Natural Regeneration: principles and practice

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What is Natural Regeneration?

'Natural regeneration' refers to the natural process by which plants replace or re-establish themselves. Cremer (1990) defines 'natural regeneration' as "reproduction from self-sown seeds or by vegetative recovery (sprouting from stumps, lignotubers, rhizomes or roots) after the tops of the plants have been killed (by fire, cutting, browsing, etc.)". Temple and Bungey (1980) define it as "regrowth which occurs naturally after stress or disturbance. It may be growth from seed of both pioneer or permanent species, or growth from lignotuber (e.g. *Eucalyptus spp.*), rootstock (e.g. *Melaleuca spp.*), etc; remaining in the ground". Planting seedlings and direct seeding are alternative methods of re-establishing vegetation.

Why use natural regeneration?

Natural regeneration is a powerful tool for anyone wishing to re-establish vegetation on a property at minimum cost and is an essential part of managing a bushland area. Areas that are managed in a way that enables natural regeneration to occur can be self-sustaining and may not require further expensive establishment costs. Natural regeneration ensures that the plants established on a site are from parents that currently occupy the site. Hence it helps to preserve genetic identity and variation throughout Victoria's plant species. This natural 'conditioning' to a site means that these plants are capable of withstanding long-term natural fluctuations and should do well, once established. Natural regeneration is particularly useful for establishing plants on a broad scale but can also be used in localised areas. Natural regeneration has also been used as a means of producing seedlings for planting in other areas.

Throughout much of rural Victoria this natural process is no longer occurring. Mature plants are reaching the end of their lifespan and the benefits associated with them are being lost (e.g. shade and shelter, wildlife habitat).

Under what circumstances is natural regeneration a useful option?

So long as there are mature and healthy native plants on the site, natural regeneration is an option. It is limited in many areas by the depleted, and therefore limited range, of species existing at a site compared to its natural diversity. Supplementary planting or the introduction of seed from other areas is often required to attain full natural diversity. Natural diversity is essential to re-establish a 'healthy' ecosystem. Natural regeneration can be a sporadic event. It is therefore not as reliable to produce results in a given season as planting might be, however, when it is successful, the results are often dramatic. For many species, natural regeneration is effective only near the parent plant.

In a healthy ecosystem natural regeneration is an inbuilt part of the process that maintains the ecosystem, its communities of plants and animals. Under natural conditions, human interference is not desirable.

How can I encourage natural regeneration?

A number of factors, both natural and man-made, are believed to be involved in the control of natural regeneration in rural Victoria. Some of these are discussed below and some management options are proposed. There are likely to be other factors not covered here.

The controlling factors

1. SEED SUPPLY

Problem: No seed, or seed of poor viability. This may be due to the absence of fertile plants with viable seed; seed harvesting by ants & predation by other insects, birds and mammals; lack of fire; lack of pollinators or seasonal variations.

Absence of fertile plants with viable seed - background:
The lack of suitable plants from which seed/spores (etc.) can be generated may preclude natural regeneration. This may occur because the plants that are present are too old or stressed, because some species are no longer present at the site, due to bad seasons, or because both sexes are no longer present in plants with separate males and females (e.g. She-oaks *Casuarina*).

Management options:
In some instances seed may not be available at the site immediately but may be carried in from nearby sources by water, wind or wildlife. In this case, simply waiting can produce results. Direct seeding or planting may be the only option in areas cleared of native vegetation. It should be noted that native plants do not produce seed in equal quantities each year. Heavy seed fall in some eucalypts is infrequent. Monitoring of seed fall may be necessary using a suitable seed trap. DCE can provide advice on a suitable design and germination testing. It may be necessary to wait for a better season, plant individuals of the other sex (in plants with separate males and females), or pollinate existing females from elsewhere.

Seed harvesting by ants and predation by other insects, birds and mammals - background:
Ants can be very effective harvesters of seed and may take 100% of the year's crop of seed for food and nest-building. This may prevent germination. Other arthropods also feed on seeds. In contrast, many insects, including ants, (& birds and mammals) also play a beneficial role in seed dispersal and germination. For example Berg (1975) found that 1500 species of Australian plants are regularly dispersed by ants because of ant-attracting structures (elaiosomes) on their seeds or fruits.

Management options:
Light raking of the soil during seed fall may hide sufficient seed from ants that consume seeds. Insect numbers vary seasonally and in most cases no action is required to prevent opportunistic predation of seeds by other species.

Lack of fire - background:
Many native plants shed seed following fire, usually from woody capsules that are designed to protect the seed from the intense heat of the fire, then open immediately following its passage. Other species, such as some *Acacias*, produce seeds with thick seed coats that must be cracked by the heat of a fire before germination can occur. Controlled burning of such vegetation, to stimulate seed release or germination, may be a pre-requisite to achieve natural regeneration.

Most Australian vegetation is adapted to withstand fires of

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be as close to natural
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seed that is set may be of

l natives to improve natural
pollinators, by providing
Connecting remnants to
lantings may encourage re-
Use of honeybees (*Apis*
t recommended. Note that
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water, leading to greater
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may prevent or restrict
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which associate with plants
by causing other effects.

fall. Follow up weed control with a knockdown (not residual) herbicide (e.g. glyphosate) may be required. In severely degraded soils, where no topsoil remains, addition of weed-free, pathogen-free topsoil may be necessary. Alternatively, use native pioneer species such as *Cassinia* which can, over time, re-condition the soil. Sterile hybrid grasses (e.g. ryecorn) have been used as 'cover-crops' to arrest erosion. Addition of a small soil sample from healthy vegetation of the same type can reintroduce lost soil microorganisms. Care must be taken that the soil sample is from healthy vegetation and is free of weed seeds and potential pathogens. Mulching will aid water retention, slowly add to the organic content of the soil and reduce weed competition but if applied too heavily will prevent germination. Where erosion is severe, other erosion control practices should be employed. Advice should be sought from DCE.

Soil chemistry

Application of chemicals
Many of Victoria's soils contain naturally low levels of elements that are important to plant growth, such as phosphorous and nitrogen. Much of our native vegetation is adapted to these low levels of soil nutrients and has developed efficient strategies for recycling nutrients. Application of superphosphate ('super'), weedicides and pesticides has changed the chemistry and biology of the soil (worms and 'super' don't mix). 'Super' favours the rapid growth strategy of introduced pasture annuals over native species. The resulting competition from weeds may effectively exclude native plants.

Lack of an 'ash bed'
Some native plants have specific soil-bed requirements for germination. For example, some species need a fire to release nutrients for use during establishment.

Soil chemistry - management options:
Do not apply fertiliser to areas that are to be regenerated or managed to retain native vegetation. Other chemicals should be used with care and in minimal quantities to achieve a management aim.

Fire may be used to promote conditions for germination (e.g. ash bed for germination) in appropriate vegetation communities. Expert advice should be sought.

3. COMPETITION

Problem: Competition from the same or other plant species may prevent successful seedling recruitment. This may be due to weeds, parent plant allelopathy (chemical inhibition) or fungal attack.

Competition from weeds
Weeds can be very efficient at occupying space, using available nutrients and consuming water. In this way they may outcompete native species in the 'race' to grow. Weeds can be expected to be a major problem in areas that have been previously fertilized and that have been subject

useful where it is necessary to retain the binding capability of plant roots in areas subject to erosion. Removal of the top few centimetres of soil (scalping) can be used to remove unwanted seeds and can be a useful technique if done at the time of seedfall of the species to be regenerated. Positive weed control strategies in areas abutting 'improved' pasture are usually required. For example, a buffer (e.g. screen of tall plants, weeded area) may be needed to prevent *Phalaris* spreading from paddocks into fenced natural areas. Specific advice should be sought from DCE.

Parent plant allelopathy - background
Many species of plants (e.g. *Eucalyptus*, *Allocasuarina*) produce chemicals that inhibit germination of their own seedlings beneath them. This prevents competition from the seedling with the parent plant. Typically, the zone of inhibition extends to the width of the crown of the plant.

Management options:
Landholders need to be aware of this effect. The area managed for regeneration should not be restricted to the base of the parent plant. If only a small area can be fenced, it should be offset downwind.

Fungal attack - background
Soil fungi, whilst vitally important to plant growth (c.f. mychorrizae), can also be pathogens of young seedlings. Attack by fungi can be a problem for seedlings.

Management options:
Sterilization of the soil is neither practical nor desirable. Fungal problems are likely to be seasonal, so repeated attempts may be necessary. Revegetation of areas with contaminated soil containing *Phytophthora* or other soil pathogens must be avoided.

Other seedlings - background
Where there is a range of plants all germinating together (same or different species) there will be competition between individuals for the available resources. Some plants (of a species), or other species, may do better than others. This should not necessarily be seen as a problem unless the successful competitors are weeds (see above). Some seedlings may die whilst stronger and more successful ones survive.

Management options:
If the aim of management is to increase diversity, you may wish to selectively remove competition against 'rare' species by selectively weeding around them using a suitable technique (e.g. hand-weeding).

4. PREDATION OF YOUNG PLANTS

Problem: Seedlings may be destroyed by predators such as insects and other invertebrates; stock; rabbits and hares; or wildlife. Seedlings and young stems may lack natural deterrents (toxic or unpalatable chemicals, hard leaves or leaf structures such as thorns and hairs) and so be

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fencing. Specific advice f
to exclude is availabl
Conservation and Environ
Department of Agricultur
has also been effective in
commensurate with a
effective rabbit control
subject to large numbers o
on the best methods to su
are difficult to exclude a
season and less of a prob
baits could be used over
encouraged by providing
requirements. 'Benign' ch
be useful in specific instan

5. NATURAL HAZARD

Problem: There may be
physical constraints upon
include fire, flood, wind,
(e.g. frosts), time of year

Background:
Natural events can affe
Drought, fire or flood ma
require natural events to
example, acacia seeds ge
River Red Gums respond
be hazardous to young
situations. There is s
regeneration events are
particularly 'good' year
rainfall when the soil is w
prevent germination (e.g.
mature tree may allow lig
germination). Germinat
vegetation community du
rains may initiate germina

Management options:
There is little that can be
course. It is advisable no
season. Where it is obvi
due to man-induced chang
regeneration you can se
DCE.

Some basic rules

A number of manageme
above to deal with many
natural regeneration. The
regeneration techniques is
where it is done and when

It is suggested that you ta
principles:

experience. The rewards are great for those who are prepared to show some dedication, are open to investigation or experimentation and can learn from experience. There are no guarantees with natural regeneration. Talk to those people who have experience in your area.

4. Be patient, if it doesn't happen this year it may next year.

The tools

The following practices form the basic inventory of 'tools' available to encourage natural regeneration. Others may be devised from the suggestions given here.

fencing to control stock and pest animals; select a fencing technique that is the most appropriate for your stock and which may avoid any pest animal problems that you would expect to occur on your property.

destocking to control soil damage and browsing caused by stock; may not protect ground flora.

scarifying (loosening the top few centimetres of soil with a suitable hoe or tiller) to loosen compacted soils, and crack seed coats of soil-stored seed (e.g. wattles).

burning to promote seed release and conditions for germination of many native plants, as a means of weed control and to promote germination (crack seed coats, etc.).

hand-weeding to control weeds; labour intensive but avoids using harmful chemicals.

herbicide application to control weeds; an alternative to hand weeding which is much less labour intensive but employs potentially harmful chemicals, DCE can advise on specific non-residual 'knockdown' chemicals.

soil scalping to remove seeds present in the topsoil as a method of weed control; usually not suitable if ground flora is to be conserved and it can be destructive.

mulching to improve water/soil retention and suppress weeds; can prevent natural regeneration by eliminating light.

supplementary sowing (direct seeding) to add species where the full natural complement of species is not present and you do not wish to wait for wind/water or animal dispersed seed to establish.

planting to add species to those that regenerate naturally with the aim of introducing local native species which can become natural regenerators.

pesticide application to control insect predation on seed/seedlings; use of pesticides, which may have other less beneficial effects, should be avoided wherever possible.

1080 application, warren fumigation, warren ripping, etc. alternative methods of pest animal control, particularly for rabbits. DCE can give specific advice.

raking/repellent emulsions to hide seed from predators and ants; bitumen emulsions have been used to deter ants in direct-seeding trials.

erosion control to stabilise soil; specific advice is available from DCE.

soil supplementation to reintroduce soil micro-organisms to degraded soils where there is a lack of seedling vigour; healthy soil from vegetation of the same type must be used and it is advisable to try other techniques first.

The use of fertilisers and supplementary watering regimes are not recommended. Fertilisers may alter soil chemistry whilst supplementary watering should be unnecessary if the plant stock is local. Both treatments add costs.

The methods

The method of achieving natural regeneration will vary according to the situation. For example, bushland areas would be managed differently to paddocks.

Bushland areas

'Natural' techniques are usually the most appropriate in native bushland. Natural processes should be allowed to continue as often as possible. A controlled fire will probably be necessary to retain diversity, but advice should be sought first. Hand-weeding or burning are the preferred methods for removing weeds, though chemicals may be the only practical means in some circumstances. Soil disturbance by humans should be avoided in remnant native vegetation, as this can promote weeds. Human access is best confined to areas with no remaining natural ground flora.

Farms and disturbed sites

There is no definitive formula that will provide the desired results every time. If natural regeneration does not occur, further investigation will be needed as to the cause. Some strategies are suggested below (see also Note 16):

Strategy one: Fence and do nothing else.

This will almost always be the first step on land under production or other use. (i.e. not necessarily in bushland). Fencing can be carried out at any time but early autumn is the most likely time for regeneration to occur (spring-summer in cold wet climates). Follow-up plantings of additional understorey and ground species may be required. Problems with weeds should be anticipated. Patience is usually essential.

Strategy two: Fence and scarify.

To regenerate species in an area with compacted soil, such as a stock paddock, attempt to fence and 'tickle-up' the soil adjacent to remnant native vegetation. Problems with weeds may necessitate secondary measures.

Strategy three: Fence, apply weed control and/or fire with light soil scarification.

1. Fence in early spring. 2. Apply weed control just prior to seed fall (from February for most species), with follow up occurring throughout the period of germination, and/or apply fire in early autumn taking advantage of dry fuel produced by fencing before spring growth (take note of fire restrictions and precautions). 3. Lightly scarify the soil at the time of seed fall. Rapid regrowth of weeds can be expected. Fast growing acacias and other species may overshadow and eventually exclude some weeds.

Strategy four: Reduce stocking rate and control pest animals

If fencing is not an option, reducing the stocking rate, particularly if combined with an effective pest animal control program, can achieve successful regeneration especially in 'good' seasons for plant growth. There are many other strategies that could be devised using the tools suggested previously.

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