does not necessarily endorse all opinions or ideas contained within these references.

Bennett, et al. 2000. Revegetation and wildlife: a guide to enhancing revegetated habitats for wildlife conservation in rural environments, Australian Government Dept of Environment and Heritage.

Corr, K. 2003. Revegetation techniques: a guide for establishing native vegetation in Victoria, Greening Australia Victoria.

Department of Environment and Conservation (NSW). 2005. Recovering bushland on the Cumberland Plain: best practice guidelines for the management and restoration of bushland. Department of Environment and Conservation (NSW), Sydney.

Department of Sustainability and Environment. 2006. Native Vegetation Revegetation planting standards – Guidelines for establishing native vegetation for net gain accounting. Victorian Government, Department of Sustainability and Environment, East Melbourne. Available at: http://www.dse.vic.gov.au/__data/assets/pdf_file/0005/97349/NativeVeg_Reveg.pdf

Ensby, R. & Johnson, A. 2007. Noxious and environmental weed control handbook: a guide to weed control in non-crop, aquatic and bushland situations (3rd edition). NSW Department of Primary industries. Available at: www.dpi.nsw.gov.au/agriculture/pests-weeds/weeds/publications/noxious-enviro-weed-control

Hancock, N., Harris, R., Broadhurst, L. and Hughes, L. 2018. Climate-ready revegetation. A guide for natural resource managers. Version 2. Macquarie University, Sydney. Available at: https://www.researchgate.net/profile/Rebecca_Harris5/publication/310612393_Climate-ready_revegetation_A_guide_for_natural_resource_managers/links/5d27c66a92851cf4407a7917/Climate-ready-revegetation-A-guide-for-natural-resource-managers.pdf?origin=publication_detail

Lindenmayer, D., Michael, D., Crane, M., Florance, D., & Burns, E. 2018. Restoring farm woodlands for wildlife. CSIRO Australia.

Munro, N. & Lindenmayer, D. 2011. Planting for wildlife: a practical guide to restoring native woodlands. CSIRO Publishing.

Rawlings, K., Freudenberger, D., Carr, D. 2010. A guide to managing box gum grassy woodlands, Commonwealth of Australia.

Standards Reference Group, SERA. 2017. National Standards for the Practice of Ecological Restoration in Australia. Second Edition. Society for Ecological Restoration Australia.