A Revegetation Guide for Temperate Grasslands

Australian Government
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Greening Australia

Landcare Australia

A REVEGETATION GUIDE FOR TEMPERATE GRASSLANDS

Who this guide is for

This introductory guide is for people wishing to learn about the basic principles and practices for revegetation of temperate grassland communities. This guide describes eight key steps that need to be followed to help ensure a successful revegetation project.

The importance of Temperate Grasslands

The temperate grasslands of south eastern Australia have an irregular distribution from north of Adelaide in South Australia, east into inland Victoria, south into the midland plains of Tasmania and northwards through inland New South Wales and the Australian Capital Territory to the northern regions of New South Wales. By and large they encompass a zone of 500 mm average annual rainfall that can occur throughout the year.

Temperate grasslands are composed of four readily identifiable plant types:

1. Grasses with a C4 photosynthetic pathway (warm season active);

2. Grasses with the C3 photosynthetic pathway (cool season active);

3. Native forb species (primarily perennial wildflowers); and;

4. Non-indigenous grass and forb species (weeds).

Perennial tussock grasses produce most of the total plant biomass and ground cover. Of the native grasses, *Austrostipa* , *Austrodanthonia*, *Poa* and *Themeda* are the dominant genera. Annual and perennial forb species occupy the interstitial gaps amongst these grasses providing the bulk of plant diversity.

There is an urgent need to restore many patches of grassland as up to 99% of south eastern temperate grassland communities have been destroyed by prolonged and disruptive human impacts stemming from agricultural activity and urban development. Most remaining examples are found along roadsides and rail reserves, or as small patches on farmland (Photos 1a and 1b). The composition (density, stature and diversity) of remnant grassland communities is thought to be strongly correlated with the history of local disturbance events such as grazing, burning, slashing and drought.

Photo 1a.

Photo 1b.

Photo 1 (a-b). Highly diverse and colourful temperate grasslands were once widely distributed across southern Australia and Tasmania, but 99% have been destroyed or highly simplified. The few quality grasslands left are often found in (a) cemeteries or (b) along country roads.

STEP 1.

Assess site conditions

Assessing the history of the grassland site is the first step in the planning process. First assess if planting is needed or if natural regeneration can occur. Revegetation is most often required when there are local constraints that limit the natural return of grassland species (as is most often the case). Constraints include:

Poor recruitment

- Lack of seed;
- Lack of suitable sites for seed germination (establishment niche).

Altered physical environment

- Temperature extremes - hotter or colder than within a natural grassland;
- Wind exposure - can quickly dry out young plants;
- Lack of fire or too frequent fire;

Hostile soil conditions for native grasses and herbs

- Soil compaction from vehicles and livestock (poor water and air penetration);
- Soil erosion by wind and water;
- Nutrient enrichment (most sites in agricultural zones exhibit high levels of Phosphorus and Nitrogen – good for weeds but not for most native plants);
- Poor soil structure;
- Lack of soil biota (e.g. worms, fungi, microbes) that greatly assist native plant survival and growth.

Threats to plant survival

- Competition from introduced pasture grasses and broadleaf weeds;
- Insect pests; and
- Over grazing by sheep, cattle and horses.

Examine your site to determine if there are any of these constraints. If there are, then active revegetation and amelioration of constraints will be required. Reducing the impacts of any of these constraints will help to establish grassland species.

STEP 2.

Set clear site objectives

There are many different reasons to re-introduce grassland species. They include:

- Biodiversity restoration;
- Enhancement or expansion of remnant populations;
- Providing habitat niches for native wildlife and dispersal corridors
- Drought tolerant and low input fodder for livestock;
- Salinity management (perennial grasses have deep roots and use more water than annual weeds);
- Carbon sequestration; and
- Amenity value – wildflower grasslands are stunning.

Work out what is most important to you and your site; conservation or sustainable pasture productivity. If conservation is your first priority, then grazing is a tool to enhance and manage grassland diversity. However, if agricultural productivity is your top priority, then native grasslands are a source of income and plant diversity is secondary and may be compromised by more intense grazing.

Landscape context

In many cases grassland restoration is undertaken to buffer, expand or connect existing remnant communities, particularly those that are protected by covenants, or are in formal conservation reserves. In many remnant grasslands there is an abundance of native wildlife including birds, reptiles, insects, marsupials and other soil fauna. Restoration of new grassland, or enhancement of existing grasslands, can provide habitat for the colonisation of native fauna and provide ‘stepping stones’ to allow movement of wildlife across fragmented landscapes. Strategic restoration of this type can increase the resilience of remnant vegetation to disturbance events or climatic extremes, and assist in improving biodiversity at landscape scales.

STEP 3.

Secure a source of quality seed

Access to appropriate quantities of quality seed from a range of species is often the most limiting factor in achieving good restoration outcomes. For field-based collections, most guidelines advocate a 'local is best' approach. However, due to the small and fragmented nature of most remnant grasslands, recent research questions an overly strict adherence to this prinicple. The aim of grassland seed collection should be to:

- decrease the risk of establishing inbreeding populations;
- restore the geographic range of species; and
- increase access to greater seed quantities (especially for grasses).

Therefore, strict adherence to 'local is best' rather than a regionally focussed collection may be counter productive if local populations have been isolated by clearing, likely inbred and produce small quantities of seed.

Whether for nursery propagation, or use in direct seeding, seed collection zones should aim to match the environmental conditions of the revegetation site(s) particularly with respect to soil type and topography (e.g. slope). Ideally, collectors should aim to take seed over an entire growing season, from as many individuals as possible (e.g. 50 to 500). This figure will be much larger when mechanical harvest methods are ultilised. Where possible, collection should avoid conscious selection decisions (e.g. largest, most colourful) by working along transect lines to avoid closely related plants. Together, these collection practices will aid in capturing a wide representation of the genetic characteristics exhibited across wild populations.

It may not be realistic to restore all species that occur in a collection zone to a new site. This may be because of limitations of seed, species range, or technical capacity (e.g. time, cost and skill). If the goal is restore some degree of biodiversity, restorationists should aim to select a mix of species that include representatives of the various 'functional groups' (plant types) that exist within grasslands. This may include groupings such as grasses (C_3 and C_4), annual and perennial species, legumes, plants that produce below ground structures (e.g. lilies) or those that exhibit key above-ground shapes such as groundcovers, or low or medium growing plants. In addition to utilising environmental resources in different and often complimentary ways, a diversity of these functional groups will provide a range of habitats for other life forms, such as insect pollinators, insectivorous and seed eating birds, and grassland reptiles. By successfully occupying a range of niches, a broad range of functional plant groups may also help resist the invasion of sites by weeds.

Securing wild seed has to be considered at least 1-2 years in advance to restoration. Seed of any particular species may only be able to be harvestable for short periods in its natural habitat. This in particular is the case during extreme seasons. Advanced planning is needed to obtain the necessary permits to collect seed, organise with a landholder to remove livestock prior to seeding and obtain the necessary seed harvesting equipment. When purchasing seed for grassland revegetation, give suppliers at least 1 year advance notice. Like any crop, native seed quantity varies from year to year based on the season (temperatures, rainfall, winds).

> *"Collecting or buying native seed is not the same as buying a packet of veggie seeds from the shops".*

Seed production

In many cases wild harvest will not supply the quantities of seed required. Indeed, care must be taken that repeated wild harvest des not have a negative impact on remnant communities. Seed from species that are rare (listed under State and Federal Acts) is generally unavailable for collection or from seed suppliers. Under both scenarios the establishment of seed production nurseries may be necessary. Seed production nurseries or areas are designed with the purpose of growing plant species as seed crops. Seed Production Areas (SPAs) can be as simple as a polystyrene 'box' system to more sophisticated containerised or in-ground plots (Photo 2abcd). Each approach comes with advantages and disadvantages in labour

Photo 2a.

Photo 2b.

Photo 2c.

Photo 2 (a-d). Except for a few common species of grass, Seed Production Areas (SPAs) will need to be established because harvesting large quantities of seed from the wild is unsustainable. SPAs can be as simple as growing a single species in a foam-box to small irrigated rows to large plots sown to a single species.

efficiencies, outputs and costs.

However, in general each system (or combination thereof) comprises seedlings grown at high densities (for suitable cross pollination or genetic factors) through to maturity and subsequent harvest. In recent years SPAs established in several south eastern States and regions have successfully grown seed from a range of grassland species in large quantities.

Seed Production Areas need to start with at least a small quantity of wild seed. This should be carefully collected to capture genetic quality and diverse traits within the defined collection zone. Similarly, in the SPAs, harvest protocols should aim to ensure these genetic features are preserved. In practice this means mixing and sub-sampling of wild seed-lots for propagation of seed crops, then an avoidance of selection bias when pricking-out (thinning) seedlings. Bias should also be avoided when harvesting seed from mature crops grown in SPAs.

Ideally SPA populations for each species should contain as many individuals as possible given space and resource factors. Aim for at least 100-1000 individuals per species . Another strategy to maintain genetic diversity in seed production is to introduce new seed from wild populations every 2-3 years.

The establishment of Seed Production Areas to support restoration projects has many positive features including reducing collection pressure on remnant wild populations, simplifying seed harvest and producing more reliable quantities of weed-free seed at times when field population may be impacted by drought and/or other unfavourable events such as inadvertent burns, grazing, and predation. Through SPAs that include irrigation, it is possible to extend the period of seed-set for many grassland species through summer and into autumn when plants in wild populations have become dormant.

Seed testing

Regardless of the seed source (wild or from SPAs) restoration outcomes rely heavily on seed quality. For this reason, it is always preferable to obtain some indication of the quality characteristics of any seed-lots used. Purity testing is one relatively simple and cost effective method of assessment. Purity testing determines the percentage (by mass) of the seed that is pure filled seed of the species; the percentage (by mass) of impurities of other species seed (e.g. weeds); and the percentage (by mass) of inert matter (e.g. stems, seed appendages and seed coverings). If purity testing highlights particular issues, such as very low seed fill, other test methods such as cabinet germination or chemical viability tests can be conducted. However, both these involve longer time lines and increased costs. In summary, seed testing is important in understanding the quality of seed at the time of sowing (or propagating); allowing restorationists to more rigorously evaluate sowing outcomes.

STEP 4.

Secure quality nursery seedlings

When using container-grown stock, use only healthy seedlings. The health of container stock (e.g. size, root structure) can be critical to their survival after transplantation in the field. Planting unhealthy stock can result in early death, slow growth, and long-term decline of plants. Nursery stock should be inspected for healthy vegetative and root growth exhibiting strong growing tips and lots of roots relative to above ground material. Container stock should also be hardened-off (involving nutrient limitation and exposure to low temperatures) properly prior to their use, otherwise plantings may be set back or killed when transplanted into hot or frosty conditions (as is often the case). Plants should arrive on-site well watered, green but not too lush.

STEP 5.

Site preparation

A number of site preparation techniques can be used in grassland restoration, however no one method is likely to suit all sites or situations. For this reason it is best that site and project-appropriate measures are developed to avoid costly waste of what are often limited resources. However, the establishment of plants in the field from nursery containers or directly sown, is influenced by a range of factors including:

- Prior and current land use;
- Prevailing weed-seed bank;
- Adjacent vegetation (weed sources; shading and drying);
- Soil characteristics (structure, moisture, nutrient status);
- Prevailing weather conditions;
- Pre and post restoration weed control; and
- Herbivory (e.g. insects, livestock, rabbits, marsupials).

Taking into account these factors, restoration should aim to introduce nursery seedlings or seed onto well prepared sites with good soil preparation and weed control. When site preparation is ignored, restoration outcomes are often unsuccessful in terms of expenditure and conservation objectives.

Access to adequate moisture throughout the soil profile at the time of seeding or planting is an essential factor to the survival and growth of newly germinated seeds or transplanted seedlings. Ideally soil moisture is built up in the 12-24 months prior to restoration. This commonly entails removing weeds which use this moisture. Weed control is then followed by a period of 'fallow' to allow moisture to buildup in the profile. Subsequent weed control may be required during this period.

It is also worth reinforcing that restoration outcomes may also be severely compromised if plants or seedlings are heavily grazed. In most situations, fencing the restoration site is sufficient to limit livestock grazing. However, more expensive materials and fencing may be required to limit rabbits and marsupials. While fencing may be considered a major revegetation cost, restored grasslands represent high value outcomes. Chemical treatments (pesticides or miticides) may also be considered for invertebrate pests, while repellents are also available for native grazers.

Weed control

Chemical herbicides are commonly ultilised in controlling weed species within grassland communities or prior to restoration. Non-selective systemic herbicides (such as glyphosate) are routinely used in spot applications or as boom mounted wick wipers that target the foliage and inflorescences of weedy species that project above that of indigenous species (e.g. when enhancing degraded grasslands). However, these techniques require a good understanding of the differing morphologies of weed and indigenous species if damage to non-target (native) species is to be avoided. Boom mounted application of non-selective (systemic) herbicides is also commonly used to remove weed vegetation from a restoration site prior to seeding or planting.

The use of selective herbicides (targeting broad-leaf or monocots) may be an option when the goal is to enhance diversity in degraded sites dominated by either group of exotics. Pre-emergent herbicides are most effectively used to restrict weed germination and emergence in sites where native species have been introduced by planting or to 'clean-up' restored sites where native plants have established as adults and native recruitment can be sacrificed for some period. Both approaches are commonly used in seed production systems where native species are grown as monocultures for seed crops.

Surface manipulation utilising standard agricultural techniques (plowing, chiselling, disking or harrowing) can be used to remove standing weeds prior to creating a friable seed or planting bed for restoration. However, soil disturbance and subsequent weed seed bank stimulation, means that chemical weeds controls are likely to be required in tandem with these actions. In most cases, site cultivation and weed control should begin up to 12 months prior to restoration activities. In many cases, adequate attention to pre-seeding or planting activities can minimise (but seldom negate) the requirement for post-restoration maintenance.

Soil scalping

An assessment of prevailing soil nutrient and weed bank characteristics at a restoration site may indicate that these factors are likely to overwhelmingly favour the growth of exotic species (weeds) and reduce the likelihood of restoration success. A number of studies of grassland restoration in the Northern Hemisphere, and more recently in Australia (the Grassy Groundcover Restoration Project), have shown that a technique described as 'scalping' can significantly enhance outcomes where high nutrient and weed loads prevail. Scalping, or topsoil removal, physically removes weed seed and bud material and reduces nutrient loads at the sowing surface significantly limiting the competitive effect of weeds. The depth of scalping is site-specific and depends on how far nutrient loads and weed banks extend into the profile (both determined through the testing process). While some dismiss scalping as unmanageable at scale and uneconomic, it is relatively simple using readily available equipment such as road graders (Photo 3ab). Ideally, scalped topsoil can be spread at adjoining locations at low cost and utilised for agricultural purposes. Several research studies have shown that scalping can be far more successful that those initiated using chemical weed controls only (Photo 4ab).

Another technique that aims to reduce high soil nutrient loads is known as soil impoverishment or "reverse fertilisation". This approach involves the removal of nutrients from soils, through the addition of soluble carbon. Additions of soluble carbon stimulates soil microbial growth, which in turn then accumulates available Nitrogen in their microbial biomass, making it unavailable for plant growth. Sources of suitable carbon sources include sucrose (sugar), straw, sawdust or grain hulls. While these methods have been shown as effective in reducing Nitrogen levels, they are not long lasting and additional carbon is required at regular intervals for any prolonged effect (thus increasing costs).

Photo 3a.

Photo 3b.

Photo 3 (a-b). Removing weed and nutrient enriched topsoil (scalping) is a highly effective way to prepare soils for grassland restoration. Scalping can even be done at a large scale with road graders. These photos are of sites included in the Greening Australia and Melbourne University's Grassy Groundcover Research Project.

Photo 4a.

Photo 4b.

Photo 4 (a-b). (a) This photo was taken three years after seeding of a scalped site. Note the desirable gaps between the wildflowers and native grasses with no one species dominating and little weed competition. (b) A site which was not scalped prior to seeding with same the same seed mix as the photo above. On the right, note the lack of gaps between grass tussocks, no visible wildflower, nor native grasses, and high exotic grass biomass dominating.

STEP 6a.

Planting

For field plantings up to 3000 seedlings a day can be planted per planter using a 'Pottiputki' (a steel tube with a trigger release at the bottom; click here). The Pottiputki is pushed into the ground, the bottom of the tube is opened, and a plant passes down the tube into the ground so the root ball is below the mound surface. The ground is then compacted around the plant using the feet and the planter moves onto the next placement. For grassland restoration, normally seedlings are planted at densities of 4-12 plants per m^2. While plant densities in remnant communities commonly range between 60-120 plants per m^2, planting at such densities for restoration is generally considered cost prohibitive. Ideally the upper soil horizon is moist at the time of planting. If this is not the case, then seedlings should be watered if possible, but this can be impractical for large plantings.

The best time for planting can vary from region to region and between seasons. In winter rainfall areas, planting may take place after an 'autumn break' (the onset of rains after the dry summer period). However, in times when the autumn break is unreliable or does not eventuate (e.g. during drought periods), early spring planting should be considered, when soil temperatures are rising and soils still retain moisture from winter rains. However, take care in frost prone areas or with frost-sensitive species.

STEP 6b.

Seeding

Historically, conservation of remnant communities has been the focal objective the long-term protection of native grasslands. However, conservation on its own has not proved effective in halting the decline of these communities and restoration is now seen as an important component alongside conservation. To date, most grassland restoration projects have been conducted on relatively small scales (less than 1 ha) utilising container-grown stock or translocated plant material. Both have been popular with land managers and community groups, primarily because of the relative ease of planting material into the field and because of the instant visual effect. While these methods represent an effective use of a limited seed resource, reintroduction of nursery seedlings is labour intensive and quite expensive on a per hectare basis. Scientific reviews of many seedling plantings have also highlighted variable and sometimes quite low success under field conditions.

Direct seeding has the potential to deliver and establish many more plants (and species) than through planting seedlings. As the need and opportunity to restore grasslands has become more widely accepted, there has been a growing interest in adapting agricultural technologies to improve the efficiency and success with which seed can be introduced into restoration projects. Seeding techniques vary in nature, complexity and cost. Some examples of currently used methods include hydro-seeding (for steep slopes and batters), seed-drilling and broadcast seeding.

Tractor-mounted seed-drills have been shown as effective in seeding herbaceous species into cultivated soil profiles. However, while direct drilling offers excellent seed to soil contact, the drilling equipment can be problematic. Those species with fuzzy, hairy and long awned seed (e.g. Asteraceous and Poaceous species) often become entwined and tangled, preventing individual seeds dropping from hoppers into seed drills. This problem can be lessened by adding a bulking agent such as coarse vermiculite to the sowing-mix to facilitate its free flow, or by cleaning to 'pure seed'.

Agricultural fertiliser spreaders have been used to deliver seed onto cultivated seed beds. However, delivery is often unreliable (particularly under windy conditions) and this machinery present difficulties with calibrating the seeding rate.

The Victorian-based Grassy Ground Cover Project (GGRP) run by Greening Australia in partnership with the University of Melbourne, investigated the use and modification of machinery used in the landscaping and turf businesses. There is a commercially available machine developed to aerate and de-compact soils in urban parks and sporting grounds (AERA-vator®), which has also proved ideal for seed bed preparation in agricultural sites (the width of the machine is 1.5 m).A traditional tube-feed seed-hopper mounted on the machine was modified to improve the flow of the seeding mix with all tubes removed (Photo 5).

Photo 5. The Grassy Groundcover Research Project seeder was developed to sow a complex mix of grassland species onto a weed free soil surface. This is a modified turf seeder originally designed for sowing golf courses and the like.

The seed mix (combined with medium grade sand) was then drawn through the base of the hopper by an adjustable rotating bar, falling as a 'curtain' onto the prepared seed bed. The machine also included a mounted rake and roller to lightly cover the seed and press it into the soil. Seed flow rates and tractor speed could be adjusted to achieve accurate sowing rates. This research seeder proved effective in seeding any combination of grassland species, including wildflowers, across a broad range of soil types from sandy loams through to heavy basaltic clays (Photo 6abcd).

Broadcast seeding is another method used in grassland restoration, particularly in small-scale or experimental sowings. Broadcast seeding is described as any method of seed dispersal that places seed on the ground surface, as opposed to placing it in the soil. Advantages of broadcast seeding include minimal soil disturbance. However, poor soil to seed contact increases the likelihood of seed predation and the loss of surface seed to wind and surface water flows.

Photo 6a.

Photo 6b.

Photo 6c.

Photo 6d.

Photo 6 (a-d). These four sites were all sown to a diversity of grasses and wildflowers using the seeder shown in photo 5. For all sites, the topsoil was scalped using a grader (photo 3). The sites were established and are being monitored by the Grassy Groundcover Research Project (Greening Australia and Melbourne University).

The use of ring-rollers and mulching agents following broadcast sowing can improve seed contact with the soil lessening the chance of seeds being washed or blown away, and limit the degree of seed predation.

A form of broadcast seeding is achieved by spreading a 'seed-hay' of single or multiple species. In south eastern Australia, kangaroo grass (*Themeda* spp.) is the species most likely to be used as a baled seed-source, or seed hay. When spread with awns intact, the seed buries itself into the soil profile over time, enhancing the chance for germination and establishment. One drawback of this technique is that the seed of undesirable species may also be inadvertently harvested, baled and introduced onto a restoration site.

Estimates for the quantity of seed to be sown in grassland restoration vary a great deal. However, several projects have used rates for grasses at 15-40 kg/ha, while broad leaved forb species have been sown at 10-30 kg/ha depending on seed supply, species identity and seed purity. Surveys of complex grassland vegetation restored at research sites have shown plant establishment rates ranging 50-120 plants/m^2, using seeding rates of 50 kg/ha (20 kg grasses, 20 kg dominant forbs and 10 kg subdominant forbs). Seeding rates for establishing seed production crops may be higher. For example, grasses may be seeded up to 60 kg/ha as monoculture plantings to ensure dense crops with maximum capacity to resist weed invasion.

STEP 7.

Maintenance for diversity

Restored sites should be managed to preserve and develop the diversity of the original sowing and restrict weeds. This can include a range of management actions, both chemical and physical. Biomass build-up (dead and alive) is a significant factor in lowering diversity in complex grasslands where native grasses dominate. Diverse grasslands need small patches of open ground for the germination of many wildflowers (Photo 4a). Targeted fires, short-term intense grazing, or mowing followed by removal of slash can be use to reduce the smothering effect of biomass build-up.

Photo 4a. This photo shows desirable gaps between the wildflowers and native grasses with no one species dominating and little weed competition.

Managing biomass - fire

Several studies have shown that most mature grassland plants are relatively robust and insensitive to the effects of fire season. The effect on long-term seed regeneration of differing fire seasons may however be an important determinant in the evaluation of appropriate timing of these events. It is generally accepted that restored (or remnant) communities should not be burnt until species have finished flowering and shed their seed which in most lowland grasslands and grassy woodlands occurs spring to mid-summer. Therefore, late summer to autumn is often considered an appropriate time to burn for biomass reduction. However, restorationists should always adhere to local fire regulations, restrictions and requirements for permits. Use the skills and knowledge of local fire brigades to help undertake burns safely and effectively (Photo 7).

Photo 7. Members of the Snake Valley Fire Brigade assist in reducing biomass loads at a Grassy Groundcover Research Project site near Chepstowe in south west Victoria by conducting an autumn burn. Controlled burns such as this help to maintain open spaces between grass tussocks (Photo 4a) so a brilliant diversity of wildflowers can persist.

Managing biomass - grazing

Livestock grazing has been shown to be effective in maintaining species diversity within semi-natural grasslands in northern Europe, however, the effects of grazing on the maintenance of species diversity within restored and remnant grassland communities in south eastern Australia is still under investigation. Negative effects of grazing by livestock can include defoliation and litter reduction, trampling, soil compaction, possible importation of seed (both natives and weeds), localised deposition and return to the soil of dung and urine, and modification of seed and fruit dispersal.

Local studies have shown that cattle graze tall native perennial grasses (such as *Themeda* and *Dichanthium*) in preference to smaller tussock grasses (like *Austrodanthonia* and *Austrostipa*). Sheep are more selective of palatable species and graze closer to the ground. 'Crash' or 'Pulse' grazing, involving high stocking rates in defined areas for limited time periods (few hours or days), may reduce selective grazing impacts while effectively removing biomass. Grazing as a tool for grassland management requires fencing (fixed, movable or electric) and good stock management skills. Deferred and rotational grazing are alternative approaches where stock have access to vegetation from late summer to mid-winter when most species have finished flowering or rapid growth. Again, the objective for such grazing is to maintain or enhance grassland biodiversity (plants and animals) by reducing herbage biomass and maintaining gaps between perennial tussock grasses.

Native species like kangaroo grass can become dominant just like exotic pasture species such as phalaris if not managed.

Managing biomass - mowing

Biomass reduction on public road reserves or lands is often carried out by mowing. This is a valuable tool to control the structure and composition of grassland vegetation due to the ready access to machinery and relatively low cost. Ideally, slashing is followed by raking and baling to remove biomass (Photo 8).

Photo 8. Another way to control the biomass of dominant native grasses is to mow and bale. This reduces the build up of native grass biomass allowing sub-dominant wildflowers to access sunlight, moisture and soil nutrients.

Herbage left on site can return unwanted nutrients and smother vegetation or restrict seedling recruitment. Mowing to remove excessive grass canopy in late winter can benefit the growth of early flowering forbs, while a late summer-autumn slashing and raking can provide canopy gaps for the recruitment of autumn germinating forb species. However, some drawbacks of mowing include the possible introduction of weed seeds brought in on equipment, soil compaction, and physical damage to plant structure by the tires of mowing equipment.

STEP 8.

Monitor to learn and improve

Most grassland restoration projects that plan to establish complex communities up to 3 ha in size or larger should plan for a minimum five-year cycle for maximum success. This period allows for 1-2 years of site preparation, seed collection and seed production before seeding or planting, then at least two years of monitoring and maintenance. Following seeding or planting, sites will be vulnerable to weeds, grazing and insect pests. This will require close monitoring to ensure management actions are taken when and where required. However, monitoring should start at the beginning of a project. Monitoring should record what is done at each step of any restoration project (Figure 1). Successful restoration projects show that effective monitoring benefits from setting clear objectives and goals and these can be easily forgotten a few years later. Too often monitoring starts at the wrong end of this sequence.

There is a common desire to monitor restoration outcomes. However, it is also prudent to first monitor (record) the Objectives and Strategies of a restoration project, followed by a record of the Actions to be implemented, then the Results of those actions (e.g. dead or alive plants). The Table below provides a suggested list of fields (bits of data) that should be collected to monitor all aspects of a grassland restoration project.

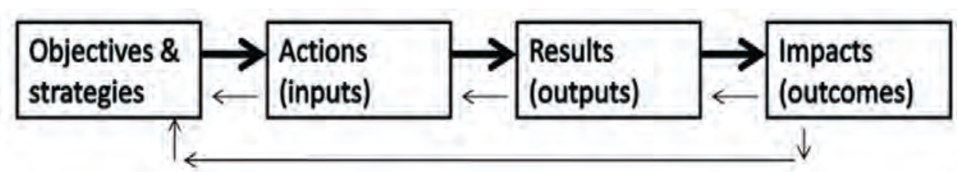

Figure 1. A framework that identifies the multiple points at which monitoring is needed to improve revegetation practices and identify outcomes. The thick arrows indicate the consequences of implementation and the thin arrows indicate key interpretation and learning feedback loops (from Freudenberger 2012).

Key monitoring data for revegetation sites (adapted from CSIRO/ABARES research). Click here to download free database (VegTrack).

Data type	Details	Definitions
Site Data		
1. Data record	Unique identifier for the site	The site is the area of the revegetation work for that season
2. Date	Day/Month/Year	Date of primary observation
3. Data source	Name of observer Contact details	Data collector's name and contact details including agency or business name
4. Site location	Nearest Town & State GPS coordinates for a site access point Tenure of Site Owner of land	Google Earth can be used to determine the coordinates (Lat/Long) of an access point like a gate if a GPS is not available.
5. Site area	Hectares	Google Earth can be used to measure the area of a site
6. Existing land cover	Describe the pre-planting vegetation cover or type of land use	Include dominant plant species covering the site pre-revegetation
Establishment Data		
7. Revegetation objective(s)	Improvements in: shade & shelter wildlife habitat seed production Riparian health or water quality soil stability carbon sequestration etc.	If more than one objective, specify primary and secondary objectives
8. Funding source and resources invested	Agency or person supply funding Dollars spent per site (grant and in-kind) Hours of labour Materials (fencing, herbicide, total kg of seed or total number of seedlings)	Include multiple funding sources. Dollars spent includes site preparation, planting and maintenance to date.
9. Site preparation	Dates Weed control technique (e.g. glyphospate at X ml/ha) Soil preparation (e.g. rip and mound, or scalp with direct seeder)	Describe the dates and methods used to prepare the site for planting and/or direct sowing of seeds
10. Species planted or sown	Species name (Latin binomial) Seed provenance (source location)	Specify species of seed or seedlings used and where the seed was collected from (when known)
11. Planting or sowing rate	Kg of seed/ha/species directly sown Nursery seedlings planted/ha/species	List the planting or seeding rate for each species
12. Revegetation methods	Direct seeding Nursery seedlings Tree guards Mulches Watering Stimulate natural regeneration (e.g. fire or ripping) etc	Describe what was done to establish more native plants on the site
Monitoring and Maintenance		
13. Monitoring frequency	None Occasional-opportunistic Regular (planned)	If regular, list how often per year
14. Monitoring method(s) for revegetation	Casual look around Plots and formal surveys What measured	Describe the method(s) used to monitor the status or health of the planting
15. Revegetation monitoring results	Date Names (Latin binomial) of surviving species % of species planted that have survived Density of surviving species (number/ha) % of seedlings planted still surviving General health or vigour of the reveg Species of weed Cover of weeds (e.g. low, medium, high)	Describes and quantify the success rate (results) of the revegetation at this site
16. Site Management	Date Observed threats to the revegetation Management activity Effectiveness	Lists management activities on the site post revegetation (e.g. weed and pest control) and describe how well they worked
17. Methods to measure outcomes	None Bird surveys Habitat Hectares Carbon sequestration Salinity etc	Describe methods used to measure or estimate the outcomes of the planting. Outcomes are the consequences or environmental ***impacts*** of the revegetation.
18. Results of outcomes monitoring	Date Survey or observational data	What found and what it means
19. Other observations/notes	Date Text or data	Other observations conducted at the site

Further Reading

Australian National Botanic Gardens (2012) Growing Native Plants on the Web.

Broadhurst, L. (2007) Managing genetic diversity in remnant vegetation. Technical Note 01/2007.

Broadhurst, L. M., A. Lowe, D. J. Coates, S. A. Cunningham, and M. McDonald. 2008. Seed supply for broadscale restoration: maximizing evolutionary potential. Evolutionary Applications 1:587-597.

Coor, K. 2003. Revegetation Techniques: A Guide For Establishing Native Vegetation In Victoria. Greening Australia Victoria.

Cole, I. A., I. Dawson, W. Mortlock, and S. Winder. 2007. Guideline 9: Using native grass seed in revegetation. FloraBank. Available from URL

Cole, I. A. and W. H. Johnston. 2006. Seed production of Australian native grass cultivars: an overview of current information and future research needs. Australian Journal of Experimental Agriculture 46:361-373.

Foster, P. R. Reseigh, J. Myers, J. P. 2009. An introduction to the nutritional composition of Australian Native Grasses: forage and seed. Rural Solutions, Adelaide.

Gibson-Roy, P. G., Moore, G., Delpratt, J. and Jess Gardner, J. (2010) Expanding horizons for herbaceous ecosystem restoration: the Grassy Groundcover Restoration Project. Ecological Management and Restoration 11: 176-186.

Grassy Groundcover Gazette. 2006-10. Greening Australia. Available from URL

Hall, M., J. Delpratt, and P. Gibson-Roy. 2006. Viability testing of Victorian Western Plains grasses. Australasian Plant Conservation 15:23-25.

McDougall, K. L. and J. Morgan. 2005. Establishment of native grassland vegetation at Organ Pipes National Park near Melbourne, Victoria: Vegetation changes from 1989 to 2003. Ecological Management and Restoration 6: 34-42.

Mortlock, W. 2007. Basic germination and viability tests for native plant seed. Guideline 8. FloraBank.

Prober, S. M. and K. R. Thiele. 2005. Restoring Australia's temperate grasslands and grassy woodlands: integrating function and diversity. Ecological Management & Restoration 6:16-27.

Smallbone, L., S. M. Prober, and I. D. Lunt. 2007. Restoration treatments enhance early establishment of native forbs in a degraded grassy woodland. Australian Journal of Botany 55:818-830.

Further Assistance

For further assistance or advice we suggest you try contacting:

Greening Australia
ph 1300 886 589
or find us on the web page

Your Regional NRM (catchment) Organisation

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