

# Chapter 8

## Restoration of Degraded Landscapes

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### **Definitions**

*Degraded:* Reduced in status; degenerated or lowered in condition, quality or character.

*Restoration:* Reconstruction to a former, original or normal condition; recovery from ruin or decay; rehabilitation; renewal; repair.

*Recharge:* An altered catchment hydrology where excess water soaks into the ground to the watertable.

*Discharge:* Where recharge causes watertables to rise to within the plant root zone or the soil surface.

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### **Introduction**

The mosaic of landscapes that occur across the Riverine Plains today largely reflect the history of land management over the last 150 years.

In this relatively short time, the changes to the ecology of the landscape have been dramatic. Some of this change has been necessary for agriculture, however, pushing the country too hard can result in degradation that impacts on both the lands productive capability and conservation values.

Clearing, overgrazing, river regulation and feral animals are just a few of the degrading influences that have shaped our landscape.

Sometimes, land can degrade to a point where rehabilitation or restoration action is required to maintain or improve the productive and/or environmental values of the land.

Restoration of an ecosystem is less desirable than the prevention of degradation. Restoration can rarely

reproduce the condition of the former landscape, as severe or large-scale degradation may result in the permanent loss of species or genetic material from a local area.

Vegetation is the key to restoration of degraded landscapes and its management will be the single most important consideration in any restoration project (refer Chapter 9). Vegetation is vital for stabilising soil, reducing watertables or maintaining habitat and biodiversity. For most restoration projects, the objective will be to return the land to as near natural condition as possible. To achieve this it stands to reason that restoring the lost vegetation will be the main focus.

This chapter briefly covers the process and several techniques involved in restoring degraded land at a site specific or property scale.

### **Landscape degradation**

Degradation will generally occur in two ways. Firstly, a single or series of discrete “catastrophic” events can result in change, such as severe overgrazing, clearing, drought, rabbit plague or a combination of

these factors. Secondly, degradation may occur slowly over time such as through grazing pressure selectively removing sensitive plant species from a paddock and allowing invasion by undesirable plants. Rising watertables and the resulting salinity problems from clearing and irrigation are another example of a relatively slow degradation process.

### **Sensitive soil landscapes and vegetation communities**

Certain soil landscapes of the Riverina are more susceptible to degradation. The lighter textured rises in the landscape, including sandhills, lunettes and prior streams are particularly sensitive. When the protective vegetation cover is removed through clearing or heavy grazing, these light soils become susceptible to wind and water erosion. It is particularly important to manage these soil landscapes carefully to maintain vegetation cover and prevent soil erosion.

Rabbit infestations also tend to be higher in the sandy soils and this adds to the total grazing pressure in such areas. As a result, vegetation communities that occur on light textured soils including Black Bluebush (*Maireana pyramidata*) or Cypress-pine (*Callitris* spp.) Mixed Woodlands tend to be more degraded. Fences and watering points should be situated so that they do not increase grazing pressure on these vulnerable soil landscapes.

Bladder or Perennial Saltbush (*Atriplex vesicaria*) shrubland is a plant community that can be easily degraded. Overgrazing the saltbush so that most of the leaves are removed can result in the death of the plant. Large scale death of mature plants is significant as saltbush seed remains viable in the soil for only 3 to 5 years. If the seed does not have suitable conditions for germination and establishment in this time, the saltbush will be depleted or lost from the area. Once removed it is likely to be replaced with less desirable species such as

Poverty Bush (*Sclerolaena* spp.) and Dillon Bush (*Nitraria billardieri*).

Woodlands suffer from degradation on a large scale as they are highly fragmented from clearing. Grazing pressure within woodland remnants tends to remove the understorey shrubs and suppress regrowth of trees. This will often result in a woodland that lacks structural diversity and does not have any young trees to replace those that age and die.

### **Landscape restoration**

Left alone for long enough, degraded land may recover to an extent, but it rarely recovers to its original condition. More often, degradation will get worse before it gets better and restoration action is required to reverse the trend.

There are four key aspects to a restoration project:

1. Recognising *cause* and *effect* and targeting the cause;
2. Site stabilisation;
3. Environmental reconstruction, and;
4. Monitoring.

### **Cause and effect – target the cause**

For every effect or symptom of degradation there is an underlying cause. To restore degraded land the *cause* of the degradation must be identified and addressed. Land is unstable if the degrading influences are still active, as the condition of the land will continue to decline.

For example, fencing off and planting trees in a dieback affected Black Box (*Eucalyptus largiflorens*) depression will not ultimately restore the health of the vegetation if the tree death is resulting from salinity or a lack of flooding. The fencing and revegetation may slow the rate of decline, but the site will be unstable and

continue to degrade until the water management issues are addressed.



**Figure 1:** Dieback of Black Box near Hay, caused by lack of flooding.

Table 1 provides several examples of degradation problems and the possible causes.

### **Site stabilisation**

Once you know where to target your efforts, the restoration project site should be stabilised by implementing action to remove the degrading influences.

Removing the degrading influences will usually reduce the rate of decline in condition at the site, and it can also initiate immediate improvement. However, stopping the active degradation will not necessarily improve or restore a site to its former condition. For example, a claypan caused by overgrazing will still be very slow to recover if it is fenced to exclude stock. In situations like this, additional work is required to fully restore the site. A stable site where the cause of the degradation is removed is much easier to rehabilitate and improve than an unstable site that is still in decline.

Stabilisation is the minimum level of restoration that should be undertaken in any degrading landscape to prevent the situation from becoming worse.

### **Environmental reconstruction**

Following stabilisation and the removal of the degrading influences, works can be undertaken to restore the land to the desired condition. This is the environmental reconstruction stage.

The extent and nature of the reconstruction works will depend on what you are trying to achieve for the site. Most restoration projects will aim to achieve one of the following objectives:

- Agricultural production.
- A natural environment or ecosystem.
- Partial restoration for a mix of production and environmental benefits.

The extent of restoration will also depend on the resources available to commit to the project.

In reconstructing a natural environment or ecosystem you should find out what the land, vegetation and habitat characteristics were like before degradation. This can be done by referencing similar vegetation communities and soil landscapes that are in good condition and through discussions with the Department of Land and Water Conservation (DLWC), Greening Australia and other landholders.

### **Monitoring**

For any restoration project it is important that monitoring is undertaken to ensure that the site is stabilised and improving in condition and that no new degradation is occurring.

**Table 1:** Cause and effect of several degradation problems.

PROBLEM	EFFECT Signs, Symptoms and Related Factors	CAUSE (often in combination)
Salinity	<ul style="list-style-type: none"> <li>• Rising watertables</li> <li>• Soil surface salting</li> <li>• Dieback of trees</li> <li>• Increase in salt tolerant ground plants</li> <li>• Bare, unproductive ground</li> <li>• Waterlogging</li> </ul>	<ul style="list-style-type: none"> <li>• Clearing</li> <li>• Irrigation</li> <li>• High grazing pressure in the catchment</li> <li>• Loss of perennial plants in the catchment</li> <li>• Altered catchment hydrology</li> </ul>
Soil Erosion	<ul style="list-style-type: none"> <li>• Low ground cover</li> <li>• Loss of perennial shrubs and grasses</li> <li>• Dust storms</li> <li>• Buried fences</li> <li>• Claypans</li> <li>• Silted tanks and dams</li> </ul>	<ul style="list-style-type: none"> <li>• Altered catchment hydrology</li> <li>• Clearing</li> <li>• Cropping practice</li> <li>• Drought</li> <li>• Fire</li> <li>• High grazing pressure</li> <li>• Rabbit diggings</li> </ul>
Fragmented Landscapes and Vegetation Dieback	<ul style="list-style-type: none"> <li>• Isolation of vegetation communities</li> <li>• “Edge effects”</li> <li>• Branch tips die</li> <li>• Extensive defoliation</li> <li>• Epicormic regrowth</li> <li>• Tree or shrub death</li> <li>• Caterpillar invasion of saltbush</li> <li>• Waterlogging</li> <li>• Salinity</li> <li>• Water stress</li> </ul>	<ul style="list-style-type: none"> <li>• Clearing</li> <li>• Altered catchment hydrology</li> <li>• River regulation</li> <li>• Drought</li> <li>• Root rot or fungal diseases</li> <li>• Herbicide drift</li> <li>• Insects</li> <li>• Natural death of old trees</li> <li>• Self thinning of dense regrowth</li> <li>• Vegetation fragmentation and isolation</li> </ul>
Degraded Wetlands, Streams and Floodplains	<ul style="list-style-type: none"> <li>• Stream bank instability</li> <li>• Erosion</li> <li>• Loss of vegetation along waters edge</li> <li>• Poor vegetative regrowth</li> <li>• Dieback</li> <li>• Turbid water</li> <li>• Low numbers of native fish</li> </ul>	<ul style="list-style-type: none"> <li>• Carp</li> <li>• Snags and willows redirecting flow to riverbanks</li> <li>• Stock activity</li> <li>• Excavation in the stream bed or on banks</li> <li>• River regulation</li> <li>• Floods</li> <li>• Waterlogging</li> <li>• Water stress and lack of natural flooding events</li> <li>• Altered catchment hydrology</li> </ul>
Woody Weeds	<ul style="list-style-type: none"> <li>• Increase in species such as Turpentine (<i>Eremophila</i> sp.), Hop Bush (<i>Dodonaea viscosa</i>) or Puntty Bush (<i>Senna</i> sp.).</li> <li>• Low ground cover of grasses and forbs</li> </ul>	<ul style="list-style-type: none"> <li>• Changed fire regime</li> <li>• High grazing pressure</li> <li>• Drought</li> </ul>

## Restoration techniques

### Saline landscapes

It is generally not possible to fully restore saline land to natural condition. However, it can be rehabilitated to a point where some production and environmental benefits may be realised.

#### **Recharge stabilisation**

For saline land restoration, the first step is to determine the source of the recharge. If this can be identified, action should be taken to reduce the leakage of water into the ground.

Where irrigation is causing the recharge, options include:

- improved crop water use efficiency;
- improved irrigation layout;
- improved surface drainage and recycling; and
- sub-surface drainage such as tile drains, etc.

Where the recharge is from local runoff or from cleared land, the options include:

- revegetation with locally native trees and shrubs;
- introducing perennial pastures such as Lucerne;
- management of grazing to promote perennials; and
- surface water drainage/interception works.

#### **Reconstruction of saline land**

With measures in place to stabilise recharge, restoration of the discharge site can commence. Restoration measures can include the following

#### **Fencing**

Stock will often preferentially graze or camp on saline areas. Fencing out a saline area allows grazing to be better managed without affecting the entire paddock. Stock exclusion will allow natural regeneration of ground cover to occur.

Saline sites should only be grazed when plants are established and the ground is dry.

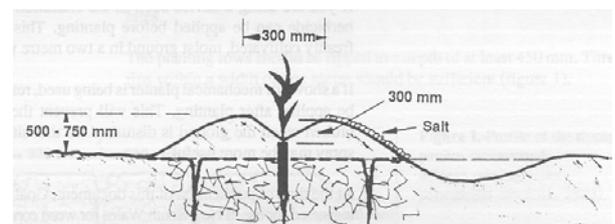
#### **Retain Remnant Vegetation**

Protect and retain existing vegetation to ensure a source of seed for regeneration. Retain dead trees for habitat.

#### **Revegetation**

Revegetation works through tree, shrub or grass planting will accelerate the restoration process and enable the re-introduction of species that may be lost from the site.

- Ground preparation – mounding of planting sites to a height of 30 to 50 centimetres creates better drainage allowing salt to be washed away from the roots of the establishing plants (Figure 2).
- Species selection – if the restoration objective is production oriented, species could consist of a plantation of Old Man Saltbush (*Atriplex nummularia*) or salt tolerant pasture species. If the aim is to partially reconstruct the ecology, you will need a range of salt tolerant trees, shrubs and ground covers that are (where possible) locally native.



**Figure 2:** The mounding technique recommended for use in saline ground (Source: Nicholls).

#### **Cultivation**

Cross ripping or cultivation of bare ground can improve salt leaching and trap wind blown seed.

### **Interception Plantings**

Extensive revegetation up-slope of a discharge site can intercept groundwater and slow the rate of discharge.

### **Runoff Interception Earthworks**

Surveyed diversion banks up-slope of a saline discharge area may be used to prevent clean runoff water flowing over the site and adding to the problem or transporting salt off site.



**Figure 3:** Groundwater discharge showing waterlogging and death of trees and ground cover (near Deniliquin).

### **Groundwater Pumping**

Bores, spear points and evaporation basins can be used to lower watertables. These options do not address the cause of the problem, but are quite effective stabilisation measures.

### **Eroded soil landscapes**

Soil erosion is initiated when there is low vegetation cover on the soil surface. Wind erosion is the dominant force in the Western Riverina but water erosion can also cause significant degradation.

### **Stabilisation**

Stabilisation options for erosion generally rely on a combination of structural works, grazing management and vegetation management. Structural works for water erosion control are site specific and require specialist design, survey and construction. Such works include dams, banks, waterways and flumes. While

structural works may stabilise the erosion, they generally do not address the cause of the problem.

In grazing country stabilisation of wind erosion will be through grazing management. On cultivated soils, stabilisation can be through:

- wind breaks;
- alley farming;
- retention of stubble;
- conservation farming techniques;
- minimising stock and machinery traffic; and
- agronomic practices that improve soil structure, water holding capacity and maximise ground cover.

A ground cover of at least 50 percent is required to minimise wind erosion, and 70 percent to minimise water erosion.

Appropriate management of total grazing pressure and revegetation in the paddock or catchment is a key step in maintaining ground cover.

### **Reconstruction**

Following stabilisation works, restoration of eroded land is mainly through fencing to exclude stock and promote natural regeneration of vegetation with revegetation works as required (Chapter 9). Where soil erosion is caused by a change in catchment hydrology (ie. there is too much runoff moving too fast), grazing management and revegetation or changed cropping practice in the catchment can rectify this situation

Scalds or claypans are a common feature of the Riverina. Scalds are extensive bare areas where topsoil has been eroded leaving a clayey subsoil that is often saline and relatively impermeable to water.



**Figure 4:** Scalded prior stream in Black Bluebush shrubland north of Moulamein, 2001.

Scald reclamation options include the following.

#### **Waterponding**

Surveyed banks in either horseshoe or circle configurations can be constructed that pond water over the surface of the scald. The water infiltrates, leaching out salts as well as cracking the surface, thereby improving soil conditions for plant establishment and growth. This is the most successful form of scald reclamation.

#### **Contour Furrowing**

On slopes greater than 2 percent, one option is to rip furrows along the contour. The furrows trap water, soil and seed and provide favourable sites for plant growth and establishment. Best suited to areas of low slope in Bluebush country.

#### **Revegetation**

Revegetation works should be targeted at the re-introduction of chenopod shrubs, generally Bladder Saltbush, Black Bluebush or Old Man Saltbush. Early deep ripping with follow up direct seeding into the rip lines can be effective.

#### **Checkerboard or Cross Ripping**

As with furrowing, rip lines can be used to trap wind blown seed and soil and provide suitable sites for plant establishment.



**Figure 5:** Checkerboarding for scald reclamation at One Tree, 1962.

#### **Fencing and Grazing Management**

It is generally impractical to fence out smaller scalds, however, grazing management is important and fencing will help. Paddocks with scalds should be periodically spelled and rabbits controlled to increase regeneration. This should be done in conjunction with other mechanical techniques.

#### **Farm Infrastructure**

Situate watering points away from sensitive landscapes to avoid scalding. Ensure that paddock fencing does not isolate sensitive landscapes near fence lines, especially the south west of paddocks.

#### **Mulching**

Spreading lambs tails on the scald will add organic matter, trap wind blown soil and seed, and increase soil water retention. Mulching with stem trash and seed heads will have a similar effect.

#### **Animal Impact**

Feeding mobs of stock on a claypan will disturb the soil, break the soil crust and add organic matter, seed and nutrients through dung and residual feed.

## **Fragmented landscapes and vegetation dieback**

A fragmented landscape is where vegetation only occurs as remnant patches. There are two steps in the restoration of a fragmented landscape:

1. Enhancing the condition and quality of remnant vegetation; and
2. Increasing the area and connectivity of native vegetation through strategic revegetation and regeneration.

To enhance the condition of remnant vegetation and stabilise the decline, the first step is to remove the degrading influences of the “edge effects”. Chapter 9 covers this process for restoration through grazing management, weed control, regeneration and revegetation and minimising the “edge effects”.

As fragmentation of the landscape is caused by clearing of vegetation, reconstruction requires the replacement of vegetation in locations where it will increase the size of existing remnants and improve the connectivity between remnants. The principles that guide the planting of corridors and links are covered in Chapters 3 and 9.

In restoring saltbush dieback, grazing management in the years following a dieback event is critical to saltbush survival. In the 3 to 5 years following dieback the saltbush must be given the opportunity to regenerate while there is still viable seed in the soil, and to give live bush an opportunity to recover.

## **Riparian and flood dependant landscapes**

The restoration of riparian and flood dependant landscapes presents a unique set of challenges. Chapter 5 outlines a number of these issues.

Depending on the cause of the degradation, restoration measures for erosion include:

- removal and control of willows;
- release of native fish into waterways;
- fencing to exclude stock;
- adoption of off-stream watering points;
- revegetation with aquatic and terrestrial plants;
- weed control; and
- develop a love of fishing and a taste for carp!

For dieback, restoration options include:

- removal of block banks etc;
- improving drainage;
- running water to stressed communities through channels or harvesting runoff; and
- reduced grazing pressure.

The principles outlined in Chapter 9 for improving the condition of vegetation apply to these areas. Weed control is particularly significant with introduced weeds such as Lippia (*Phyla nodiflora*) and Bathurst Burr (*Xanthium spinosum*) or environmental weeds such as Cumbungi (*Typha* spp.) or Bushy Groundsel (*Senecio cunninghamii*) causing particular problems.

## **Derived landscapes**

Derived landscapes are essentially vegetation communities that have changed in composition and character from their original form. The original vegetation has been replaced by a community that may be stable and biologically diverse (or it may be a monoculture), but does not represent

the original vegetation that was present prior to a degrading, or change inducing influence. This change is called *succession*, and can be induced by management, particularly grazing.

Fenceline effects are a graphic example of changed landscapes, however, recognising derived landscapes is not always this easy. Some common derived landscapes are Dillon Bush shrublands, woody weed (Turpentine, Hop Bush, Budda etc.) shrublands and many grasslands.

A careful investigation of the area should reveal signs of the past vegetation community.

Reconstructing prior vegetation communities can prove difficult, and even impossible. However, where the process is actively occurring it is possible to stabilise the situation and reverse the trend.

The restoration of these areas is dependent on several factors:



**Figure 6:** Fenceline effect at Tchelery Experimental Area (2001) showing grassland derived from mixed woodland.

1. Sound grazing management (refer to Chapter 7);
2. Appropriately situated farm infrastructure; and

3. Reinstating an appropriate fire regime for woody weeds.

Boree country will readily recover with reduced stocking, as the seed stock remains viable in the soil. Saltbush country will not recover without revegetation due to the short seed life.

Close attention to the principles of grazing management and well-planned farm layout (Chapters 3 and 7) can effect an improvement in condition, even if it cannot reproduce the former landscape.

### **Cropped landscapes**

Land that is subject to dryland or irrigated cropping can suffer degradation. However, restoration is generally not an option as the land is managed for production. Soil erosion, soil acidification, soil structural decline, soil sodicity and soil nutrient depletion are all degradation problems experienced in cropping.

Addressing these issues is usually related to agronomic practice, and does not generally constitute restoration of land to natural condition.

### **Intact landscapes**

Landscapes and ecosystems that are in good condition and are not degrading do not require restoration. However, they do require *protection* and *monitoring* to ensure that they do not start to decline.

### **Seek advice**

With any degradation problem, there is rarely a simple solution that can be applied to work in all cases. In most cases, each problem is unique and will require solutions that can be tailored to the site.

Where possible, seek advice, or at least a second opinion. The DLWC, NSW Agriculture and Greening Australia all have staff that can provide land or vegetation restoration advice.

## **References and further reading**

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