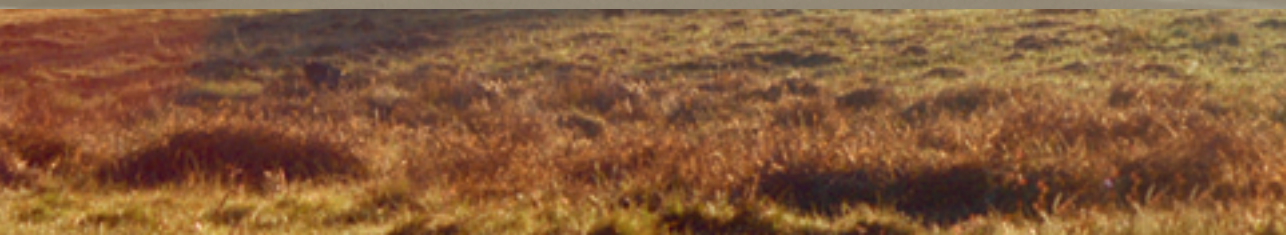
CARING FOR COUNTRY

A sustainable land management guide for rural living in north central Victoria



The North Central Catchment Management Authority (CMA) acknowledges Aboriginal Traditional Owners within north central Victoria, their rich culture and their spiritual connection to Country. We also recognise and acknowledge the contribution and interests of Aboriginal people and organisations in the management of land and natural resources.

In using the title Caring for Country, the North Central CMA acknowledges the significance of this term for Indigenous people, the custodians for many thousands of years of the land we share. We now all share the responsibility to act as custodians of the land that supports us and all living things.

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For additional copies of this publication or for further information, please contact:

North Central CMA
628–634 Midland Highway
(PO Box 18)
Huntly, VIC 3551

Telephone (03) 5448 7124
Facsimile (03) 5448 7148
info@nccma.vic.gov.au
www.nccma.vic.gov.au

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Contents

Recognition of Traditional Owners

"Country … is a nourishing terrain. Country is a place that gives and receives life. Not just imagined or represented, it is lived in and lived with … Country is multi-dimensional – it consists of people, animals, plants, Dreamings, underground, earth, soils, minerals and waters, surface water, and air …

Country in Aboriginal English is not only a common noun but also a proper noun. People talk about country in the same way that they would talk about a person: they speak to country, sing to country, visit country, worry about country, and long for country. People say that country knows, hears, smells, takes notice, takes care, is sorry or happy …"

From the Strategy for Aboriginal Managed Lands in Victoria, December 2003.

We acknowledge, with great appreciation, the traditional custodians of this region, the Dja Dja Wurrung, Barapa Barapa, Wamba Wamba, Wergaia, Wadi Wadi, Yorta Yorta and Taungurung peoples.

Aboriginal people have been connected to what is now known as Victoria for over 40,000 years. We recognise and respect the knowledge that Aboriginal people have in managing land and conserving biodiversity. We consider Aboriginal people as equal partners in managing our land and water. Caring for country is a cultural obligation and a birth right. Cultural knowledge supports sustainable living practices and strengthens identity and connection.

Aboriginal people refer to land and people as one, so looking after their country – its plants, animals and waters – is integral for the maintenance of culture, land and people.

As non-Aboriginal people 'manage' their land, Aboriginal people regard themselves as 'negotiating with country', interpreting and responding to signals from country. Whereas non-Aboriginal people say they are 'managing their land', Aboriginal people's phrase is '**caring for country**'.

Over 150 years of agriculture have brought untold benefits to north central Victoria, but they have also wrought erosion and salinity, damaged rivers, wiped out native species and brought many more to the brink of extinction. As we embark on the twenty-first century, we increasingly understand that we have much to learn from Aboriginal ecological knowledge, its interpretation and application to natural systems. Traditional owners should be supported to retrieve and record information, ensuring intellectual property is recognised.

Government agencies have taken to controlled burning as a means of reducing fuel loads in forests, killing weeds and regenerating native species. Farmers are discovering the benefits of native pastures, which have evolved with this landscape for millennia. Communities are even discovering the richness of bush tucker, and finding that in many places, it's best to grow indigenous plants. In some places, introduced European farming practices may not work at all.

Just as we can learn about land from Aboriginal people, we have a responsibility to care for the physical and cultural heritage embedded in the landscape. Throughout north central Victoria middens, earth mounds, scar trees or other cultural artefacts exist. As landholders we have a legislative obligation to prevent harm to Aboriginal cultural heritage, to recognise these sites, protect them and to learn from them.

We have arrived at the day when caring for our culture is the same as caring for our land, as we realise that having healthy land, streams and air is fundamental to our survival and the continuance of our own culture.

As a land manager, this guide will help you **care for country**.

Introduction

North central Victoria is an area of diverse landscapes and land-use. It is bordered by the mighty Murray River to the north, the Great Dividing Range and Wombat State Forest to the south and Mt Camel Range to the east. Major towns across the region include Bendigo, Kyneton, Woodend, Castlemaine, Echuca and Swan Hill. The region's main waterways are the Campaspe, Loddon, Avoca and Avon-Richardson rivers, which form part of the southern Murray-Darling Basin. The region also has a diversity of natural environments, including rivers and floodplains, Box-Ironbark forest and woodlands, iconic River Red Gum forests and Riverine Plain grasslands. These habitats contain significant biodiversity, including many endangered flora and fauna species.

Much of the landscape in north central Victoria is used for agricultural land-use – 87% of land in the region is privately owned. The region's landscapes provide a rich variety of land and soil types that sustain a diverse range of agricultural enterprises. There are extensive areas of irrigation in the north, productive cropping and mixed farming in the west and cropping and grazing country in the mid and upper catchments. Intensive animal and horticultural enterprises are also found throughout the region. In 2009–10 the gross value of agricultural production within north central Victoria was approximately $1.43 billion. Rural living is an emerging and expanding land use across the region.

> **"Sustainable land management involves managing land without damaging natural processes or reducing the diversity of biological species."**

This is crucial if we are to maintain the variety of native species and habitats, the health of natural life-support systems and the stock of renewable resources such as productive soil, fresh water and clean air throughout the region. Sustainable land management is not an easy task, as land is often managed for multiple benefits, such as agriculture, conservation, fresh water and housing. All land managers have a responsibility to manage their land sustainably so that they don't negatively impact the broader catchment or the condition of the land for future generations.

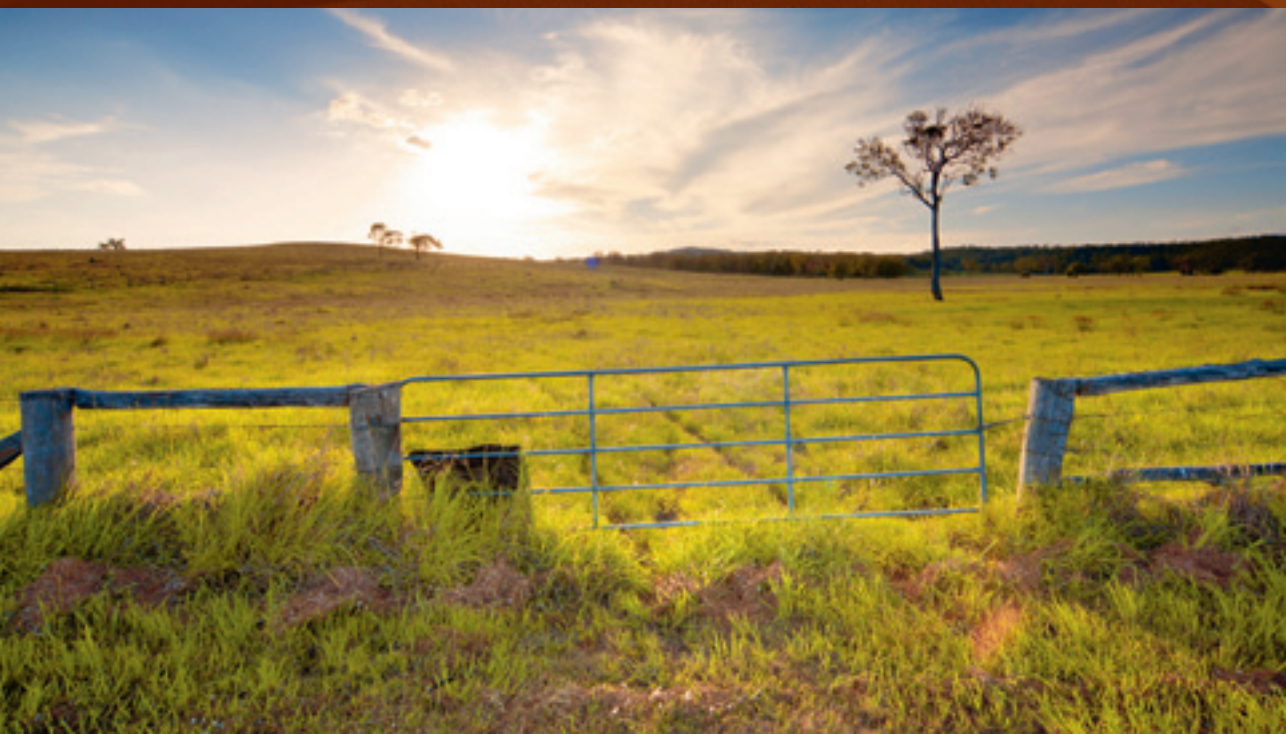
The *Caring for Country* (land management guide for north central Victoria) aims to assist new and existing land managers, particularly those in the rural living zone, to protect the health of their land and the broader environment. It provides a starting point for information on a variety of topics, ranging from property planning to revegetation to pasture management. The guide is divided into eight main chapters: property planning, water, biodiversity, soils, plants, animals, climate and community. Links to further information can be found at the end of each chapter. A glossary of key terms, as highlighted throughout the text, is provided at the end of the guide.

We hope you find this guide useful and thank you for contributing to the sustainability and health of our natural environment.

Figure 1: Topographic map of north central Victoria.

PROPERTY PLANNING

“ Planning is the secret to many successful farm businesses and rural properties, as it provides a process by which landowners can choose between a range of different land management options. ”



Chapter 1
Property planning

Before you buy

Before purchasing a small property or farm there are a number of important aspects that need to be considered. These include: potential land use options, access to water and your legal obligations and responsibilities. Working through the following ten point checklist will help determine whether a property is suited to your requirements or not.

Before you buy checklist:

1. Is the property capable of sustaining what you want to do?

- Are the soils and **land capability classes** suitable?
- What is the soil type and how healthy is it?
- Do I have access to past soil tests?
- Depending on your plans you may need to consider capital improvements such as fencing, stockyards, watering points and fertiliser inputs.

2. What are the relevant planning requirements?

- What are my legal obligations for managing the property? Source regional and local government environment plans, **catchment** strategies and land management guidelines.
- Are there restrictions on land use that may prevent or make it difficult for me to do what I want? For example, covenants, subdivision, vegetation clearing, and pest plant and animal control regulations.
- Am I planning to change the use of the land? How is my land zoned? Sometimes land use changes require planning permits, as not all land uses are permitted in certain zones. Check with your local council or view the planning scheme online before undertaking any development or land use change. Planning schemes set out the policies and provisions for use, development and protection of land. Each local council area in Victoria is covered by a planning scheme, which applies to both public and private land.
- Am I am planning to build? What planning permits do I require? Where can I get a **Land Capability Assessment** before I buy? Check with your local council for specific information and requirements.

3. What services are available to the property?

- Is power, water and gas connected to the property? If not, what is the connection cost for each service that is available?
- What council services (e.g. waste disposal) are available? What do these services cost?
- What is the road access like? What would the road be like in winter and summer? Local councils don't have the resources to bitumen every road, or maintain gravel roads to be pothole or corrugation-free at all times.

4. Does the property have the required quality and quantity of water?

- Does the existing water supply cater for my intended land use?
- Will I be able to access more water if needed?

5. Is grazing livestock on the property an option?

- Are there any restrictions on agriculture or the number of animals that can be kept on the property? Check with your local council or view the planning scheme online for specific information and requirements. Note, even if a neighbour is using the land for agriculture, as a result of historic planning schemes, this land use may not be permitted when land ownership changes.
- How many livestock could the property carry?
- How much feed and water will any livestock need?
- What are my responsibilities under the **National Livestock Identification Scheme**?

Is there a risk of previous chemical or disease contamination that might affect the ability to graze livestock? For example, arsenic, lead, copper, DDT or Ovine Johne's Disease.

6. Are there signs of land degradation?

- Repair of serious land degradation problems can be costly.
- Are there any signs of **salinity** or **erosion** on the property?
- Refer to Chapters 4 and 5 for further information on land degradation and weeds.

7. Are there serious pest plants or animals and what level of threat and/or control is required?

- What pest plants or animals are present?
- Control of declared pest plants, in particular, is a legal requirement.
- Do pest plants or animals on neighbouring properties pose a threat?

8. Assess the property's natural resource assets:

- Presence of **remnant vegetation, wildlife habitat** and healthy natural resources can be significant environmental assets.
- What do I want to do with these assets?
- Laws exist to protect **native vegetation**, wildlife habitat and natural resources from detrimental land management practices, such as clearing, and significant penalties apply for illegal activity. Check with your local council for specific information and requirements.
- Refer to Chapters 2 and 3 for further information on natural resource assets

9. Investigate land use on neighbouring properties and the likely impact on your land and lifestyle:

- What existing activities are in my neighbourhood? If I am buying in a rural zone, am I prepared for rural activities that may include noisy machinery and livestock?
- Land use and lifestyle aspirations can be greatly affected by what happens on nearby neighbouring properties.
- Will my intended land use have adverse impacts on neighbouring properties and lead to possible conflict?
- What opportunities and expectations are there in the surrounding community? Consider joining rural groups such as the Country Fire Authority (CFA), Landcare or other community interest groups.

10. Assess the risk associated with extremes of climate or impacts of nature:

- Flood prone land, areas of high fire risk or high drought incidence can have severe impacts on land use and lifestyle choices.

11. Do I have the skills to undertake what I want to do?

- Are contractors available (e.g. fencing, transporting livestock)?
- Is agistment, leasing or share farming an option?
- Do I require training in land management?

Mount Franklin

Just purchased a rural property?

Property management options

The traditional concept of owning and managing your own small property or farm is just one of a number of different property management options available. Other options include leasing, agistment or share farming. These alternative options can be a great way to get into farming, as they reduce the capital outlay required and the level of risk. For small landholders, these options can provide a mechanism by which their land can be managed by an experienced farmer while they still enjoy the country lifestyle.

Agistment

Agistment of livestock is a feeding option that farmers can utilise when stock feed is short on their home property. It can also provide a risk management option against climate variability and high feed costs. The arrangement is usually short-term and can be informal. A written agreement is highly recommended however to avoid disputes, as it clearly stipulates the responsibilities of each party.

Share farming

Share farming is an arrangement between the share farmer(s) and the landowner to share the work, costs and income from the property. The arrangement should form a written contract that clearly outlines the responsibilities of each party, for example: start and finish dates, income and cost sharing arrangements, agreed farming practices and so on. A number of industry groups have standard contracts that can be adapted to the individual situation.

Leasing

Leasing land is a longer-term arrangement that offers more secure income than share farming for the landowner. The returns to the landowner are not influenced by variations in climate, commodity prices or farming ability. The arrangement also offers a more certain future to the lease. A written agreement is required to document how the land can be used, all the conditions the tenant must follow and a dispute resolution process. For example, the agreement may include: stocking rates, fertiliser applications and crop rotations. A lease longer than three years can be registered on the land title to give security of tenure regardless of whether the land is sold during the lease period.

Planning your property

After you have bought your property, it is advisable to plan, design and manage your property based on its natural resources and economic factors. Such a process is sometimes referred to as ‘whole farm planning’.

Whole farm planning helps you establish and run your property by identifying sustainable property design and land management practices for small-scale, alternative and conventional farming. The aim of whole farm planning is to produce farm layout and land management strategies that will minimise land degradation and optimise efficient layout and management of your property. It also provides the knowledge and skills to be able to plan a sub-division, irrigation layouts, assess land capability and farm potential.

Whole farm planning requires land managers to take stock of their property’s assets – the soil, water, remnant vegetation, wildlife, pastures, soils, topography and fences – and plan how to sustainably manage the property into the future. The plan will also identify the risks to the property’s assets.

As part of the whole farm planning process, land managers set short- and long-term objectives and then work out environmentally friendly ways to achieve them. Most whole farm plans incorporate the following components:

- How to maintain and improve the land, soil and water
- Available finance and works budget
- How to work with the available labour
- Weed and pest animal control
- How to protect and enhance existing vegetation
- How to conserve wildlife
- Production capability
- Appropriate work safety procedures
- Farm water supply
- Drought and flood management
- Fire prevention
- Prioritising works
- Identifying threats and assets
- Developing realistic action plans.

This list is not exhaustive and is a guide only. Check with your local Landcare group or DEPI about workshops or courses for developing whole farm plans.

House design

If you are building on a rural property you have the opportunity to create a sustainable house, which is designed to be efficient in water and energy resources whilst minimising waste. The bonus is that your house is cost-efficient over time, comfortable, cheap to maintain and complements our unique environment. Your home can be up to 5°C warmer in winter and up to 10°C cooler in summer, making it brighter and more comfortable to live in throughout the year. It is very simple to include the basic concepts of sustainable design into your new house or to apply them to an existing dwelling.

The main principles of energy-smart house design include:

- Daytime living areas with large north-facing windows to receive unobstructed winter sun
- Internal planning to create zones that reduce the amount of energy required for heating and cooling
- Windows appropriately orientated and sized with protection from winter heat loss and summer heat gain
- Adequate thermal mass (heavy building materials) to stabilise indoor temperatures
- Adequate insulation in walls, ceilings and floors
- Good draught-proofing
- Cross-ventilation for summer cooling
- An efficient hot water system and fittings
- Efficient lighting and appliances
- Landscape design that helps modify the microclimate for more comfortable conditions inside.

Table 1: Management strategies for the reuse and disposal of specific wastes on rural properties.

Type of waste	Waste management strategies
Chemicals	• Never dispose of chemical wastes (e.g. pesticides, engine oils or lubricants) on your property, as they can pollute the soil, **groundwater** and waterways. • Check with your local council about chemical waste disposal or contact ChemClear, the national program coordinating chemical waste collection and disposal. • Chemical drums should be triple-rinsed and stored in a safe place before being returned for recycling or disposal.
Dead livestock	• If possible, carcasses should be used or rendered, as disposal of dead livestock on farm can cause pollution (especially near waterways), spread disease and/or produce odours. • Commercial disposal services are available – contact your local veterinarian, council or rural supplier for details. • If disposing of dead livestock on your property burying is the best option, however don't bury the animal where erosion or pollution issues may arise. • Livestock burning is permitted only when it is impractical to bury the carcasses or where burning is mandatory due to the presence of certain exotic diseases.
Tyres, hay band and silage wrap	• Must not be burned, only tree branches can be burned on rural properties. • Tyres should not be used for erosion control purposes. • Unless there is a legitimate on-farm use (e.g. tree guards or on silage stacks), tyres should be delivered to a location nominated by your local council.
Used concrete and bricks	• May be reused for engineering works, provided the materials are fit for purpose and free of contamination (e.g. farm tracks). • Used concrete and bricks must not be used to stabilise waterways.

Rural landscape

Managing waste

Managing waste is an important part of rural living, as poor management can negatively impact the health and viability of soils, waterways and neighbouring properties. Wastes may include household garbage, domestic effluent (sewage and grey water), organic matter, chemicals, large waste items and dead animals. Managing each of these wastes sustainably can save time and money, and protect rural properties and the surrounding environment from negative impacts.

The disposal of waste on rural properties is limited to green waste (e.g. compost and tree branches) and limited numbers of dead livestock. The disposal of all other waste on rural properties is prohibited. The burning of waste on rural properties is also prohibited except for tree branches. Wastes from rural properties should be disposed of, or recycled, at landfills and transfer stations. Before collection or disposal, waste should be stored in a manner that will not contaminate water, land or risk the health of humans, livestock or crops. Table 1 on Page 9 outlines further management strategies for specific wastes from rural properties.

Reduce, reuse and recycle

There are three simple ways to cut down your waste and make a big difference to the environment:

1. **Reduce**: Consider carefully the things you buy and refuse the things you don't need. This may involve: selecting products with minimal packaging and/or recyclable packaging, buying in bulk to reduce the amount of packaging you accumulate, replacing plastic bags with reusable bags and containers and planning your meals to avoid wasting food.

2. **Reuse**: Reuse or repair items instead of disposing of them to reduce waste and save money. This may involve: donating unwanted items to charity, washing and reusing takeaway containers and glass jars, repairing household items instead of replacing them and consider using recycled materials.

3. **Recycle**: Waste products can be reprocessed into new products saving resources and reducing pollution. A broad range of items can be recycled including: glass, hard plastics, metal, paper and cardboard. Recycling facilities are available in most areas, check with your local council for further details and what products can be recycled. Specific recycling programs may be available for certain items, such as electronic goods (e.g. mobile phones, which contain heavy metals), waste oil, unwanted or expired farm chemicals (Chemclear) and farm chemical drums (the national drumMuster program collects and recycles empty, cleaned, non-returnable farm chemical containers). Furthermore, homeowners can recycle kitchen and garden waste into valuable garden nutrients by composting; refer to the information box above.

Composting

Almost half of household waste is organic matter. Most of this waste can be composted, including food scraps, garden clippings, **herbivore** animal manure and paper. Compost is valuable garden mulch, as it allows nutrients to be returned to the soil, improves soil structure and increases the water holding capacity of the soil. Composting involves mixing the right amounts of organic matter with air, water and soil biology. The soil biology (worms, insects, bacteria and fungi) then break down the organic matter into rich, dark and crumbly compost. Compost can be created using worm farms or larger compost heaps and bins. Creating good compost involves:

- Turning it regularly
- Avoiding the addition of diseased plants, meat, fat, oil or household cleaners
- Avoiding the addition of too much salty water or ash from wood fires
- An ideal compost heap contains about 20 parts carbon to one part nitrogen by volume. Dry, brown and woody garden refuse is usually high in carbon, while soft, green garden waste and food scraps are usually high in nitrogen.

Composting

Domestic effluent management

Many rural properties don't have access to mains sewage and wastewater collection services, and instead need to install and maintain their own effluent management system. Before installing a septic tank or other domestic effluent treatment system approval must be sort from the local shire council.
It is also important that effluent treatment systems are appropriately managed and maintained to prevent sewage pollution into the environment. Sewage pollution can result in the contamination of water, spread of diseases or environmental degradation. Appropriate management may involve:

- Monitoring the discharge quality from the system
- Checking they operate efficiently and effectively
- Ensuring the tank and disposal field aren't disturbed or built over
- Inspecting the system at least annually
- Desludging the tank at least every three years or as directed by the local council.

Homeowners can also consider recycling grey water (non-toilet wastewater) for use on their garden, particularly during summer or droughts. Further information on grey water systems can be found in the following chapter.

Resources and further information:

Association of Victorian Regional Waste Management Groups: www.avrwmg.org.au

Central Murray Regional Waste Management Group: www.cmrwmg.vic.gov.au

ChemClear: www.chemclear.com.au

Department of Transport, Planning and Local Infrastructure: www.dtpli.vic.gov.au

drumMUSTER: www.drummuster.com.au

Environmental Farm Plan: www.environmentalfarmplan.org.au

Environment Protection Authority: www.epa.vic.gov.au

Environment Protection Authority (2009) Farm Waste Management. Environment Protection Authority, Melbourne.

Farm Style Australia – specialised small farm advice: www.farmstyle.com.au

Highlands Regional Waste Management Group: http://hrwmg.vic.gov.au

Macedon Ranges Shire Council 'Our Landscape Profiles' website: www.ourlandscapes.mrsc.vic.gov.au

Planet Ark's Recycling Near You Website: www.recyclingnearyou.com.au

Planning Schemes Online: http://planningschemes.dpcd.vic.gov.au/index.html

Search 'small landholder' or 'whole farm planning' on the DEPI website: www.depi.vic.gov.au.

Sustainability Victoria: www.sustainability.vic.gov.au

Your Home – design for lifestyle and the future: www.yourhome.gov.au

WATER

“Healthy catchments provide a source of clean drinking water, habitat for plants and animals, natural vegetation and waterways for recreation, reliable and clean water for livestock and irrigation, and opportunities for sustainable agriculture and industry.”

Chapter 2
Water

Our catchments

What is a catchment?

A **catchment** is an area of land bounded by natural features, such as hills or mountains, where water is collected (Refer to *Figure 2*). In a catchment all rain and run-off water makes its way to a low point in the landscape, such as a stream, river, wetland, ocean or underground into the **groundwater** system. During periods of low rainfall the groundwater system can slowly feed water into the river system.

> "Natural and human systems such as rivers, dams, wetlands, bushland, plants, animals, people, towns and farms can co-exist in a catchment."

Healthy catchments provide a source of clean drinking water, **habitat** for plants and animals, natural vegetation and waterways for recreation, reliable and clean water for livestock and irrigation, and opportunities for **sustainable** agriculture and industry. The health of a catchment depends on how people living and working in the catchment manage and interact with it. The way we manage water, livestock, land and gardens, design houses, dispose of waste, collect firewood, treat our waterways, and care for trees and other vegetation all affect our catchment. Water quality is a key measure of a catchment's health. Humans and their activities can easily pollute streams and waterways, and pollution increases **salinity**, reduces oxygen and changes the pH and water temperature; all affecting catchment health and aquatic **ecosystems**. Land managers need to be aware of their impact and the consequences for others in the catchment.

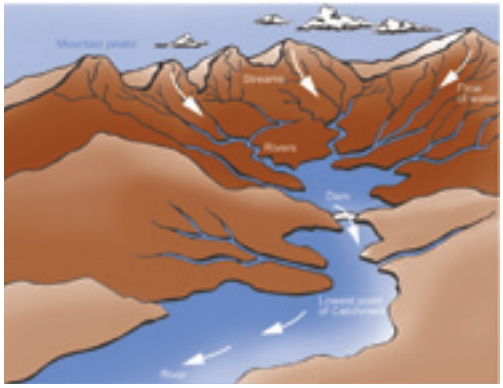


Figure 2: A catchment is an area of land bounded by natural features where water is collected.

Regional Catchment Strategy

The North Central CMA region is rich in natural assets of regional, national and international significance. It is also a region that faces some of the most complex environmental problems in Victoria.

The North Central Regional Catchment Strategy 2013-19 (RCS) provides a long-term vision for natural resource management within the North Central CMA region. The RCS sets regional priorities for the management of natural assets, sets overall direction for investment and coordination of effort by landholders, partner organisations and the wider community. It provides a framework that supports and encourages participation in protecting and enhancing our environment. The vision of the RCS is: 'A community active in protecting and enhancing the integrity of its catchment'.

Declared water supply catchments

Some natural catchments are also known as Declared (Proclaimed) Water Supply Catchments. These areas provide a basin to catch and store water for domestic, agricultural and commercial use. There are 17 Declared Water Supply Catchments in north central Victoria, refer to *Figure 3*. Five of these catchments also have Special Area Plans, which specify *significant planning development restrictions,* where various land uses can occur and how they should be undertaken in order to minimise any adverse effects on water-related values. The plans identify water courses, drainage lines, mineral springs and water storages, and outline any buffer distances that must be observed to protect water quality from adjacent land uses.

In Victoria there are 19 different water corporations that manage the supply of water for domestic, livestock and irrigation purposes. These water corporations also provide sewage treatment, drainage and salinity mitigation services. Some water corporations also manage bulk water storages and recreational areas. The water corporations in north central Victoria are Central Highlands Water, Coliban Water, Goulburn-Murray Water, Goulburn Valley Water, Grampians Wimmera Mallee Water, Lower Murray Water and Western Water - refer to Figures 4 and 5 for the geographic area of urban and rural water corporations.

Figure 3: Declared Water Supply Catchments in the North Central CMA region.

Figure 4: Urban water corporations in the North Central CMA region.

Loddon River, Wombat Forest

Figure 5: Rural water corporations in the North Central CMA region.

2013–21 North Central Waterway Management Strategy

The North Central Waterway Management Strategy is a planning document that sets the direction for managing waterways and wetlands in the North Central CMA region. The strategy outlines the most important actions for waterway and wetland management activities across the region.

A key objective of the 2013-21 Water Management Strategy (currently in development at time of print) is to involve the community in planning and implementing river and wetland projects. Landholders are vital to the success of such projects, as most works are on privately-owned land or affected areas that require the cooperation of private landholders. Effective natural resource management involves creating and sustaining partnerships between various levels of government, communities and community groups, Indigenous communities and private landholders.

Rivers and creeks

Rivers are one of the major forces shaping catchments. They are dynamic systems that have evolved over a very long time in response to an extremely variable climate. Flow variability largely determines the shape and ecology of rivers. A river's catchment – the slope, geology, soil, vegetation and surrounding land uses – also affects the river's condition.

Four river catchments are found in north central Victoria: Campaspe, Loddon, Avoca and Avon-Richardson. The Campaspe River is the major waterway flowing 245 km north from its headwaters in the Great Dividing Range to its confluence with the Murray River at Echuca. Its catchment covers approximately 400,000 ha. The Campaspe River's major **tributary** is the Coliban River. Other significant tributaries include the Axe, McIvor, Mount Pleasant, Wild Duck and Pipers creeks.

The Loddon River catchment covers approximately 1,500,000 ha and extends approximately 395 km from the Great Dividing Range in the south to the Little Murray River. Major tributaries include Tullaroop, Bet Bet, Bullock, Bendigo, Serpentine, Gunbower and Pyramid creeks.

The Avoca River catchment covers approximately 1,200,000 ha and is an anabranch system, meaning the river diverts from the main channel and later rejoins it downstream. The Avoca River has one of the most variable flows of all the Victorian rivers in the Murray-Darling Basin. The river rises near Amphitheatre and eventually terminates in Lake Bael Bael. Major tributaries include Glenlogie, Sugarloaf, Cherry Tree and Strathfillan creeks. In the lower catchment, two ephemeral effluent streams of Lalbert and Tyrell creeks flow west to terminate in Lake Timboran and Lake Tyrell respectively.

Loddon River near Vaughan Springs

The Avon-Richardson catchment is a land-locked system covering approximately 330,000 ha. It extends from the Pyrenees foothills near St Arnaud north to the nationally significant Lake Buloke. The catchment has little river regulation to modify or prevent flood flows. The two main waterways in the catchment are the Avon River and the Richardson River.

The Murray River between Echuca and Swan Hill forms the region's northern border. The Murray is the single largest source of water in the region for irrigation. The Loddon, Campaspe and Avoca rivers all contribute water, salt and nutrients to the Murray River, as well as the exchange of aquatic species (e.g. migratory fish).

"The Murray River is a waterway of national importance and is integral to the health of the internationally significant Gunbower Forest and Kerang Lakes wetlands."

The Murray-Darling Basin Authority's Sustainable Rivers Audit (SRA) provides a long-term assessment of the condition and health of the 23 river valleys in the Murray-Darling Basin. The data collected in the 2008-10 audit, on five environmental themes: fish, macro-invertebrates, vegetation, physical form and hydrology, reveals that the four river valleys in the region are in very poor to poor overall health.

Wetlands

In north central Victoria wetlands comprise of swamps, billabongs, lakes, salt marshes, bogs, soaks and mudflats. Wetlands are areas that have acquired special characteristics because they are wet on a regular or semi-regular basis. The term also applies to depressions in the landscape of more arid regions that only occasionally hold water but teem with life and become environmental focal points when they do.

Considered essential components of our landscape, wetlands provide a link between our waterways and the surrounding land. They maintain water quality, reduce the impact of flooding, and provide habitat, feeding and breeding areas for many significant plants and animals. Of significant environmental value, wetlands support a range of distinctive **flora** and **fauna** communities consisting of common and many threatened or endangered species.

Unfortunately, there has been an overall decrease in wetland area and quality since European settlement, largely because of the development of urban and agricultural areas, the diversion of watercourses to drainage lines and alteration to water quality and flow patterns through regulated dams, weirs and levee banks.

Despite a growing recognition of their many values and functions, wetlands remain one of our most endangered environments. In Australia many wetlands are transient, remaining dry for part or all of the year and filling only during wet seasons after rain. Consequently, recognition of less well-known wetlands can be difficult, especially in dry years.

The health of wetlands and even their existence is sometimes in jeopardy. Changes to water flow can significantly alter wetlands, bringing about disruptions in natural productivity cycles, creating changes in vegetation, and affecting the normal exchange of nutrients and organic matter between rivers and floodplains – an exchange needed to keep wetlands healthy. Changes in land use and land management practices such as grazing livestock and cropping have reduced the quality of water available to wetlands. Salt levels have risen because of these practices, which can have a drastic affect on the health of wetlands.

Wetlands are also important socially and economically. As a unique part of our landscape, they are popular for tourism and recreation, and in some cases, contain significant cultural **heritage** sites. They are often valuable resources for agriculture, timber harvesting, fishing, education and research.

Dams

Dams modify the volume, speed and frequency of stream flow. Taking too much water from streams for dams can mean the flow diminishes and destructive levels of nutrients build up in the streams. Building a dam in a proclaimed catchment means that some of the water that was relied on as part of the domestic water supply system for a town or city has been diverted away from the system. Landholders must check the licensing and/or planning permit requirements before constructing or modifying a dam. Planning permits are required by some local councils to build a new dam or to extend an existing one. If the proposed or existing dam is on a waterway, a permit may also be required from the relevant water authority.

Dam alternatives

Before constructing or modifying a dam, alternative water storage options should be considered, such as rainwater tanks and gravity fed watering systems. Rainwater tanks can be used to collect reliable, good quality water from buildings at relatively low costs. They also have minimal construction and maintenance requirements compared to dams. Rainwater can be used for household consumption, livestock watering and/or garden irrigation. For livestock watering, a gravity fed system can be used to transfer water to troughs around the property. In this system, water is typically pumped from the rainwater tank to a header tank using a windmill, solar pump, electric pump or fuel pump. The header tank then uses gravity to supply water under pressure to the troughs. Header tanks are located at a higher point on the property than the troughs. However, if your rainwater tank is located at a higher point on your property than the troughs a header tank isn't required.

Dam construction

Building a dam is a major engineering feat and there are a number of safety factors that should be considered. Dams that have a wall five metres high or greater or hold 50 megalitres or more of water are classified as potentially hazardous. The safety of downstream neighbours, their property and stock may be at risk in the event of a dam collapsing. A property owner who is planning to build a new dam can improve its safety by:

- Having the dam properly planned and designed
- Having it properly constructed to meet design requirements and specifications
- Ensuring that professional advice is obtained for all of the above.

Healthy dams

A healthy farm dam is an important resource supplying water for livestock, irrigation, gardens and fire management, providing valuable **wildlife** habitat and increasing farm productivity and property values. Farm dams need careful management to ensure they are kept in good condition.

Management strategies to enhance dam health include:

- Manage livestock access to the dam by fencing and providing alternative water (for example, gravity feed the water to a trough below) or by designing suitable access points. When livestock drink directly from a dam they cause **erosion**, foul the water and risk drowning. Sometimes it may be necessary to access a dam in an emergency for water for fire fighting, so design fences accordingly.
- Don't plant trees and deep rooted shrubs on the dam wall, spillway or inflow area as their roots can cause tunnelling and leakage. Instead, plant mat-forming **perennial** species or small shrubs with outward-extending fibrous roots. 100% pasture cover should be maintained on the spillway, drainage lines and depressions all year round to prevent erosion.
- Check dam walls regularly for signs of damage from burrowing animals or plants. Leaking dams waste water and can contribute to erosion.
- Check trickle pipes in the dam wall regularly to ensure they aren't blocked.
- Plant shelter belts against the prevailing winds to help prevent evaporation.
- Incorporate native plant species (trees, shrubs, groundcovers and aquatic plants) that would typically be found in local wetlands in and around the dam to provide habitat for fish, frogs, birds and other wildlife. A log, dead tree or an island in the dam are excellent roosting sites, and islands provide security from predators such as foxes. Wildlife-friendly dams can provide a number of co-benefits such as improved water quality, shade and shelter for livestock and natural pest control in pastures.

On large properties it may not be possible to carry out all the management strategies described above on all dams; however you can prioritise different actions according to the dam's proximity to waterways, size, usage patterns and existing features or problems.

Groundwater

Groundwater is an important source of water for many property owners and is used by one in ten Victorians. Groundwater can be sourced from private bores, springs or public water supplies. A licence from the local water corporation is needed to extract groundwater for irrigation purposes, unless the water is for domestic or livestock use. Domestic or livestock use includes household purposes; watering of animals kept as pets; watering of cattle or other stock; or irrigation of a kitchen garden, but does not include use for dairies, piggeries, feedlots, poultry or any other intensive or commercial use.

Before boring for water, contact the local council and water corporation. The zone or overlay controls on a property, or activities associated with installing the bore (i.e. clearing of **native vegetation**), may require a planning permit.

Mineral springs

Mineral springs are abundant in the southern part of north central Victoria, especially around Daylesford. The springs in this area are fed by rain falling onto **recharge areas** along the crest of the Great Dividing Range. Water percolates down into a deep groundwater system where it reacts with the underground rock. Minerals from the rock dissolve into the water. The mineralised waters then travel two to 45 km from the crest of the Great Dividing Range before emerging as mineral springs at the surface.

There are two main threats to mineral springs. The first is contamination and reduced quality, and the second is reduced flows. In the past, septic tank effluent and fertilisers have contaminated springs. As a result, some septic tank systems are being removed from mineral spring's catchment areas and homes are being connected to reticulated sewerage systems. Today, the main contamination risks are from agricultural chemicals and salty groundwater from cleared agricultural land. In urban areas, chemicals, pesticides and fuel are the main contamination risks.

Irrigation

The irrigation of land within north central Victoria occurs largely across the Loddon Campaspe Irrigation Region, which covers approximately 714,000 ha of land (refer to *Figure 6* below). There is also irrigation along the Loddon and Campaspe Rivers and in the upper Loddon Catchment around Newlyn, Ascot and Waubra where groundwater is used in conjunction with surface water. The intensity of irrigation is greatest in the lower reaches and floodplains of the Campaspe and Loddon rivers.

History of irrigation in north central Victoria

In the decades leading up to federation, farming within the northern plains region of Victoria became increasingly difficult. Farmers struggled against the region's variable climate of low rainfall and periodic drought. In an effort to overcome these problems landholders began experimenting with irrigating land in an attempt to increase its productivity.

New irrigation infrastructure

Figure 6: The Loddon Campaspe Irrigation Region.

In 1905, the State Rivers and Water Supply Commission (State Rivers) was created by an act of parliament. Under this act, the State Rivers was responsible for acquiring land to develop as irrigation farms and for building water supply infrastructure to service farms established within constituted irrigation districts.

Land deemed suitable for irrigation was divided into 40, 60 and 100-acre blocks. In general, 40-acre blocks were transformed into horticultural farms whilst the 100-acre blocks were developed as dairy farms. Irrigation farms were generally provided with a 100-acre feet water allocation (approximately 123 megalitres). This allocation was deemed by authorities to be sufficient for someone to make a reasonable living from the land. Land continued to be developed for irrigation up until the late 1960s. The completion of the Campaspe Irrigation District in the 1970s signalled the end of state-sponsored irrigation development in northern Victoria.

Supplying water for irrigation

Irrigation occurs within the Torrumbarry, Loddon Valley and the Rochester-Campaspe areas in north central Victoria. Irrigators in the Torrumbarry Irrigation District receive their water via the Torrumbarry Weir on the Murray River. Water is diverted at the weir through the National Channel into Gunbower Creek to supply irrigators near Cohuna.

Loddon Valley irrigators receive their water via two separated systems, the Loddon and Goulburn Rivers. The Waranga Western Channel carries water from the Goulburn River system to supply irrigators in the southern areas of the Loddon Valley Irrigation District.

Water is supplied to irrigators in the Rochester-Campaspe Irrigation District via the Waranga Western Channel and from the Campaspe River.

All irrigation systems have highly reliable water entitlements. Irrigators receive 100% of the water entitlement 98 years out of 100 on the Murray system and 96 years out of 100 on the Goulburn system. Campaspe irrigators receive 100% of the water entitlement 97 years out of 100 whilst Loddon irrigators can expect to receive 100% of their water entitlement 94 years out of 100.

Irrigation modernisation

The traditional patterns of land use are changing rapidly across the Loddon Campaspe Irrigation Region. There is an increasing area of dryland within the region where water is no longer intensively applied due to irrigation system rationalisation and modernisation, and because water entitlements have been purchased for the environment and for human consumption.

“The traditional patterns of land use are changing rapidly across the Loddon Campaspe Irrigation Region.”

Adapting to a decade long drought followed by the worst flooding in living memory, has changed the established pattern of land use within the region and will continue to do so. The reduced water availability, combined with climate variability and fluctuating commodity prices, has caused landholders to adapt their enterprises to be more resilient, viable and productive.

There is also a shift in property management and type. The number of small-scale hobby farms is expected to increase in areas within close proximity to larger towns. Agricultural properties are being amalgamated to a magnitude of scale to support family corporations. Such changes are likely to bring their own set of land management changes.

The beginning of the 21st century signalled a need to radically rethink irrigation. A ten-year drought, an increasing focus on the ‘rights’ of the environment, pricing pressures facing irrigators and ageing irrigation infrastructure put the region under increasing pressure.

Land management for healthy catchments

Safe, clean water

Inappropriate land use and development can undermine the safety and reliability of water supplies in our catchments. Water authorities, local councils and communities must preserve the quality of our water to safeguard public health, protect our water supply, reduce water tariffs, and ensure a secure and reliable long-term supply of drinking water.

Inappropriate development and land use in catchments could ruin water supplies, so planning authorities look closely at catchment planning and management. Consequently, development proposals in declared water supply catchments now receive more scrutiny than ever. Catchment protection and water quality have become some of the most significant issues confronting rural land use planning in Victoria. Authorities and local communities have to consider and guard against the cumulative impact of individually insignificant developments and activities. *Table 2* below outlines some of the major threats to catchment health and water quality.

Looking after waterways

Protecting the health of waterways is a crucial part of owning a property, and run-off has to be managed so it does not affect water quality. Polluted water such as septic effluent and contaminated surface run-off must be kept clear of dams, as well as rivers, streams and drainage lines crossing your property. Land managers should aim for the water draining from their property to be as clean as when it arrived.

Good planning and managing run-off by planting trees, shrubs and grasses as buffers helps stop nutrients, pathogens, chemicals and sediments from entering waterways and water storages. *Table 3* on Page 23 lists ways that land managers can reduce their impact on catchment health.

Table 2: Major threats to catchment health and water quality.

Major threats to catchment health and water quality
Nutrients and wastewater from intensive animal industries (such as piggeries), forestry and urban stormwater.
Nutrients and chemical leaching from intensive agriculture, such as potato farming.
Unsustainable land management practices in rural areas, i.e. activities leading to long-term decline in soil, water, vegetation and community values.
On-site wastewater treatment and disposal that cannot be contained on-site and may flow off-site via run-off and contaminate waterways and groundwater.
Old wastewater treatment systems that no longer effectively treat and dispose of wastewater.
Towns and settlements close to waterways where higher building densities lead to a greater risk of polluted surface run-off.
Agricultural run-off (chemical, dirty water, nutrients and sedimentation) in areas without enough distance to buffer waterways and vegetation.
Uncontrolled stock access to waterways and reservoirs leading to water contaminated by pathogens, nutrients and sediments.
Chemical spills and surface water run-off from roads located near rivers, streams and reservoirs.
Poor river health contributing sediment and nutrients into waterways.
Specific points on a waterway or on land where the soil or water is being polluted or has the potential to be contaminated, e.g. stock watering point, water reclamation plant discharge point, school or scout camps, businesses next to a waterway, and so on.

Table 3: Land management practices that promote catchment health.

Land management practices that promote catchment health
Use chemicals efficiently and carefully, or seek alternative methods where possible.
Control weeds and pests.
Retain and plant native vegetation to prevent erosion.
Protect stream bank vegetation so it provides a filter against pollution.
Manage on-site wastewater treatment systems (septics) properly.
Develop improved wastewater and stormwater treatment systems.
Manage land to prevent or minimise the impact of large-scale bushfires.
Report accidental spills near waterways.
Get involved in Landcare, Waterwatch or other local community groups.

Accidental spills

Take responsibility immediately for any spills into a waterway, for example fuel, fertiliser or herbicides. Firstly, contain the spill without flushing or diluting it, as that can spread the contamination. Contact the Environment Protection Authority (EPA Victoria) after containing as much as possible of the spill. EPA Victoria doesn't have the necessary equipment to carry out a clean-up of a spill but the agency can provide advice on what to do to rectify the situation, including providing details of private contractors with expertise in cleaning-up spills.

If there is a chemical or fuel spill within a proclaimed catchment such as the Lake Eppalock catchment, contact the local water authority as well as EPA Victoria. Immediate measures might need to be put in place to protect water supply reservoirs and treatment plants from the polluted water flowing downriver.

Revegetating riparian zones

Riparian land is any land that adjoins or directly influences a body of water (see *Figure 7*). It includes:

- The land immediately alongside small creeks and rivers, including the river bank itself
- Gullies and dips that sometimes run with water
- Areas surrounding lakes
- Wetlands and river floodplains that interact with the river during floods.

It is important not to think of riparian land as just a narrow strip along each river bank. Depending on the nature of the land (floodplain, gorge or valley) and the adjacent land use (national park, farming, forestry, urban housing), the width of riparian land that requires special management will range from a very narrow to a wide, densely vegetated corridor.

In areas where the riparian vegetation is patchy or absent, **revegetation** is an essential first step. Revegetating waterways with **indigenous plants** has many benefits, such as:

- Stabilising banks and controlling bank erosion
- Providing habitat and food sources for native animals, including beneficial insects and parasites that may help control crop and pasture-feeding pests.
- Providing shade and shelter for livestock
- Providing shelter from damaging winds for pastures and crops
- Improving the appearance of farm land
- Maintaining water quality by providing a buffer strip that acts as a filter for nutrients and sediments (see Figure 8).

In some situations, fences will encourage natural **regeneration** by giving land managers the ability to control the timing, duration and intensity of livestock grazing. However if the site is isolated from natural seed sources, replanting may be necessary. Local, native riparian plants should be the first choice, as replanting with introduced species will not recreate the habitat needed to support the full range of native wildlife in and along the waterway.

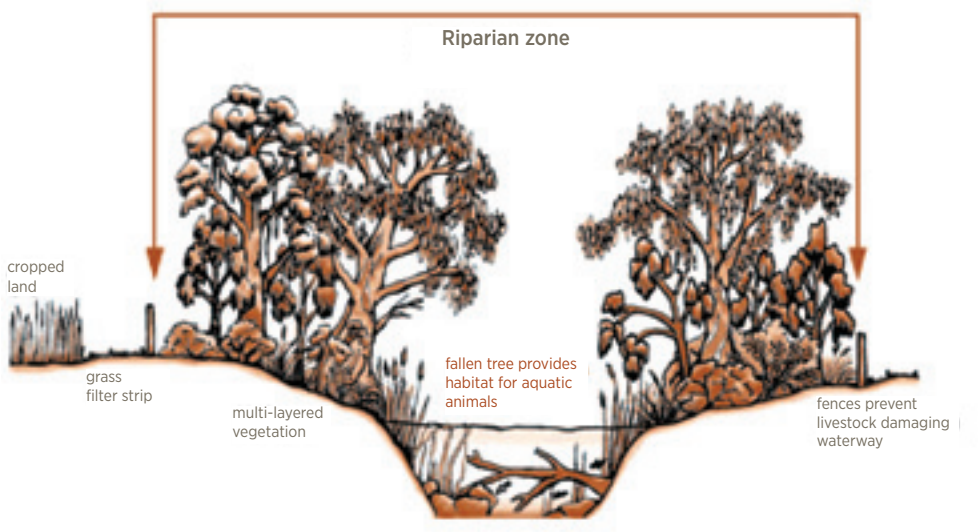


Figure 7: Cross section of a river showing the riparian zone.

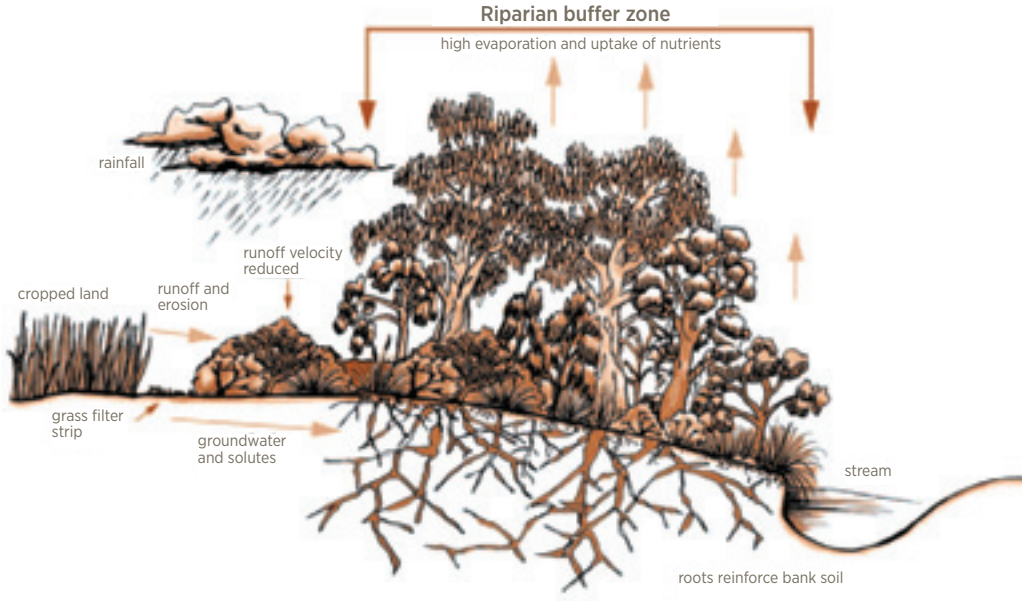


Figure 8: A riparian buffer zone and grass filter strip combine to trap sediments, nutrients and other contaminants from entering the waterway.

Managing livestock

Livestock that are allowed free and uncontrolled access to riparian land can directly foul the water with their waste. They also increase soil erosion by over-grazing and forming bare walking tracks and camping areas. These impacts reduce water quality for downstream users by introducing:

- Pathogens from livestock faeces, which can increase the risk of disease
- Nutrients from livestock faeces and urine, which can lead to algal blooms
- Sediments from erosion and soil disturbance, which may harm aquatic life and clogs waterways.

Furthermore, it is not uncommon for livestock to fall down steep riverbanks or become bogged along the water's edge, resulting in injury or death to valuable livestock. This is not only expensive for the livestock owner, but can also lead to further pollution of water supplies for downstream users.

It is often not necessary to permanently exclude livestock from riparian land, but is important to control their movement and to manage grazing pressure. The simplest way of regulating livestock access and grazing pressure on riparian land is to erect a fence between it and the rest of the property. In managing livestock grazing on riparian land, the aim is to maintain continuous groundcover, with enough vegetation to protect the soil surface from heavy rain and to provide a filter for sediments and manure contained in runoff. Land managers may also wish to maintain vegetation for bank stability as well as for wildlife and in-stream habitat. In general, timing, intensity and duration of grazing all need to be considered. Funding may be available to land managers for fencing and provision of off-stream watering points. Contact your local Landcare group or the North Central CMA.

Snags are good

As the trees beside a stream or river age, die and decay, large branches and sometimes even whole trunks can fall onto the stream bank or into the river. Before European settlement, most rivers had lots of this woody material, usually known as **large woody debris** (or 'snags') along their banks and in their channels. To the early settlers, snags were often a nuisance. It was generally incorrectly thought that snags blocked the channel and caused additional flooding at times of peak flow. As a result, especially in southern Australia, millions of snags were removed from streams and usually piled on the bank and burned.

Snags provide habitat for animals and fish and help stem flows. Woody debris plays an important role in maintaining a diverse aquatic habitat by helping to scour out pools in the stream bed, creating variable flows and providing a diversity of habitat for aquatic life. Murray Cod, Trout Cod and River Blackfish all rely on snags for their survival. Woody debris also provides habitat and food for the algae, bacteria and bugs that form the basis of aquatic food webs. Birds and snakes use large woody debris above the water surface for resting and as vantage points for hunting.

Livestock in Gunbower Creek causing erosion and nutrient pollution

Large woody debris in the Loddon River near Jarklin

Waterwatch

The North Central Waterwatch program is a community monitoring and environmental literacy program that focuses on building the knowledge of environmental issues affecting rivers and wetlands. The program works in collaboration with communities, individuals, landholders and school groups.

North Central Waterwatch supports a network of 60 community water quality monitors across 100 monitoring sites. The data collected by monitors is kept in a regional database, with specific reports available on request.

The program also engages eight schools in the environmental education program, River Detectives, to get schools involved in monitoring local waterways. Waterwatch also runs community events and produces educational publications.

If you'd like to participate in the North Central Waterwatch program or want any further information, please contact the North Central CMA.

"The Waterwatch program has given us a strong sense of ownership of our local creek."

Anne Perkins, Castlemaine Landcare Goup

Saving water

Water is a precious resource in north central Victoria, as climate variability can result in periods of drought and low water supplies. Population growth in major towns, such as Bendigo, is placing further pressure on our waterways and water supply systems. It is becoming increasingly important for communities in the region to conserve water to ensure we have enough to get through even the driest summers. Using less water also means there is more for our rivers and streams, which helps keep them healthy.

On average, a person uses about 200 litres of water every day. Only five to ten litres of this is required for basic survival, that is, drinking and food preparation. The remaining 190 litres is used for lifestyle purposes such as showering, toilets, clothes washing and the garden. Over half of this water ends up as waste water. Some communities have been able to reduce their daily water usage to 130 litres per person by employing water saving practices and products, refer to *Table 4* below for water saving ideas.

Rainwater tanks

Rainwater tanks are an easy and excellent way of harvesting rainwater on rural properties. They can reduce water bills, conserve water and be used as a storage for year-round fire fighting (in the peak of summer, dams can sometimes be empty when water is most needed).

Using rainwater can save large amounts of water. The easiest way is to use it in the garden, which accounts for 35 to 50% of domestic water use. Using rainwater in the garden requires a relatively simple system, and is encouraged by many water corporations. Further savings can be made when rainwater is used for toilet flushing (about 20% of domestic water use), as well as in the laundry, kitchen and bathroom. It can also be used in pools and for washing cars.

Rainwater can be used for drinking, washing, bathing and gardening. Provided the rainwater is from a well-maintained system, is clear and has little taste or smell, it should be safe to drink. In many situations in rural areas rainwater is used for all domestic uses as there is no access to the mains supply.

Harvesting rainwater simply involves collecting rain from the roofs of buildings and storing it in rainwater tanks for later use. There are many different design possibilities for a rainwater system. The key features include:

- Water pressure – use a pump or a header tank to provide pressure
- Water quality – first flush systems, leaf guards and filters.
- Size of tank – will depend on roof capacity, local rainfall and the level of capacity needed.

Table 4: Water saving ideas for the home and garden.

House	Garden
Install a rainwater tank.	Use grey water on the garden.
Install water-saving devices – AAA rated shower heads, grey water systems and dual flush toilets.	Keep lawn areas to a minimum.
Fix taps that leak. A small drip can waste over 200 litres of water per day.	Water in the cool of the evening or morning.
Reduce shower length from 8 to 4 minutes and save up to 20,000 litres of water a year.	Water the garden less often but more thoroughly.
Avoid using running water where possible. E.g. half fill the sink to rinse dishes or fruit and vegetables.	Use water-wise plants (e.g. indigenous plants)
Turn the tap off when brushing teeth.	Mulch and compost garden beds.
Try the economy cycle on the dishwasher.	Group plants with similar water needs together.

Recycling water

As mentioned in the previous chapter, recycling grey water for use in the garden is another water saving strategy, which is particularly useful during times of drought and water restrictions. Grey water is the non-toilet wastewater and includes the water from kitchen sinks, washing machines, laundry tubs, hand basins, showers and baths. It is usually mildly contaminated with organic materials, pathogens, bacteria, viruses and cleaning products. Plants will readily use the nutrients in the cleaning products and organisms in the soil will digest pathogens.

Homeowners can install temporary systems, which simply involve connecting a pipe from your washing machine to your garden. These systems are useful during summer or in droughts and are designed for immediate grey water use only. Alternatively, homeowners can install specialist systems that recycle grey water year-round, although a permit is required from your local council before installation and an agreed on-site treatment plant management program must be followed.

All grey water should only be used when following basic safety guidelines, as it can pose risks to human health and the environment. The EPA supports water conservation methods and believes that grey water can be used effectively and safely in domestic situations by following several simple tips outlined in *Table 5* below. To look at putting in a permanent system for grey water use, start by getting a copy of the EPA's Information Bulletin *Domestic Wastewater Management Series, Reuse Options for Household Wastewater*, Publication 812.

Table 5: Management tips for recycling grey water for use in the garden.

Do	Don't
Use wastewater only from baths, showers, hand basins and washing machines, preferably the final rinse water.	Use grey water on vegetables or other edible plants if the crop is to be eaten raw.
Only use grey water on the garden and rotate which areas are watered.	Use grey water that has faecal contamination, e.g. wastewater used to launder nappies.
Only apply the amount of water that the soil can absorb.	Use kitchen wastewater (including from dishwashers) due to the high concentration of food wastes and chemicals that are not readily broken down by soil organisms.
Always wash hands after watering with grey water.	Store grey water for more than 24 hours.
Stop using grey water when it rains or the ground is wet.	Let children or pets drink or play with grey water.
Stop using grey water if it smells or plants don't appear to be healthy.	Allow grey water to flow from your property or enter stormwater systems.
Use natural and safe detergents, cleaning agents and soaps (e.g. low phosphorus, environmentally friendly) to prevent contamination of water.	
Use grey water immediately	
Deliver grey water by sub-surface drip irrigation.	

Resources and further information

ABC Science – Catchment Detox: www.catchmentdetox.net.au

Australia's Water: www.environment.gov.au/water/

Central Highlands Water: www.chw.net.au

Coliban Water: www.coliban.com.au

Cooperative Research Centre for Irrigation Futures: www.irrigationfutures.org.au

CSIRO Land and Water: www.csiro.au/Organisation-Structure/Divisions/Land-and-Water.aspx

Department of Environment and Primary Industries' Farm Water Solutions webpage: www.dpi.vic.gov.au/agriculture/farming-management/soil-water/water/solutions

Environment Protection Authority's Onsite Wastewater webpage: www.epa.vic.gov.au/your-environment/water/onsite-wastewater

Goulburn-Murray Water: www.g-mwater.com.au

Goulburn-Murray Water Connections Project: www.g-mwater.com.au

Goulburn Valley Water: www.gvwater.vic.gov.au

Grampians Wimmera Mallee Water: www.gwmwater.org.au

Greening Australia (2012) A Revegetation Guide for Temperate Riparian Lands: www.greeningaustralia.org.au/index.php?nodeId=289.

Irrigation Australia: www.irrigation.org.au

Land and Water Australia: www.lwa.gov.au

Lower Murray Water: www.lmw.vic.gov.au

Murray-Darling Basin Authority: www.mdba.gov.au

New South Wales Department of Primary Industries' Water and Irrigation webpage: www.dpi.nsw.gov.au/agriculture/resources/water

New South Wales Department of Primary Industries (2009) Primefact 781: Building a farm dam: www.dpi.nsw.gov.au/agriculture/resources/water/storage/publications/building-a-farm-dam.

New South Wales Irrigators' Council: www.nswic.org.au

North Central CMA: www.nccma.vic.gov.au

Save Water Website: www.savewater.com.au

Smart Gardens for a Dry Climate: http://www.coliban.com.au/smart_gardens/index1.asp

The Farm Dam Handbook: www.sca.nsw.gov.au/publications/publications/farm-dam-handbook

Victorian Department of Environment and Primary Industries' Water website: www.water.vic.gov.au

Victorian Department of Environment and Primary Industries' Managing Dams webpage: www.dpi.vic.gov.au/agriculture/farming-management/managing-dams

Victorian Resources Online: www.vro.dpi.vic.gov.au

Water Storage iPhone Application: www.bom.gov.au/water/waterstorage/iphone.shtml

Waterwatch Victoria: www.vic.waterwatch.org.au

Western Water: www.westernwater.com.au

BIODIVERSITY

“Protecting creatures of all sizes – down to the tiniest microorganism – and their habitats, helps reverse the effects of human activities that threaten life and life-support systems and agricultural productivity.”

Chapter 3
Biodiversity

What is biodiversity?

The term **biodiversity** – or biological diversity – is used to describe the variety of all life forms. Biodiversity is considered at three levels: the different plants, animals and microorganisms (species diversity), the genes they contain (genetic diversity), and the **ecosystems** of which they form a part (ecosystem diversity).

Biodiversity is constantly changing; it is increased by genetic change and evolutionary processes and reduced by **habitat** degradation, population decline and extinction. It emphasises the interrelatedness of the biological world, and covers terrestrial, marine and other aquatic environments.

From a human perspective, the conservation of biodiversity provides significant cultural, economic, educational, environmental, scientific and social benefits. Given the recent extreme weather events and the rising mean global temperature, an environment rich in biodiversity offers the best chance for adapting to change.

Why plants and animals are so important

Protecting creatures of all sizes – down to the tiniest microorganism – and their habitats, helps reverse the effects of human activities that threaten life and life-support systems and agricultural productivity. Animals and plants help rebuild soil, clean water and air, store and cycle nutrients, provide climate stability and help repair damaged ecosystems. These activities are called '**ecosystem services**'.

Australians are just beginning to recognise the value of biodiversity and ecosystem services. Ecosystem services provide food, medicine, wood, timber, ornamental plants and fish supplies as well as recreation and education opportunities, nature's beauty and a rich cultural landscape. They also boost land values.

The ecosystem services that nature provides include:

- Boosting productivity by maintaining the foundations of a healthy and **sustainable** environment – healthy soils, clean air, clean water
- Easing the potentially devastating and costly environmental problems, including **salinity** and **erosion**
- Purifying air and water
- Lessening the effects of flood and drought
- Detoxifying waste and aid decomposition
- Generating and renewing soil and soil fertility
- Pollinating crops and **native vegetation**
- Helping control agricultural pests
- Dispersal of seeds and nutrients
- Protecting us from ultraviolet rays
- Regulating climate
- Moderating temperature extremes and the forces of wind and waves.

Biodiversity of north central Victoria

Much of Australia's biodiversity is distinctive because of the continent's isolation for millions of years and its diversity of environmental conditions. The variety of life in north central Victoria is no exception. Evolutionary time and variations in climate, soil type and topography have produced an abundance of plant and animal species and habitats.

Remnant native vegetation is found throughout north central Victoria. It occurs in the Riverine Plains to the north, through the Box-Ironbark Forest ecosystem of the Goldfields, down to the wetter forests around Macedon Ranges (Central Victorian Uplands), across to the Volcanic Plains in the south-west and up to the Wimmera and Mallee regions along the western border. These areas are called **bioregions** (see *Figure 9*).

They reflect soil type, climate and topography, and consequently contain plants and animals that are often endemic to those areas. Bioregions are related to patterns of land use and can be used to identify the relationship between many natural resource based activities and biodiversity assets.

The North Central CMA in partnership with DSE (now DEPI) developed the North Central Native Vegetation Plan in 2005. The plan aims to protect and enhance the native vegetation communities of north central Victoria. It provides information on the status of vegetation communities and identifies priorities for targeting vegetation and species. The plan is also a framework for involving and supporting community groups in activities to achieve these aims.

Figure 9: Bioregions in north central Victoria.

More than just trees

Native vegetation is more than just trees. It includes other plants that occur naturally, such as shrubs, grasses, groundcovers and herbs. Strictly speaking, mosses, fungi and lichens are also native vegetation, and they are often overlooked. Collectively, these plants form part of the biodiversity of an area and provide habitat for native animals, as well as each other.

Vegetation types

In their natural setting, plants occur in association with each other. These different types (or groups) of vegetation associations are sometimes referred to as **Ecological Vegetation Classes** (EVCs). They are derived from land system information (e.g. **geomorphology**, rainfall), vegetation structure, floristic characteristics and other environmental information, including aspect, fire frequency and ecological responses to disturbance. EVCs describe local patterns of vegetation diversity but are not bioregion specific. They can be used to plan on-ground vegetation management activities and **revegetation**.

Vegetation structure

The basic structure of native vegetation can include a combination of an overstorey, mid-storey, understorey and herb layer – it all depends upon the vegetation type. The layers beneath the overstorey are considered essential in nutrient cycling, as they provide a more immediate supply of nutrients to the soil than eucalypt leaves.

The different layers of vegetation provide different types of habitat, and many native animals have adapted to use one or more specific layers. As a result, a number of animal species can occur in the one place without necessarily affecting each other. Similarly, vegetation structure provides habitat for various plants.

Different vegetation layers can also be used for different reasons by one species. For example, the threatened Grey-crowned Babbler is a bird that requires shrubby, thick growth of a certain height in which to make its nest. But it also forages for insects on the bark of older trees, as well as on the open ground. Therefore, if one of these structural components is missing – e.g. no tall shrubs or bushy eucalypt growth, no old trees, or the ground layer is too thick – you won't find Grey-crowned Babblers.

Heathy Woodland at Stuart Mill

Vegetation structure also relates to the age of the **remnant vegetation**. As plants age, particularly trees, they get bigger and tend to dominate the resources immediately around them. They command more of the light, soil nutrients and moisture, and subsequently create space around them. A patch of younger-aged vegetation tends to be more closely spaced, whereas mature vegetation with larger trees tends to have a more open structure.

In theory, a diversity of structure across the landscape will provide a diversity of habitat for different animal and plant species. In reality, however, the landscape is greatly altered and simplified. Historical and continuing disturbance of native vegetation has left us with very few old-growth trees, let alone anything in a pristine or 'natural' condition. Time – well beyond our lifetimes – can address this loss of old growth; but introduced plants and animals have altered habitats forever.

What are the threats to biodiversity?

Gold mining, agricultural production and urban development have highly modified the north central Victorian landscape since European settlement. The region is now one of Australia's most highly cleared and fragmented landscapes, with only about 19% of remnant vegetation remaining (refer to *Figure 10* for the extent of native vegetation in 1750 compared to 2005). This has negatively impacted the region's biodiversity, natural ecosystems and the services they provide. While development has resulted in a productive and vibrant regional economy, it continues to threaten the region's biodiversity and it is now crucial to protect and rebuild biodiversity assets for the future.

Some of these threats to biodiversity are the unforeseen consequences of historical over-clearance (e.g. salinity), some are new and unprecedented (e.g. global warming), but most are the same human activities that brought about the massive alterations to the landscape in the nineteenth and twentieth century's. *Table 5* on Page 35 lists the threats to biodiversity and their impacts.

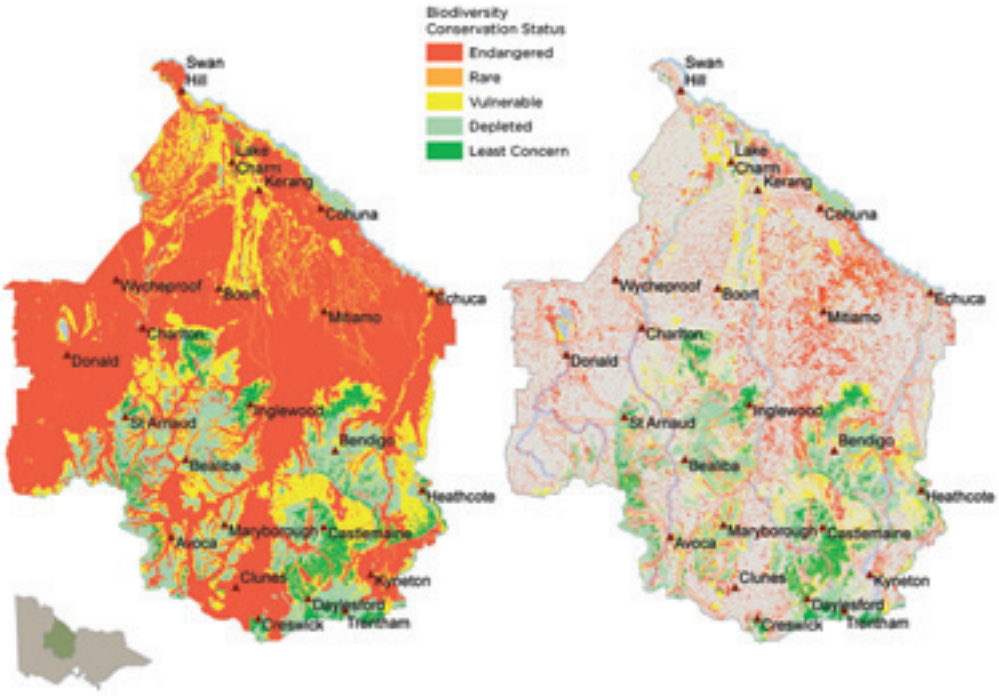


Figure 10: The extent of native vegetation cover in 1750 compared to 2005. The maps also show the biodiversity conservation status of different areas of native vegetation, ranging from endangered to least concern.

Table 5: Threats and their impacts on biodiversity.

Threats	Impacts
• Clearing for agriculture, urban or other uses • Global warming / rapid climate change • Weed invasion • Over-grazing by livestock, feral animals and native herbivores • Salinity • Soil disturbance • Habitat fragmentation and isolation • Alterations to natural fire regimes • Altered hydrology • Other invasive exotic species e.g. rabbits, goats, carp • Timber and firewood harvesting practices • Off-site effects of nearby land-uses.	• Loss of ecological resources • Reduction in species richness and diversity • Decline in habitat quality and condition • Decline in water quality • Loss of landscape function • Decline in soil health • Decline in landscape amenity and intrinsic value.

Some common animal and plant species are 'generalists' and can cope with, or are even advantaged by, varying conditions including a fragmented or disturbed environment, for example, magpies. But many species are more specialised in their habitat requirements, and are adversely affected by the amount of clearing, fragmentation and alteration of habitat.

The total area or cover of remnant vegetation is critical. Although the amount of native vegetation required for long-term survival varies for different species, a recent study found that in a landscape of 100 square kilometres 30-35% cover was necessary to maintain sustainable populations of most **woodland** bird species. Below this, species may be present even though their populations are in decline.

Fragmentation itself can be a barrier for some species. Open areas can inhibit movement of less mobile animal species or those that need plant cover at all times. This means that isolated populations can become in-bred in the long-term, or become locally extinct after a catastrophic incident such as wildfire or severe drought. These same effects can also apply to some plants.

The quality of remaining remnant vegetation is important. For instance, some species prefer woodland vegetation that grows on lower, more fertile and moist soils – most of which has been (and continues to be) preferentially cleared for agriculture. These species are now restricted to patches and linear reserves that are degraded by grazing, road works, weeds, fire and the stresses of being 'edge' habitat. Species such as the Powerful Owl can tolerate a drier environment but need a mature, hollow-rich habitat. Because of historical timber harvesting, little of this habitat remains in north central Victoria. Other species are dependent upon a shrubby layer as protective cover or for nesting, but inappropriate fire regimes and grazing removes and fragments this habitat. The size of the individual remnant can influence which species are present. Animals such as the Crested Bellbird and Brush-tailed Phascogale tend to occur in larger blocks of remnant vegetation.

Threatened native animal species

Given the impacts of European settlement, it is no surprise that many native animal species are now in decline in Australia. Since European settlement, 10 species (all mammals) have become extinct in Victoria. Approximately 101 native species found in north central Victoria have depleted or unknown populations and are consequently officially listed as threatened. Some of these animals are on the verge of extinction. *Table 6* on Page 37 lists some examples of threatened native animal species in north central Victoria and their biodiversity conservation status.

Some of these endangered animals could be mistaken for more common species. For example, the harmless and unobtrusive Pink-tailed Worm Lizard is often killed by landowners mistaking it for a baby Brown Snake (an offence, either way). This legless lizard spends most of its life underground feeding on ants, termites and their larvae. So depending upon your point of view, some might consider this animal to be a natural form of 'pest' control.

To the unaware, the Swift Parrot could be mistaken for a lorikeet or grass parrot. But this incredible species migrates in the hundreds to the mainland every year from Tasmania to feed on nectar and lerps (the little sugary covers of sap-sucking insects on eucalypt leaves). Swift Parrot numbers are in decline, and you would be privileged to have them visit your property.

The Brush-tailed Phascogale is often unknown to landowners until their cat brings one in dead, or when they find one drowned in a water tank. They sometimes take up residence in sheds or the roofs of houses, and their droppings might be mistaken for a rodent's. These small nocturnal mammals spend time foraging on the ground and in trees. They are part of a group of mammals in which the adult males die after mating. Subsequently, any loss in number because of cats or road accidents is a contributing threat to local populations.

If you think that you might have seen one of these threatened animals, or want to know more about their identification or habitat requirements, contact the DEPI or Parks Victoria. To view lists of threatened **flora** or **fauna**; visit the DEPI website on www.depi.vic.gov.au and search for '**threatened species** advisory list'.

All native animals are protected by law under the *Wildlife Act 1975* (unless exempted under licence or other government orders). Some of these species are further protected under legislation such as the *Flora and Fauna Guarantee (FFG) Act 1988* or the Federal Government's *Environment Protection and Biodiversity Conservation (EPBC) Act 1999*. For information about your obligations regarding the Victorian Acts, your first point of contact should be DEPI. For information about the *EPBC Act 1999*, contact the Australian Government's Department of the Environment. Your property may be covered by an overlay to protect vegetation or a threatened species. Contact your local government planning department to find out.

Snakes

Killing or interfering with native **wildlife** – including snakes – is an offence. Snakes are protected in Victoria under the *Wildlife Act 1975*. Ironically, most cases of snakebite occur when people are trying to catch or kill snakes. Contact DEPI Customer Service Centre on 136 186 to get details of your nearest licensed snake catchers (they usually charge a fee for service). In addition, landholders can modify the habitat around buildings to make them unsuitable for snakes and their prey and in turn reduce the risk of snakebites. For example, keeping grass very short, removing rubbish and other forms of cover, or get a dog or geese to warn of the presence of snakes.

Table 6: Some of the threatened native animal species found in north central Victoria and their conservation status under the EPBC Act 1999, FFG Act 1998 and DEPI Advisory List of Threatened Vertebrate Fauna in Victoria (DEPI 2013).

Common name	Scientific name	EPBC Act Status	FFG Act Status	DEPI Status
Barking Owl	Ninox connivens connivens	-	Listed as threatened	Endangered
Bearded Dragon	Pogona barbata	-	-	Vulnerable
Brolga	Grus rubicunda	-	Listed as threatened	Vulnerable
Bush Stone-curlew	Burhinus grallarius	-	Listed as threatened	Endangered
Brush-tailed Phascogale (Tuan)	Phascogale tapoatafa tapoatafa	-	Listed as threatened	Vulnerable
Grey-crowned Babbler	Pomatostostomus temporalis temporalis	-	Listed as threatened	Endangered
Growling Grass Frog	Litoria raniformis	Vulnerable	Listed as threatened	Endangered
Lace Monitor (or Tree Goanna)	Varanus varius	-	-	Endangered
Malleefowl	Leipoa ocellata	Vulnerable	Listed as threatened	Endangered
Pink-tailed Worm Lizard	Aprasia parapulchella	Vulnerable	Listed as threatened	Endangered
Powerful Owl	Ninox strenua	-	Listed as threatened	Vulnerable
Regent Honeyeater	Anthochaera phrygia	Endangered	Listed as threatened	Critically endangered

Threatened native plant species

About 130 threatened plant species occur in north central Victoria. Fifty-two are nationally threatened and 41 are listed under the *FFG Act 1988*. Threatened plant species include: Australian Anchor Plant, Red Swainson Pea and Spiny Rice-flower. Details of some threatened native plant species found in the region are outlined in *Table 7* below.

The patterns of clearing for agriculture, settlement and activities such as alluvial gold mining have selectively affected the low-lying and more fertile areas in the landscape. Consequently, many of the threatened plants are associated with **grasslands**, woodlands, river and creek flats and wetlands. Other species have been adversely affected by the processes of settlement, and cannot cope with weeds, grazing, or other changes in their environment.

Growling Grass Frog *(Litoria raniformis)*

Slender Darling-pea *(Swainsona murrayanna)*

Table 7: Some of the threatened native plant species found in north central Victoria and their conservation status under the EPBC Act 1999, FFG Act 1998 and DEPI Advisory List of Rare or Threatened Plant in Victoria (DEPI 2005).

Common name	Scientific name	EPBC Act Status	FFG Act Status	DEPI Status
Australian Anchor Plant	Discaria pubescens	—	Listed as threatened	Rare in Victoria
Clover Glycine	Gycine latrobeana	Vulnerable	Listed as threatened	Vulnerable in Victoria
Matted Flax-lily	Dianella amoena	Endangered	—	Endangered in Victoria
Slender Darling-pea	Swainsona murrayana	Vulnerable	Listed as threatened	Endangered in Victoria
Southern Shepherd's Purse	Ballantinia antipoda	Endangered	Listed as threatened	Endangered in Victoria
Spiny Rice-flower	Pimelea spinescens subsp. spinescens	Critically endangered	Listed as threatened	Vulnerable in Victoria
Turnip Copperburr	Sclerolaena napiformis	Endangered	Listed as threatened	Endangered in Victoria
Yellow-lip Spider-orchid	Calendenia xanthochila	Endangered	Listed as threatened	Endangered in Victoria

Managing native vegetation on your property

Native vegetation forms a vital part of any rural property, and, on a broader scale, the **catchment** you live in and its biodiversity. Just as managing weeds, looking after soil health and water quality is an integral part of being a responsible landholder, so too is looking after remnant vegetation.

In order to maximise the benefits and minimise the impacts of any actions you undertake, you should first familiarise yourself with the basic characteristics of your land. Note things such as patches of remnant vegetation, large old paddock trees, dead trees, fallen timber, wildlife, creeks or other water features such as drainage lines or depressions, adjacent vegetation including roadsides and the presence of forested public or private land in the neighbourhood.

If you suspect that you have a threatened species on or near your property, please contact your local DEPI office for confirmation and advice. Conservation of the species might only involve a continuance of what you are already doing, but ill-considered alterations might tip the balance out of that species' favour.

You can contribute to maintaining and improving biodiversity by:

- Protecting and improving existing vegetation and habitat, including large old paddock trees
- Expanding existing remnants by revegetating, including alongside roads or other vegetated land (public or private)
- Linking remnants by establishing wide **corridors** or large patches of native vegetation, to create corridors or 'stepping stones' in the landscape for species to live in and move through
- Replacing vegetation in critical areas such as along creeks, drainage lines and depressions
- Reinstating wetlands by allowing water to drain into them
- Leaving fallen timber, large dead standing trees and rocky outcrops for habitat
- Controlling pets (particularly cats), weeds, and pest animals
- Managing domestic stock to protect remnants and waterways.

Gaining an intimate knowledge of your land takes time – time over the seasons, time comparing 'good' and 'bad' years and how your land responds, and even time as you become more aware and educated. Once you begin, the discoveries uncover more and more complexity, and the journey can take you as far and long as your curiosity lasts.

Northern Plains grassland

Managing remnant vegetation

Well-managed remnant vegetation is critical if we are to maintain and improve biodiversity in north central Victoria. There are a few basic principles to follow:

- Protect remnant vegetation
- Enhance remnant vegetation
- Build on remnants
- Create landscape links.

Protect remnant vegetation

Remnant native vegetation is very valuable, partly because it is so difficult to re-create, and should be the initial focus of protection and management. Compared to starting from scratch, remnant vegetation (even in poor condition) is often more stable, less weedy and often more species-rich than can ever be created.

Protection measures might include fencing, eliminating rabbits from the site, and weed control. Carefully controlled grazing, and/or even the use of fire, might be an option to manage very grassy sites to maintain an open structure and diversity.

After protection, wait and observe. Often plants – perhaps even different species – will regenerate. You can then decide whether further assistance is needed. Keep in mind that bulbous/tuberous plants might only appear seasonally, especially in spring.

Enhance remnant vegetation

Remnant vegetation has often been degraded by grazing (rabbits, domestic stock or even kangaroos and wallabies), weed invasion, inappropriate fire regimes, or physical disturbance such as historical gold mining. Re-introduction of missing shrubs or ground layer species can greatly improve the remnant. Enhancement might also include allowing natural **regeneration** to occur, fencing and eliminating rabbits usually enables this.

It is important to identify the type of vegetation before you start introducing new species. Different vegetation types will have different layers and species. For example, you might have Box-Ironbark vegetation that has lost shrub and groundcover layers. A grassland remnant (which should not be planted with trees) might require a more diverse grass or small shrub layer (depending upon the grassland type).

You can find out which vegetation type (based on **EVC**) occurs on your property by visiting the DEPI website and selecting the Biodiversity Interactive Map.

Many organisations are willing to provide advice and support for managing and enhancing native vegetation. A great way to start is to join your local Landcare group – you will quickly learn about the importance of the remaining vegetation in your area, how to build or repair a fence, methods of pest plant and animal control, and so on. Visit the Victorian Landcare Gateway website or contact the North Central CMA to find your local Landcare group.

Build on remnants

Expanding from your remnant vegetation is the most efficient way to add habitat value and encourage natural regeneration. Expansion could include fencing off and revegetating a linear area next to roadside vegetation or other vegetated land, revegetating corners of your land to consolidate roadside vegetation, revegetating out from remnants along drainage lines, down from hill-top vegetation, or around paddock remnants to create a larger single patch. Streamside and drainage line vegetation is especially important habitat.

Create landscape linkages

Think about how you can contribute to linking up remnants through the landscape and enabling species to move around. Links don't necessarily have to be physical connections to be useful. Depending upon the species – both plant and animal – a gap can be 50 metres, 500 metres, or more. For example, mobile animals such as some birds, bats and kangaroos can use creek lines, roadside vegetation and other remnants as 'stepping stones' to sustain and guide them through the landscape. Although mobile species such as birds and bats can cope with gaps between good habitat, less mobile or cover-dependent species need continuous pathways or corridors of suitable habitat.

Ideally, aim to link patches of remnant vegetation to maximise the effect. If you can't physically fill a gap between patches of remnant vegetation, don't worry. Any kind of gap-filling at the landscape-scale is better than none. If possible, target areas on your property that contain streams, drainage lines, depressions or wetlands. These areas once supported relatively high-value habitats

for native animals. If you can link a remnant higher in the landscape down to your lower revegetated areas, then you are providing an interface between terrestrial and aquatic habitat, and creating diversity.

Other landscape priorities for revegetation

Salinity control

If they are cleared, hills in much of north central Victoria allow rainfall to percolate down into the groundwater, causing saline discharge further down the slope on adjoining flat land. This is especially common in sedimentary and **metamorphic** country (refer to the following chapter for further information). Revegetating hill country may help reduce salinity in the long-term. Hill country is suited to direct sowing – refer to the information notes on the DEPI website and seek further advice.

Waterway protection

Native vegetation also acts as a protective buffer in and around waterways. It maintains good water quality, prevents **erosion** and provides very rich wildlife habitat. Direct seeding can be difficult where flooding occurs, but natural regeneration is often prolific following floods if parent plants are present.

Large old paddock trees

Large old paddock trees can provide shade for livestock and help to maintain watertables at depth and prevent salinity. They also provide significant habitat for native animals, including hollow-dependent species. These trees are often stressed from exposure to extreme weather, ringbarking at their base from livestock rubbing and chewing the bark, and high levels of nutrients from livestock manure and urine. Large old paddock trees have a limited life remaining and there are usually no replacement trees. What will our landscape look like without these trees?

It is vital to keep large old trees. They are an irreplaceable feature of the landscape and invaluable habitat for wildlife. The habitat value of a tree is considered to be proportional to its age – the older the tree, the more nectar it produces – and the rough bark provides lots of places for insects to hide and other animals to forage. As trees reach the age of 100 years or more, they begin to form hollows. With further ageing, a variety of hollows is formed and the tree becomes a multi-storey housing complex for many different animals. Conservation of less mature trees is also extremely important, as these will be the next generation of large old trees.

If you are going to revegetate some of your property, consider fencing off areas that include large old trees. This will enable natural regeneration to occur with a greater chance of survival, is much easier and cheaper than planting tube stock, and helps protect precious habitat.

What should you do with dead and fallen trees?

Old dead trees and fallen timber (sometimes referred to as 'woody debris') provide great habitat for birds and other animals. Before you 'clean up' or burn your fallen timber, consider its value as habitat. A variety of animals use old dead trees for habitat. For example, the threatened Brush-tailed Phascogale prefers to look for food, such as insects, on dead standing trees. Because old dead trees are often hollow, many animals continue to use them as homes and protection. Birds also look for these trees for perches – either for basking in the sun, resting, announcing their presence or to spot prey.

The importance of fallen timber is also often overlooked. Try a little test – carefully look under some fallen timber and see how many different insects there are. You might even see a frog or gecko. (Remember to carefully replace the timber to maintain the habitat.) If you're patient and watch carefully from a distance, you will notice that birds (and small mammals) also use fallen timber as part of their habitat. Fallen timber is used in many different ways – it can be used for shelter, breeding and basking sites; and provides areas for larger animals to forage for insects. The wood itself provides food for insects and various fungi and bacteria. Fallen timber is an essential part of nutrient cycling and the food web.

Red Gum *(Eucalyptus camaldulensis)*

Protecting roadsides

It is a pleasure to drive through north central Victoria with its many tree-lined roads and magnificent panoramic views. Our roadsides are one of our greatest natural resources and, in many places, contain the finest examples of vegetation that previously existed across the landscape.

Road reserves were initially established to provide legal access and a route from one place to another. Their role has since evolved and, besides being recognised for their conservation values, they are now also service corridors for gas, electricity, drainage, sewage and telecommunication lines. Some roadsides play an important role in minimising the risk and impact of fires. As a consequence, however, roadside vegetation is increasingly under threat.

Roadsides provide habitat, allow animals to move around the landscape and connect patches of bush, especially if most of the native vegetation on adjacent private land has been cleared. Many threatened animal and plant species, such as the Brush-tailed Phascogale and the Red Swainson-Pea, make use of the roadside network throughout north central Victoria. Some roadsides are declared significant native vegetation areas, and are often marked with signs. These roadsides usually contain good examples of native vegetation and habitat, and could contain threatened plants or animals.

Councils are responsible for most road reserves in their municipality and must make decisions, in consultation with other authorities, on appropriate roadside management. VicRoads is responsible for the highways and main arterial roads. Before land managers can undertake weed treatment work or other activities along roadsides, approval is required from local councils. Similarly, if land managers intend moving livestock along roadsides, prior approval is required from local councils.

Restoring landscapes – revegetation with indigenous plants

The benefits of using indigenous plants for revegetation and improving habitat are now well recognised by farmers and land managers. They include:

- Providing habitat and food resources for native animals, including beneficial insects and parasites that may help control crop and pasture-feeding pests.
- Providing shade and shelter for livestock, pastures and crops.
- Improving the appearance of rural properties.
- Maintaining water quality by providing a buffer strip that acts as a filter for nutrients and sediments.
- Providing a source of wood products (e.g. firewood, fence posts or sawlogs).
- Generating carbon credits by storing carbon.

Sound revegetation design and planning is critical to the success of revegetation projects. This involves:

1. Assessing and understanding site conditions – existing native vegetation, proximity to remnant vegetation and limiting factors (e.g. pest plants and animals).

2. Selecting appropriate plant species – indigenous overstorey, understorey and groundcover species.

3. Choosing the right planting design and layout – plant placement, densities and the size and shape of the site to meet landholder objectives (e.g. shelter, biodiversity and/or control wind erosion).

4. Preparing the site – for example, weed and pest control, soil ripping and/or fencing.

5. Establishing the plants using the most appropriate technique(s) – natural regeneration, direct seeding or planting (refer to *Table 8*).

There is no one best way to go about revegetation and land managers should seek local advice from Landcare groups, neighbours and advisory organisations before embarking on a revegetation project.

Revegetation

Table 8: The three main methods of revegetation.

Revegetation methods	
Natural regeneration	• If you have native remnant vegetation on or next to your property there is an opportunity for natural regeneration, whereby plants grow from seed naturally distributed to the site. This is often the cheapest and most efficient way to increase the numbers of native plants. Although it can be very slow and require more maintenance such as ongoing weed control. • In some cases all that is required is the removal or reduction of grazing (by rabbits, livestock or even kangaroos and wallabies) allowing seeds to germinate from soil seedbanks or from seed transported to the site by water, wind or birds. • Careful use of fire can also be used to regenerate native vegetation, as it releases seed from the canopy, creates a nutrient-rich seedbed and eliminates competition.
Planting	• Planting seedlings is a rewarding experience and is also cost effective. Seedlings can be planted by hand or using a mechanical seedling planter into the soil. Preparation is essential and may involve soil ripping, weed control and fencing. Advantages of planting seedlings include: more reliable, immediate results and plant placement can be controlled. However sites usually look unnatural, fewer species are planted and it involves high establishment costs. • Seedlings grown in small nursery tubes are referred to as 'tubestock' and are the most common source of plants for rural revegetation projects. Recently, a lower cost container-grown alternative to tubestock has been developed. 'Plug array' or 'cell tray' methods consolidate a large number of individual, small 'tubes' into one tray. These trays allow cheaper production of seedlings and, depending on the design, may allow for healthier root systems in the plants. Both types of containers can be used for growing seedlings at home.
Direct seeding	• Direct seeding involves sowing seed directly into prepared soil by hand or mechanical sowing. It is generally a more efficient method of revegetation, as time, labour and costs are lower than hand planting. It also allows a mixture of species and plant types (trees, shrubs and groundcovers) to be sown at once and plants are more robust due to better root growth. • Direct seeding does have a number of disadvantages: it may require more planning and preparation, establishment can be patchy and take several years and isn't suitable for heavy textured soils or deep, non-wetting sands.

Why should I use indigenous plants?

Indigenous plants have adapted over thousands of years to the conditions in your locality. Generally they cope better with the climate (e.g. rainfall), soils and native predators than plant species from other parts of Australia or overseas. They also provide the most benefit to the environment and can regenerate naturally from existing seedbanks and remnant vegetation.

Indigenous plants have evolved as part of the entire ecosystem of an area. Local birds, mammals, reptiles, amphibians and insects have adapted to them, and plants and animals are often reliant upon each other for survival. Planting an appropriate mix of indigenous overstorey, understorey and groundcover species provides habitat for native animals. This will lead to a more biologically diverse property.

At some sites however, some of the local species may no longer be able to survive because of altered conditions such as salting or waterlogging. In these extreme cases, careful selection of non-indigenous species may be required.

Weed control and revegetation works over a three year period.

Management agreements

Trust for Nature covenants

Landholders who would like to permanently protect remnant vegetation on their own properties can do so with a conservation covenant. A conservation covenant is a voluntary, legally-binding agreement negotiated between the landholder and Trust for Nature, which is then registered on the property's title. Landholders can contact Trust for Nature to arrange a visit and assessment of their property. Once the conservation values of a covenanted property have been identified, a specialist management plan is developed with Trust for Nature's regional staff.

Land for Wildlife

Land for Wildlife is a voluntary scheme that encourages and assists private landholders to provide wildlife habitat on their property, even though it may be managed primarily for other purposes. There are more than 5,900 Victorian *Land for Wildlife* properties involving over 14,800 dedicated people. They are making a real contribution to native biodiversity conservation by managing over 560,000 hectares of their combined properties, of which 160,000 hectares is managed as wildlife habitat. This includes a wide range of ecosystems found on private land including forests, woodlands, heaths, grasslands and freshwater environments. For further information contact DEPI.

Native vegetation regulations

Recognising the importance of native vegetation, the Victorian Government has regulations controlling its removal and destruction. All landowners must check with their local council before attempting to cut down, trim, clear or otherwise remove native vegetation. This includes herbs, grasses and other ground flora – not just trees.

Throughout Victoria, a planning permit maybe required to remove, destroy or lop native vegetation on public or private land. On a road reserve, land manager approval must be sought and a planning permit may also be required. Planning controls and regulations form part of all local council planning schemes. Planning schemes regulate land use and development and apply to all public and private land so all people and organisations must comply with the requirements of their local planning scheme. Planning schemes also include overlay controls, which may specify additional requirements, including native vegetation protection, regardless of the size of the block.

State and local planning controls are regularly reviewed and do change. It is essential that land managers check whether planning controls or regulations apply before removing or destroying native vegetation. Early discussions with local council staff will confirm whether a planning permit is necessary and identify any other requirements.

Resources and further information

Australian Museum: www.australianmuseum.net.au/Biodiversity

Biodiversity Interactive Map: http://mapshare2.dse.vic.gov.au/MapShare2EXT/imf.jsp?site=bim

CSIRO's Biodiversity webpage: www.csiro.au/Outcomes/Environment/Biodiversity.aspx

Department of Environment and Primary Industries: www.depi.vic.gov.au

Department of Sustainability, Environment, Water, Population and Communities: www.environment.gov.au

Victorian Department of Sustainability and Environment (2009) Advisory List of Threatened Invertebrate

Fauna in Victoria - 2009. Department of Sustainability and Environment, East Melbourne, Victoria.

Department of Sustainability and Environment (2005) Advisory List of Rare or Threatened Plants in Victoria - 2005. Victorian

Department of Sustainability and Environment, East Melbourne, Victoria.

Department of Sustainability and Environment (2013) Advisory List of Threatened Vertebrate Fauna in Victoria - 2013. Victorian Department of Sustainability and Environment, East Melbourne, Victoria.

Department of Agriculture and Food - Direct seeding for revegetation: http://www.agric.wa.gov.au/PC_92518.html?s=0

Florabank – native species seed and vegetation management: www.florabank.org.au

Future Farm Industries: www.futurefarmonline.com.au

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SOILS

“Whether you own a large or small property, your soil is a most valuable asset. It provides structural support, water and nutrients for plant growth. Understanding your soil, applying the appropriate management practices and monitoring soil quality are all important steps in protecting and enhancing soil health.”

Chapter 4
Soils

Understanding your soil

Soil is fundamental to rural living and food production. Australian soils are among the oldest and most weathered in the world. They generally contain low levels of organic matter and if not carefully managed, can erode and degrade easily under European farming practices. Maintaining healthy soils is essential if farmers and land managers in north central Victoria are to support productive agricultural industries, contribute to food security and deliver soil related **ecosystem services** (e.g. clean water and air).

Whether you own a large or small property, your soil is a most valuable asset. It provides structural support, water and nutrients for plant growth. Understanding your soil, applying the appropriate management practices and monitoring soil quality are all important steps in protecting and enhancing soil health.

Soil is made up of mineral particles, organic material, water, air and living organisms. It is formed as rocks break down and organic material decays. This is a very slow process, as one centimetre of **topsoil** can take several hundred years to form.

The mineral component of soils

Inorganic mineral particles are a major component of soils which strongly influence the physical and chemical properties of the soil. The size and properties of these inorganic minerals determine the texture of the soil (refer to *Table 9* for a description of each of the five size fractions). Soil texture can provide an indication of a number of soil characteristics. For example, coarsely textured, sandy soils have a high quartz content and small surface area, which reduces the soil's ability to retain moisture and nutrients. Conversely, finely textured, clay soils have a much higher surface area and are comprised of little sheets of mineral that behave like magnets. That is, the mineral sheets have a negative charge which attracts positively charged elements (cations) to the soil particle. These two characteristics allow clay soils to retain more moisture and nutrients. Specific terms are applied to describe soil texture and these terms provide information relating to their productive potential e.g. sandy clay loam, sandy clay or silty clay.

Table 9: The inorganic mineral fractions of soils.

Inorganic mineral	Particle diameter	Characteristics
Gravel	Greater than 2 mm	Low water retention, little chemical activity (nutrient content)
Coarse sand	0.2 – 2 mm	Low water retention, little chemical activity (nutrient content)
Fine sand	0.02 – 0.2 mm	Low water retention, little chemical activity (nutrient content)
Silt	0.002 – 0.02 mm	Little chemical activity (nutrient content), compact under heavy traffic
Clay	Less than 0.002 mm	High water retention, high chemical activity (nutrient content)

Soil organic matter

Soil organic matter is an essential component of healthy, productive soils. It refers to all the living (e.g. plant roots and soil organisms) and decomposing plant and animal matter (e.g. leaves, manure and mulch). The decomposition of soil organic matter by soil organisms provides a number of soil health benefits. These include:

- Releasing essential nutrients for plant growth
- Improving soil structure and drainage
- Increasing soil water holding capacity.

The rate of decomposition relies on soil conditions that promote soil organisms. These conditions include temperature, moisture, near neutral pH, aeration and adequate nutrients. Soil organic matter levels can be increased by: growing **perennial** pastures, maintaining 100% groundcover, preventing over-grazing, retaining crop stubbles, incorporating green manure crops, and applying manure and composts. For the most part, soil organic matter levels seldom exceed 2–2.5% in north central Victoria.

Soil organisms

A healthy and functioning soil ecosystem contains a wide diversity of soil organisms. These organisms range from tiny bacteria, viruses, protozoa and fungi to larger soil animals like centipedes, earthworms, spiders, earwigs, springtails and termites. Soil organisms play an important role in cycling carbon, nitrogen, sulphur, phosphorous and all other nutrients. One hectare of good quality soil could contain around 1,000 kilograms of earthworms, 100 kilograms of other soil animals and trillions of fungi, bacteria and protozoa.

A healthy soil ecosystem and diversity of soil organisms can be encouraged by:

1. Increasing soil organic carbon – apply compost, retain stubbles and maintain at least 75% groundcover

2. Minimising cultivation and soil compaction – employ direct drilling, controlled traffic, maintain groundcover, and improve wet weather management

3. Increasing soil **biodiversity** – diverse pastures and regular inputs of organic matter.

Soil pH

The acidity or alkalinity of soil is measured by the pH scale. Less than seven is acidic, greater than seven is alkaline and seven is neutral. Most crop plants prefer a pH close to neutral. Naturally, soil pH in north central Victoria is influenced by the soil parent material, past climatic events and annual rainfall. Generally, the higher the annual rainfall, the more likely the topsoil will be naturally acidic. Most sedimentary and granitic soils are naturally acidic. In contrast, lower rainfall districts tend to have more neutral topsoils and alkaline **subsoils**.

Extremes in soil acidity or alkalinity create a number of issues for plant growth. The availability of essential plant nutrients changes with pH, for example, phosphorus availability is constrained in acidic soils while zinc is constrained in alkaline soils. pH can also influence the toxicity of elements (e.g. Aluminium in acid soils), decrease plant production and water use and impact soil biological functions (e.g. reduced nitrogen fixation).

Soil that is too acidic can be treated with lime; too alkaline with sulphur. You can check if you need to treat your soil by carrying out tests with a simple pH kit available from most nurseries and garden shops. Alternatively, soil samples can be analysed by an accredited soil testing laboratory. Keep in mind, though, that pH should only be changed to enhance agricultural productivity – **native vegetation** is perfectly adapted to the natural pH of the soil, which does not require amendment.

Soil structure

Maintaining (or improving) soil structure is a crucial part of good land management, as plants need air and water near their roots to grow well. A well-structured soil will easily absorb water, and excess water will drain freely. A soil with poor structure will shed water, increasing the risk of erosion. It will not store as much moisture in dry conditions but can be waterlogged in winter if drainage is impaired. Many soil types have naturally poor structure. Selected land management practices can either improve or destroy soil structure.

Earthworms

To maintain and improve soil structure:

- Keep soil covered by vegetation all year round – bare soil is at always at risk. Perennial plants are better than **annual plants**.
- Manage wet soils with care – vehicle traffic or livestock can compact soil.
- Use no- or zero-tillage practices to eliminate the risk of sub-surface compaction.
- Use controlled traffic farming which permanently separates wheel traffic from growing areas.
- Ensure the level of calcium is higher than magnesium in your soil.
- Maintain a continual supply of organic matter into the soil.
- Apply gypsum and/or lime (where acidity is also an issue) to sodic topsoils.

Soil fertility

Soil fertility refers to the soil's ability to supply nutrients for plant growth. There are 16 essential elements for plant growth and a deficiency in just one essential element causing plant defects and in some cases plant death. Refer to *Table 10* below for the full list of plant essential elements and their role in plants. Plants obtain carbon, hydrogen and oxygen through water and carbon dioxide in the atmosphere. The remaining essential nutrients are found in the soil and are taken up by plant roots. However **legumes** (for example, clovers, lucerne and peas) can obtain nitrogen from the atmosphere.

Plant essential elements can be subdivided into two groups: macronutrients and micronutrients. Macronutrients are required in large quantities for plant growth, as they make up more than 1,000 mg/kg of plant dry matter. Macronutrients include carbon, hydrogen, oxygen, nitrogen, phosphorus, sulphur, calcium, magnesium, and potassium. Micronutrients or trace elements are required in much lower concentrations for plant growth and usually make up less than 100 mg/kg of plant dry matter. Micronutrients include iron, manganese, zinc, copper, chloride, boron and molybdenum.

Table 10: Function of essential elements in plant growth.

Essential Element	Function in plants
Carbon	Is required for sugar production. It is sourced from carbon dioxide in the atmosphere and converted to sugar through the chemical process photosynthesis. This sugar is then used to produce energy and is a component of other important compounds, such as DNA.
Hydrogen	Is required for sugar production. Plants obtain hydrogen molecules from water, which is converted to sugars through the chemical process photosynthesis. This sugar is then used to produce energy and is a component of other important compounds, such as DNA.
Oxygen	Is required for respiration, whereby plants covert the sugars (from photosynthesis) into energy for growth and other life processes. Oxygen is sourced from water and carbon dioxide in the atmosphere
Nitrogen	Required for all growth processes and a major component of proteins, enzymes and chlorophyll.
Phosphorus	Required for all growth processes, plant cell energy and nitrogen fixation.
Potassium	Required for plant cell wall development, flowering and seed set. Plays a key role in water and nutrient uptake, nitrogen fixation and prevent plant stress.
Sulphur	Required for the formation of proteins, vitamins and chlorophyll. Also helps prevent plant stress (e.g. to drought, insects and diseases).
Calcium	Required for the functioning of growing points, clover seed set and maintaining strong cell walls.
Magnesium	Essential component of chlorophyll and required for phosphorus transport throughout the plant.
Molybdenum	Required for nitrogen metabolism and is essential for rhizobia bacteria (attached to legumes and responsible for nitrogen fixation) health.
Copper	Required for chlorophyll production, nutrient processing, and carbon dioxide absorption.
Boron	Essential for the movement of sugars throughout the plant and legume seed production. Also involved in calcium uptake and use, and the metabolism of nitrogen, carbohydrate and hormones.
Manganese	Catalyst in plant growth processes, essential for rapid germination and enzyme systems.
Iron	Required for the formation of chlorophyll, the transport of oxygen and the processing of nitrogen.
Chloride	Stimulates carbohydrate metabolism, plant enzymes, chlorophyll production and water holding capacity.
Zinc	Required for the formation of chlorophyll and enzyme systems. It also involved in the efficient intake and use of water by plants.

Table 11: The characteristics and function of the three main types of soil organic carbon.

Soil organic carbon fraction	Description	Function
Particulate organic carbon	Individual plant debris pieces between 0.053 – 2 mm.	Breaks down relatively quickly and are important for soil structure, energy for soil biological processes and the provision of nutrients.
Humus	Decomposed materials < 0.053 mm, which are complexed with soil minerals.	Plays a role in all soil functions and is particularly important for the provision of nutrients.
Recalcitrant organic carbon	Biologically stable, usually found as charcoal, a by-product of burning. Can be applied to soils as 'biochar'.	Breaks down very slowly and is relatively unavailable to soil organisms.

Soils can be naturally low in some nutrients, for example, phosphorus, sulphur and molybdenum. Native vegetation is adapted to these low nutrient levels but nutrient deficiencies may restrict the growth of some crop and pasture species. As well as soil nutrient deficiencies occurring naturally, nutrients are removed from farms as grain, fodder, meat and fibre. In order to maintain soil fertility, groundcover and farm productivity it is important that these nutrient losses are monitored and managed through soil testing, nutrient budgeting and efficient fertiliser applications. The incorrect use of fertilisers can lead to nutrient run-off and leaching, which can be costly, pollute waterways and kill sensitive native plants. In addition, soil fertility and fertiliser efficiency can be improved by improving soil structure, increasing soil organic carbon and soil biology, and the application of soil-friendly agronomic practices (e.g. direct drilling, controlled traffic etc.).

Soil organic carbon

Soil organic carbon refers to carbon derived from decomposing plant and animal materials. The amount and type of organic carbon in a soil strongly influences its properties and productive potential. Soil carbon levels vary dramatically across different soil types, land management systems and rainfall zones. Typically, in Victoria, soil carbon levels can range from around 10% in the Otways or parts of Gippsland, to less than one per cent in many Mallee soils. There are three principal types of soil organic carbon: particulate organic carbon, humus carbon, and recalcitrant organic carbon, which are described in *Table 11* above.

Soil carbon can be increased by reducing losses or increasing the input of plant residues, e.g. reducing cultivation, improving crop yields (e.g. fertiliser application) and switching to a perennial pasture system. However there is an upper limit on the total amount of organic carbon a soil could hold, which is principally determined by clay content, soil structure and soil depth. Furthermore, it is difficult to improve soil organic carbon levels in a cropping regime, even with reduced tillage, without a pasture phase.

Threats to your soil

Soil biological function principally governs nutrient cycling and delivery systems, organic matter decomposition, pest and disease suppression, filtration or breakdown of wastes, and maintenance of an environment suited to plant growth. This complex ecosystem is vulnerable to inappropriate management practices that compact, bare or poison the soil. Most of the effects of traffic, overgrazing or pesticide use are reversible to varying degrees, but the costs are measured in dollars, time or loss of long-term resilience.

Soil disturbance

Anything that removes vegetation cover or exposes soil to the open air puts your soil at risk. Ploughing which turns soil over, burying the topsoil is particularly harmful. Although aerating the soil with specialised chisel ploughs that minimise topsoil disturbance can improve the soil's structure. Any disturbance, be it cultivation for cropping, or deep ripping to relieve compaction, must be complemented by practices that enhance soil structure and build soil carbon.

Compaction and pugging

Constant trampling by livestock and tyre track damage from machinery and off-road vehicles can severely degrade soil structure. When hard-hoofed animals like horses are fed and watered in a confined area, they exert huge pressures on the soil. Horses and cattle are very social animals and will often congregate in one area. Their hooves can make deep holes or 'pugs' in wet soils. Some soil types, especially clays, can form dense, compacted layers below the surface. Rotational grazing, maintaining groundcover, removing livestock from wet paddocks and controlled traffic (restricting machinery tracks to tramlines) can all be employed to minimise compaction and protect and improve soil structure.

Soil erosion

Although **erosion** can occur naturally, it is accelerated by vegetation clearing, grazing, cropping, road and house construction, and by altering natural drainage lines. Erosion occurs when soil particles are moved by wind and water. Any force that can break soil aggregates into smaller particles can lead to soil erosion. Such forces include the impact of raindrops on bare soils, cultivation and livestock traffic. Refer to *Table 12* below for a description of the main types of erosion and suggested management options.

The part of the soil that contributes most to crop production is the topsoil. When topsoil erodes, plant growth on the remaining soils declines. When vegetation is lost, the soil surface is exposed, and erosion increases, creating a vicious cycle. Don't let it start on your property.

As well as reducing soil health and productivity, soil erosion can also have a number of off-site impacts. For example, eroded soil (sediment) can reduce the water quality of nearby waterways. Soil erosion causes damage in three places:

- It damages the land where the soil is removed
- It degrades the water or air that transports the soil
- It damages the site where it is deposited.

Gully erosion

Wind erosion

Table 12: A description and management options for the main types of soil erosion.

Erosion Type	Description	Management Options
Gully	Occurs when running water washes away soil, forming large channels. Relatively small changes in land management, such as increased discharge to a minor drainage line, can start gully erosion.	Much more effort is required to treat gully erosion once it is underway than to maintain a stable system and prevent gullies from forming in the first place. You may need to re-direct the flow of water over the land, exclude grazing animals, fence off and replant. If large gullies form, earthworks are often required.
Rill	The formation of numerous small channels, less than 30 cm deep, by concentrated run-off. Rills can often be seen on road batters, after earthworks and in bare agricultural land. Rilling increases with the length of the slope and steepness. Severe rill erosion can lead to the formation of gullies.	Rills can usually be removed by farm machinery. It can be reduced by contour drains, grassed waterways and filter strips and ripped mulch lines which all lower surface water volume and speed.
Sheet	The removal of topsoil in thin layers by rainfall run-off. It occurs when there is no protective plant cover. The loss of topsoil and soil nutrients affects plant growth. Signs of sheet erosion include visible plant roots, exposed subsoil and soil deposits on the high side of fences.	Maintain ground cover all year round through stubble retention, rotational grazing or the use of perennial pasture species.
Stream bank	Caused by changes in water flow and the loss of streamside (riparian) plants and trees. Where erosion is severe and the bank collapses, the water flow could change, leading to more erosion.	Riparian vegetation stabilises stream banks. Fencing off and replanting riparian areas is the key to controlling stream bank erosion.
Tunnel	The washing away of the subsurface soil while the surface soil is mainly intact. Tunnels start to form when water moves into cracks in the soil, root holes and rabbit burrows, and when the surface soil is saturated. Tunnel erosion produces long cavities beneath the soil surface. The cavities enlarge until the surface soil is no longer supported, and then it collapses. If the process continues, the soil surface collapses further and forms open gullies that continue to grow.	Rehabilitating tunnel eroded land can be a complex and expensive process. If possible, increase groundcover as a first step to restoring soil function. Often perennial grasses are preferred to trees in low rainfall environments. Consult soil conservation experts prior to commencing repair of tunnels. In some instances extensive earthworks maybe required.
Wind	Occurs when particles of soil are moved by the wind. Heavier particles roll along the ground, lighter particles bounce, or are blown up into the air in dust clouds. During the dramatic dust storms of February 1983 tonnes of priceless Victorian topsoil were blown to Melbourne. An average of nine kilograms of topsoil was dropped on each suburban block.	Wind erosion can be minimised by improving soil structure, maintaining ground cover and planting windbreaks.

Soil acidification

Soil acidification occurs when soils become more acidic, as soil pH decreases over time. It occurs naturally over thousands of years as a result of weathering and leaching. Soils in higher rainfall areas are generally more acidic than those in low rainfall areas, although soil parent material and past climatic events also influence soil pH levels. Soils that are naturally acidic can be expensive to amend with lime, as soil acidity persists with depth and regular maintenance applications are required. Instead, land managers may consider shifting towards more acid tolerant plant species to improve plant growth and productivity.

Some agricultural activities can dramatically increase the rate of soil acidification, such as removing plant and animal products (e.g. hay, grain, milk), applying nitrogen-based fertilisers and using shallow-rooted, **annual plants** (e.g. wheat, clover and ryegrass). Land managers need to treat soil acidification as soon as it is detected to prevent acidification of the sub-surface layer, which is more difficult and costly to treat. Lime or dolomite can be applied to increase the pH of acidic soils. Dolomite should not be used on soils high in magnesium - greater than 15% of the Cation Exchange Capacity (CEC). A range of management practices can also be applied to minimise soil acidification, such as:

- Maintaining groundcover, promoting natural **regeneration** and replanting bare areas
- Growing deep-rooted perennial species (e.g. perennial pastures and shelter belts)
- Matching nitrogen fertiliser inputs to plant requirements
- Using efficient irrigation practices to minimise leaching.

Soil sodicity

Soil sodicity negatively impacts soil structure and is caused by elevated levels of sodium attached to clay particles in the soil. It affects about 30% of agricultural land in Australia and significantly impacts agricultural productivity. In Australia, a soil is categorised as sodic when the Exchangeable Sodium Percentage (ESP) is equal to or greater than 6% of the CEC. Sodic soils display a number of soil structural issues, such as dispersion, waterlogging and gully or tunnel erosion. The presence of sodic soils often results in poor pasture or crop growth and loss of groundcover. Sodic conditions can occur at any depth in the soil but are most common in the subsoil, in particular the uppermost parts of the subsoil. Excess sodium can occur naturally in soils during soil formation from granitic or some **sedimentary rocks** or as a result of exposure to salinity. The impacts of soil sodicity can be accentuated by low soil organic matter levels.

Areas of soil sodicity can be identified by noting any soil structural issues and conducting soil tests to measure ESP levels. Deep soil tests (more than 20 cm) should be used to identify subsoil sodicity, where there are signs of waterlogging or soil erosion. Management practices that can minimise soil sodicity include:

- Applying gypsum and/or lime (where acidity is also an issue) to sodic topsoils
- Minimising mechanical disturbance from cultivation
- Maintaining 100% groundcover
- Removing stock from eroding areas
- Not using dolomite
- Only undertake deep ripping after careful consideration, as in some instances it can make the situation worse. If in doubt test a small strip first.

Salinity

Salinity refers to the concentration and movement of salt in the soil and natural waters. It occurs naturally in many Australian landscapes, especially in arid regions where there are a number of salt lakes. Salinity has increased since European settlement as the loss of native vegetation and its replacement with shallow-rooted, often **annual plants**, has allowed more rain to pass through the root zone into the **groundwater** (**recharge areas**), refer to *Figure 10* below. When this happens, the watertable rises and salts stored deep underground are 'mobilised' into the groundwater bringing dissolved salts close to the surface. When the watertable is within one to two metres of the surface, the water and salts are drawn to the surface (**discharge areas**) by capillary action causing the root zone to become saline, eventually killing all vegetation if salt levels get high enough. Salt can also cause problems in urban areas by eating away at building foundations and roads.

Telltale signs

Salinity may be evident from surface salt deposits or from the loss of vegetation from an affected area. However, the early stages of soil salinity may not be evident and it is wise to check for salinity before building or beginning a farming enterprise. Soil salinity levels can be measured by soil tests or with the use of a salinity (Electrical Conductivity) meter. If you can recognise plants easily, the vegetation present can also provide clues to soil salinity levels.

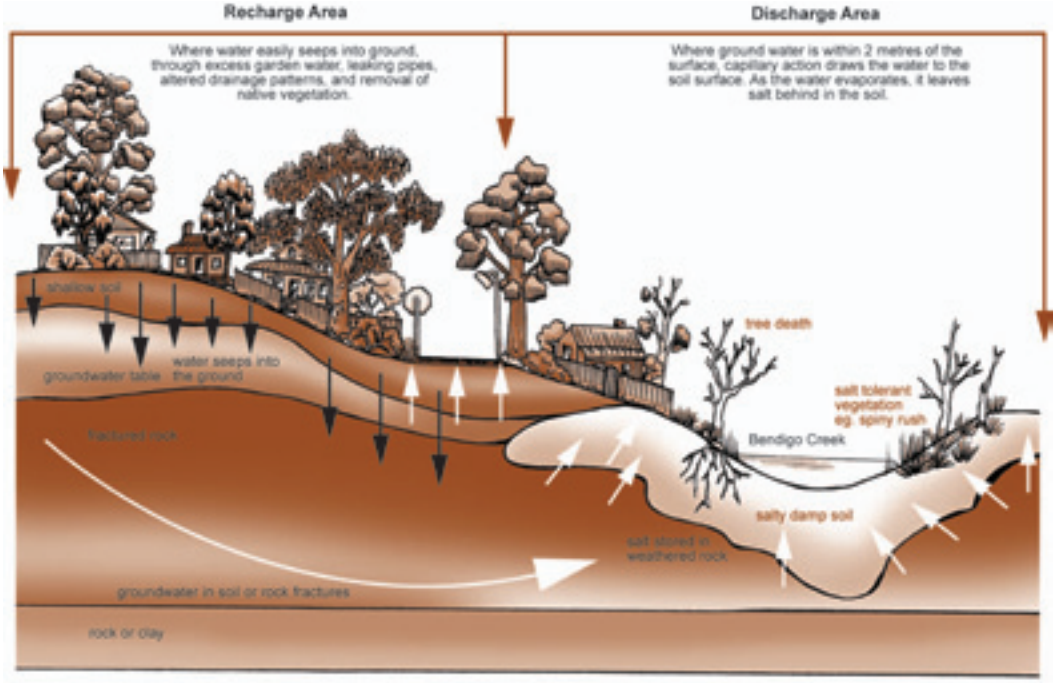
What to do about salinity

Salinity is a **catchment**-wide problem in north central Victoria that does not stop at property boundaries. Some farmers and land managers may unwittingly be adding to the problem in a catchment through vegetation clearing and/or irrigation. The consequences of these actions may not become evident for years as different groundwater systems react at different timescales. When the problem appears, it usually does so elsewhere in the catchment, while the farm that contributed to the problem may not be directly affected by salinity. If no action is taken, the land degrades and the consequences are handed on to the next generation. Clearly, salinity is a catchment-wide issue requiring a coordinated and collaborative response.

There are many activities that land managers can undertake to reduce salinity across the catchment:

- Protect and improve native vegetation
- Plant trees on hilltops and where the ground begins to flatten out from the steeper slopes of hills. This is called break-of-slope planting. Land managers should seek professional advice when using this technique, as a sound knowledge of the surrounding landscape and groundwater system is needed for best results.
- Plant out recharge areas (areas where rainfall infiltrates the soil into groundwater) with deep-rooted vegetation, such as native vegetation, commercial forestry or perennial pastures.
- Plant discharge areas with salt-tolerant species, for example, saltbush.
- Join your local community group (e.g. Landcare, Victorian Farmers Federation, etc.) or consider forming a new one in your community. Cooperate with your neighbours to tackle the problem with a total catchment management approach. Find out where your main recharge areas are (often at the top of the catchment) and start remedial action there and work down the catchment.

Figure 10: The cause and effects of salinity can be seen in towns as well as agricultural areas.



Mount Alexander granite boulders

Soils of north central Victoria

Soil type is influenced by a number of different factors including geology, landform, stream activity, vegetation, climate and geological age. These factors produce a variety of different soils, which vary in fertility, acidity, structure and many other features. Soils are characterised based on the landscape formation and the Australian Soil Classification System. Soil tests can also be conducted to measure soil characteristics and condition.

Soil formation

The soils of north central Victoria vary widely and reflect differences in soil forming processes dictated by factors such as geology, landform, stream activity, vegetation, climate and age (i.e. degree of weathering).

Soils formed on sedimentary rocks

Most of the slopes and foothills of the Great Dividing Ranges (and thus north central Victoria) comprise of sandstones, slates, shales and mudstones formed around 400-500 million years ago, during the **Cambrian** and **Ordovician** geological period. A deep ocean existed in the area during this time and layers of sediment (sand, silt and mud) accumulated on the ocean floor as ancient landscapes eroded. This deep ocean deposition continued over many millions of years and an enormous mass of layered sediment several kilometres thick developed. Late in the Ordovician period this sediment pile was uplifted and folded to become part of the continental land mass. This occurred through the action of the same tectonic forces that drive continents around the world today.

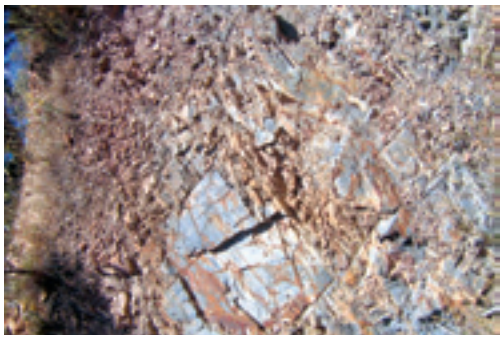
Soils formed on these marine sedimentary rocks, for the most part, exhibit a strong texture contrast between topsoils and subsoils. Most commonly, fine sandy loam topsoils rest over silty clay subsoils that in turn grade into weathered rock at depth. The uppermost subsoils are typically sodic and accordingly, they are subject to poor soil structure. In the southern higher rainfall areas of north central Victoria, yellow subsoils prevail grading into deep red soils in the northern foothills. Soils are generally more sodic in the northern lower rainfall areas of the region. At depth the red sodosols usually contain carbonate, which bestow above average calcium levels and elevated alkalinity.

Special care should be taken in managing sodosols to avoid exposing sodic subsoils. In a grazing environment the challenge is to build soil carbon, in an effort to establish strong soil structure, which will improve the water holding capacity and biological function of the soil. In cropping systems, soil structure is managed through stubble retention, occasional gypsum application and careful, well-timed livestock grazing.

Soils formed on metamorphic rock

About 400 million years ago, tectonic forces caused great chambers of molten rock (magma) to well up towards the earth's crust. They never reached the surface but remained one to two kilometres underground, where they cooled slowly to form large crystalline granitic rocks. The enormous heat generated from these giant magma chambers baked the marine sedimentary rocks, causing them to form the much harder metamorphic rocks, such as, slate, **schist** and **quartzite**. This was followed by several hundred million years of erosion, which stripped off the covering earth to eventually expose the granitic body and surrounding metamorphic rocks at the earth's surface.

Sedimentary soil



Metamorphic rock

The tougher metamorphic rocks form an **aureole**; a ring of high relief metamorphic rocks surrounding the granitic body. This landscape is common throughout north central Victoria.

Soils formed from metamorphic aureoles normally support well structured, shallow, stony gradational soils that have a very low water holding capacity and are generally acidic. Historically, high input, introduced perennial pastures have been established on these lands. However the high establishment and maintenance costs of these introduced pastures has caused farmers to consider the re-establishment of native grasses and forage shrubs, which are well adapted to the harsh conditions and require lower inputs.

Soils formed on granitic rock

As mentioned above, granitic rock forms as hot molten rock (magma) wells up several kilometres underground. The magma cools very slowly and large crystals form. Millions of years of erosion have stripped off the covering earth to expose often spectacular granite landscapes, such as Mount Alexander. Soils formed on granitic rock generally have low to moderate fertility levels and are vulnerable to poor soil structure. Most are pale grey to yellow, though brown sandy loams can develop in well-drained areas. These soils dry out rapidly and are very susceptible to erosion. Sometimes natural 'hardpans' of compacted subsoil develop, which prevent water draining and make granite soils notoriously waterlogged and sloppy in winter.

Soils formed on granitic landscapes vary enormously from one place to another and from one granitic body to another. Small differences in mineralogy and geomorphic history can produce vastly different terrain types. In some areas granitic rocks will form high relief hills and mountains, whilst in others the rock mass has been subjected to deep weathering (decay). In the latter instance natural erosion often resulted in a large low relief saucer-shaped depression surrounded by a much higher relief metamorphic aureole.

In high relief granitic landscapes, the near surface weathering of minerals that bind the rock together results in the release of small quartz grains. As they move down-slope, under gravity, thick sediment fans form along the mid to lower slopes. These soil landscapes are subject to low pH and high aluminium concentrations but even so they are highly favoured by horticultural industries, which value their excellent drainage.

Low relief granitic landscapes have quite variable soil types, again reflecting differences in hydrology and geomorphic history. In many instances they form on deeply decayed rock, and in others they form on sands that in turn rest on deeply weathered/decayed rock. The weathering is often so extreme that silica released during the decay process forms hard pans that may be impenetrable by plant roots. These landscapes are also prone to dryland salinity and gully erosion because (a) they have high salt stores that are easily mobilised by local groundwater systems following changes in the water balance, and (b) because they are soft landscapes, which readily erode to form gullies when subjected to concentrated surface water flows.

Soils formed on basaltic rocks

Basalt volcanic landscapes developed between 10 million and 10,000 years ago from volcanoes that flooded the ancient sedimentary landscapes with molten lava or produced volcanic ash

Granitic soil

Alluvial soil

'cones' (the classic volcano shape). These rocks contain many elements that produce good soils. Basalt soils are fertile and resilient and, as a result, most basalt country is intensively used for agriculture. The best soils tend to be red-brown, but waterlogged areas may be grey. Salinity and erosion are generally not significant problems, but these soils may be vulnerable to weed invasion where fertiliser use is regular. Heavy, cracking clays may form in flat areas, and can be prone to waterlogging which will suppress plant growth.

Soils formed on alluvium

Alluvial soils are formed on floodplains derived from soils washed down from the surrounding landscape. Alluvial soils are of moderate to high fertility but may have poor structure. Due to their presence in low-lying areas, alluvial soils are vulnerable to rising saline watertables.

Table 13: The main characteristics of the different soils found in north central Victoria.

	Soils formed on sedimentary rock	Soils formed on metamorphic rock	Soils formed on granitic rock	Soils formed on basaltic rocks	Soils formed on alluvium
Inherent character	Mostly texture contrast (duplex) soils. Fine sandy loam over silty clay subsoil. Tendency to be sodic. Yellow in the uplands grading to red in the foothills. Red soils are highly sodic and contain carbonate nodules in the subsoil. Accordingly they have high pH. Moderate water holding capacity.	Steep slopes. Mostly shallow red stony skeletal soils. Low water holding capacity. High infiltration and permeability. Generally low pH.	High relief granites: - Sandy well drained soils formed on sediment deposits on slopes/foot-slopes. - Tendency to be acidic with aluminium issues. - Often suitable for horticulture (e.g. the Harcourt apple industry) - Low to moderate water holding capacity. Low relief granites: - Sodic grey soils formed on deeply decayed rock. - Low permeability. - Moderate water holding capacity.	Moderate to high relief basalt: Well structured friable red soils. Excellent drainage. Moderate to high water holding capacity. Generally well suited to horticulture (particularly viticulture). Moderate to low relief basalt: Tendency to be heavy grey soils subject to water-logging. Moderate to high water holding capacity. Often have poor soil structure.	Alluvial soils vary considerably in accordance with the character of its parent rocks. Generally have moderate to high fertility bestowed by the supply of nutrients and minerals deposited over the floodplain. High water holding capacity. Alluvial soils are often the most productive in upland terrain.

	Soils formed on sedimentary rock	Soils formed on metamorphic rock	Soils formed on granitic rock	Soils formed on basaltic rocks	Soils formed on alluvium
Common problems	Prone to soil erosion, particularly hill-slope and gully erosion. Dryland salinity associated with local and sub-regional groundwater systems. Poor subsoil structure.	Low plant available water. Naturally acidity. Erosion on foot-slopes caused by excessive water shedding. Recharge areas for local groundwater systems, contributing to dryland salinity issues.	High relief: - Tendency to acidic where well-drained with aluminium issues - May shed large volumes of runoff which results in down-slope soil erosion issues. - Can behave as local groundwater recharge areas causing local salinity issues. Low relief: - High propensity for local dryland salinity issues driven by high salinity groundwater discharge. - High propensity for serious gully erosion.	High relief: - Very strong soil structure, which can be an issue for dam construction. - Sensitive to runoff and soil loss through gully and rill erosion. - Dryland salinity can be an issue in valleys down-slope of these soils (e.g. Mt Camel Range). Low relief: - High propensity for water logging and water shedding. - Typically have poor soil structure.	Can be subject to salinity in regional or sub-regional groundwater discharge areas. Often comprised of red sodosols that are subject to poor soil structure if managed poorly. Can be subject to gully erosion when poorly managed.

	Soils formed on sedimentary rock	Soils formed on metamorphic rock	Soils formed on granitic rock	Soils formed on basaltic rocks	Soils formed on alluvium
Native vegetation	Typically of the Box-Ironbark forest country. Soils often support high biodiversity where native vegetation has not been cleared for agricultural production.	Largely cleared of native vegetation but some areas retain remnants including: Eucalyptus (E.) macrorhyncha E. polyanthemos E. goniocalyx E. macrocarpa E. obliqua E. rubida E. viminalis.	Most of the granitic terrain has been cleared for agriculture. Some areas of remnant vegetation remain. E. camaldulensis abounds in valley floors and E. viminalis is common on the slopes.	The basalt plains are largely treeless and vegetation varies across EVCs. Remnants, however, typically include: E. viminalis E. camaldulensis E. ovata A. melanoxylon E. obliqua A. verticillata.	Typically, E. camaldulensis, E. leucoxylon and E. meliodora vegetation communities are found on flood plains and along drainage depressions.
Management comments	Management practices should avoid exposing sodic subsoil or mixing subsoil with the topsoil. This will avoid excessive dispersion and loss of soil structure. Gypsum and lime applications may be appropriate to repair soil structure and manage soil acidity. Practices that increase soil organic carbon are likely to improve soil health. Minimum or zero tillage is recommended in a cropping regime.	Avoid cultivation as an erosion control measure. Examine opportunities for native grass establishment. Maintain at least 75 per cent groundcover through light grazing.	Avoid cultivation as an erosion control measure. Examine opportunities for native grass establishment. Consider break of slope tree planting where there are opportunities for groundwater interception and salinity avoidance. Maintain at least 75 per cent groundcover through light grazing.	Establish deep rooted perennial vegetation (trees, shrubs and grasses) to hold the soil together. Maintain groundcover to avoid soil loss through erosion	Adopt minimum tillage or zero tillage in cropland to avoid soil loss through erosion. Maintain at least 75 percent groundcover through light grazing. Establish perennial vegetation within grazing systems.

Some soil characteristics
can be tested in the field

What type of soil do I have?

In 1996 the CSIRO developed the Australian Soil Classification scheme. For rural land managers the scheme provides a framework for communicating with scientists about soils. The scheme has 14 soils orders, where soils with similar characteristics are grouped together (refer to *Table 14* below for a description of each soil order).

Seven of the main soil orders listed in *Table 14* are found in north central Victoria - calcarosols, vertosols, sodosols, chromosols, dermosols, tenosols and ferrosols. Further information and maps for each of these soil orders can be found on the Victorian Resources Online website.

Soil testing

Soil testing is a vital tool for revealing the condition of a soil and the productivity of the land. It provides information critical to maintaining and improving soil health. Soil test results provide land managers with specific information on a range of soil characteristics, such as soil texture, pH and nutrient content. Specialist tests can also be conducted to measure pesticide residues and heavy metal contamination. These characteristics can then be used to determine whether the soil has any nutrient deficiencies or toxicities and/or soil health issues such as soil acidity or salinity. This information can then be used to improve soil conditions through the addition of fertilisers and soil amendments (for example, lime and gypsum), monitor changes in soil properties and select crop and pasture species. Given that cropping and grazing enterprises export soil nutrients from the farm as grain, fodder, meat and fibre, these nutrients need to be monitored and replaced in order to maintain soil health and plant growth.

Before submitting soil samples for analysis make sure the laboratory understands what you want to find out. It is also crucial that soil samples are collected appropriately so that results accurately reflect the soil conditions, for example, collect samples from a large number of sites within the paddock, separate samples (and analysis) for different soil types and avoid livestock camps. Agricultural retailers can collect the soil samples and analyse the results for you. Alternatively, you can collect your own samples and send them to a certified soil testing laboratory for analysis. It is important to use an accepted sampling methodology, refer to the Victoria Resources Online website for further information.

Table 14: Descriptions of the 14 soil orders of the Australian Soil Classification scheme (Adapted from Isbell 1996).

Soil Order	Description
Anthroposols	Soils resulting from human activities.
Calcarosols	Gradational texture profiles with abundant carbonates at depth.
Chromosols	Often brightly coloured and a clear textural horizon from loamy upper horizons to clay subsoil that is not strongly acid or sodic.
Dermosols	Have structured subsoils and lack strong texture contrast between A and B horizons. Often with clay skins on soil aggregates (**peds**).
Ferrosols	Lack strong texture contrast between A and B horizons and have a high iron content.
Hydrosols	Seasonally (two to three months) or permanently wet soils.
Kandosols	Lack strong texture contrast and are not calcareous throughout.
Kurosols	Soils with strong texture contrast between A horizons and strongly acid B horizons.
Organosols	Soils dominated by organic materials.
Podosols	Soils with B horizons dominated by the accumulation of compounds of organic matter, aluminium and/or iron.
Rudosols	Rudimentary soil development, young soils that have had little time to modify parent rocks or sediments.
Sodosols	Soils with strong texture contrast between A horizons and sodic B horizons, which are not strongly acid.
Tenosols	Weak soil development.
Vertosols	Clay soils with shrink-swell properties and strong cracking when dry.

Managing your soil

The land management practices employed by farmers and landholders have a large impact on soil condition. The condition of the soil contributes significantly to farm productivity and the quality of **ecosystem services** provided by a specific environment. Improving land management practices can reduce soil threats such as soil erosion, acidification and salinity.

Investing in the quality of your soil represents a sound investment in the profitability of your farm enterprise. *Table 15* below shows the influence land management practices can have on soil condition.

Table 15: Simplified relationships between land management practices and soil condition. The relationships shown are indicative of general trends and further investigation is recommended for your specific situation (Adapted from the Department of Agriculture 2013).

Practice	Increases soil carbon	Reduces the risk of wind erosion	Reduces the risk of water erosion	Reduces the risk of soil acidification (low pH)	Improve soil structure	Increase soil biology	Reduce the risk of soil salinity	Reduce risks from soil sodicity
Minimum / no tillage	Indirectly	Yes	Yes	No	Yes	Yes	No	Yes
Stubble retention	Yes	Yes	Yes	No	Yes	Yes	No	Yes
Reduced fallow	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
Soil pH testing	Indirectly	Indirectly	Indirectly	Yes	No	No	No	No
Lime or dolomite applied	Indirectly	Indirectly	Indirectly	Yes	Yes	Some times		Yes
Monitoring of ground cover	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
Use of ground cover management targets	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
Pasture phase in crop rotations	Yes	Indirectly	Indirectly	No	Yes	Yes	Yes	Yes
Increasing perennial pastures	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
Additions of organic matter to the soil	Yes	Yes	Yes	No	Yes	Yes	No	Yes
Addition of gypsum	No	Some times	Some times	No	Yes	Yes	No	Yes
Match paddock use to land capability	Indirectly	Yes	Yes	Indirectly	Yes	No	Yes	Yes

Resources and further information

Australian Soil and Plant Analysis Council (provides a list of certified laboratories): www.aspac-australasia.com

Australian Soil Resource Information System: www.asris.csiro.au/index_ie.html

Commonwealth Scientific and Industrial Research Organisation (CSIRO): www.csiro.au

Department of Agriculture (2013) Improving land management practices. Commonwealth of Australia, Canberra. Accessed from: www.daff.gov.au/natural-resources/soils/improving-land-management-practices.

Department of Agriculture, Soil webpage: www.daff.gov.au/natural-resources/soils

Healthy Soils Australia: www.healthysoils.com.au

McDonald, D and Rogers, D (2010) Soils Alive! Understanding and managing soil biology on Tasmanian Farms. Department of Primary Industries, Parks, Water and Environment; Hobart, Tasmania.

New South Wales Department of Primary Industries: www.dpi.nsw.gov.au/agriculture/resources/soils.

Saltland Genie: www.saltlandgenie.org.au

Soils for Life: www.soilsforlife.org.au

The Australian Soil Classification System: www.clw.csiro.au/aclep/asc_re_on_line/soilhome.htm

Victorian Department of Environment and Primary Industries: www.depi.vic.gov.au

Victorian Resources Online – North Central: http://vro.dpi.vic.gov.au/dpi/vro/nthcenregn.nsf/pages/nthcen_homepage

PLANTS

“ Plants play an integral role in rural properties, supplying feed for livestock and human consumption, providing shade and shelter, maintaining groundcover and improving soil health. Appropriate pasture and crop management can also minimise the spread of weeds. ”

Chapter 5
Plants

Managing pastures

Managing pastures is vital for supplying adequate feed for grazing animals. Good pasture selection and management can improve farm sustainability by reducing costs and reliance on supplementary feeding with hay and silage. Pastures also play an important role in providing groundcover, which has a number of flow-on benefits such as: minimising weeds, reducing nutrient run-off and improving soil health.

Pasture types

The first step in managing pastures is identifying what type of pasture you currently have and/or require. Pasture type and species selection is essential if pasture establishment, growth and quality are to be maximised, whilst meeting livestock requirements. Pasture selection should consider: soil type, climatic conditions and feed requirements (volume, timing and quality of feed).

Pasture species can be classified by a number of different characteristics, which include:

- **Perennial** or **annual**
- Grass or legume
- Native or introduced.

A mixture of pasture species within a paddock, or across the property, provides a more even distribution of pasture growth throughout the year and allows species to be closely matched to site conditions such as soils, aspect or drainage. Although the greater the diversity of pasture species within the one paddock, the more complex the associated management. For example, the more dominant pasture species will out-compete the less dominant species and/or livestock may selectively graze out the more palatable species if rotational grazing practices aren't used.

Table 16: The advantages and disadvantage of annual and perennial pasture species.

	Advantages	Disadvantages
Annuals	• Rapid germination and establishment • Aggressive growth habit to out-compete weeds • High production levels • High feed value – energy and protein • Ideal for hay or silage production	• Only live for one season • Require re-sowing each year • Don't utilise soil moisture at depth
Perennials	• Deep-rooted and help control salinity as they use more water • Control erosion by reducing run-off • Grow for a longer period than annuals • Shorter feed gaps and more even feed supply • Out-compete some weed species • Can respond to out of season rainfall (e.g. summer thunderstorms) • Improve soil structure	• More costly and difficult to establish • Low feed production in the first year • More intensive grazing management to ensure perennials persist and remain productive

Annuals and perennials

Annual plants grow only from seed. They germinate quickly and strongly, grow to maturity, flower, set seed and die within 12 months. Some early maturing annuals take only a few months to complete the lifecycle while others take the full year. The lifecycle of the plant is linked to the length of the growing season where it is found. Annual plants are relatively cheap to establish and can produce large quantities of feed for hay or silage production. Examples of annual pasture plants include: annual ryegrass and subterranean clover.

Perennial plants live for two years or more. Some grow from vegetative parts as well as from seed. They do not grow as quickly or strongly as annuals and take longer to establish. Once mature however, they continue to flower annually until they die. Perennial plants generally require good rainfall to establish strong, deep root systems. Once established, perennial plants can make use of out-of-season rainfall, as they can grow all year round. They can also withstand soil pugging and compaction problems caused by hard-hoofed animals, such as horses, sheep and cattle, better than annual plants. Examples of perennial pasture plants include: perennial ryegrass, phalaris, cocksfoot, lucerne and white clover.

Grasses and legumes

Grasses are monocots – they have one cotyledon (seed leaf) at germination. Their leaves grow straight off the stem and are usually long and thin. Grasses are an important source of fibre and energy in animal diets. Although they can lack vigour due to nitrogen deficiencies that reduce feed quality and digestibility, which in turn negatively impact livestock performance. These problems can be overcome if a diversity of grasses is grown as a **grassland ecosystem**, with pasture litter promoting soil biology and nutrient cycling. Examples of pasture grasses include: annual ryegrass, phalaris and Wallaby Grass.

Legumes are dicots – they have two cotyledons (seed leaves) at germination. Their leaves usually consist of three leaflets and the flowers are very distinctive. One of the major advantages of legumes is their ability to fix nitrogen from the air and convert it into plant available nitrogen through soil bacteria (rhizobia) on their roots. This process increases the fertility of the soil and reduces the pasture reliance on nitrogen fertilisers. Although if this nitrogen isn't used by neighbouring grasses, the nitrogen will leach through the soil causing soil acidity. Another major advantage of legumes is their high protein content, quality and digestibility. However this too can cause problems, as bloat can become an issue if livestock consume too much in legume dominant pastures. Examples of legumes include: clover and lucerne.

Native pastures

Australia's native pastures consist of a variety of perennial grasses that have evolved in this country over millions of years. There are over 1,000 different species in Australia, such as Weeping Grass, Kangaroo Grass and Wallaby Grass. Both summer and winter active species are available, which have the potential to provide feed throughout the year if they are combined in the same paddock.

Since European settlement, 99% of Victoria's native grasslands have been lost. Native grasslands are now severely threatened, and the protection of even small patches of remnant grasslands is essential. Every effort should be

Forage shrubs

Native pasture

Ruby saltbush *(Enchylaena tomentosa)*

made to encourage the persistence of native grasslands. They will not withstand heavy grazing like introduced pastures but they can provide groundcover for up to 80% of the year if they're managed appropriately.

Native grasses are very hardy and persistent as they can survive on soils with low fertility and withstand climate extremes. They can provide a low input grazing system, which can reduce costs. Many native grasses are perennial so they have similar benefits to those described in the perennial section above. Despite these considerable benefits there are a number of limitations of native pastures:

- they are difficult to establish using conventional sowing practices
- they are unlikely to be as productive as introduced species in areas suited to improved pastures
- some species aren't suitable for livestock production.

A lot of research has recently been conducted on managing native pastures and some of these limitations are being overcome. For example, soils contain large reserves of viable native seed even when they have been used to grow introduced species for decades. The germination of these native seeds relies on the right soil conditions rather than sowing seed.

Forage shrubs

Forage shrubs are woody plants that are usually less than two metres tall. Perennial forage shrubs can improve farm profitability and natural resource management in low to medium rainfall zones of north central Victoria. This is achieved through the following benefits:

- Providing out of season feed, which reduces supplementary feed requirements and costs
- Providing shade and shelter for livestock
- Utilising rainfall for plant growth throughout the year
- Providing essential minerals and protein for animal production
- Improving livestock health through more efficient digestion and the control of gut parasites
- Allowing grazing to be deferred on other paddocks during the opening rains thus increasing the growth of grass and legume pastures
- Surviving and providing feed during dry summers
- Reducing soil salinity through more effective water use
- Reducing soil degradation through improved ground cover
- Enhancing **biodiversity** by providing an alternative **habitat** structure in the landscape.

The benefits of forage shrubs in mixed cropping and livestock farming systems do decline however when more than 20% of the farm area is allocated to forage shrubs. Further disadvantages of forage shrubs include: expensive to establish, may harbour pests, slow growth and livestock need to be trained to eat it.

For best results, forage shrubs should be grown as a mixed species plantation, as not all species provide all the attributes required, for example, shade, high biomass and crude protein. When designing shrub-based grazing systems the following points should be considered: the inter-row provides important biomass and should be managed (inter-sown with crops or pasture), adequate machinery access is required between rows for weed control and re-sowing, and individual shrub species can be grown together (e.g. same row), as livestock simply require access to a diversity of species in the same paddock.

The Future Farm Industries CRC has a trial site testing native woody perennial species at Marnoo, near St Arnaud in north central Victoria, as part of the Enrich research project. The site has a heavy clay soil type and a pH of 5.6. Forage shrubs were planted during winter 2008 and survival has been high for most species, refer to *Table 17* below. Sheep grazed the site in 2010 and 2011 with all species, except fleshy-leaved saltbush and mealy saltbush, well grazed.

Pasture weeds

A pasture weed is any plant that is toxic to grazing animals, unpalatable or unproductive. Weeds compete with pasture plants for light, moisture and nutrients. Inspect paddocks closely throughout the year to identify pasture weeds. They occupy a lot of space when they are green and can make a paddock look healthy and lush. When they dry off over summer and set seed, bare patches become evident and the true state of the paddock is revealed. Controlling pasture weeds requires constant monitoring and can incorporate a number of techniques, including:

- Rotational grazing to promote adequate recovery periods for the most desirable pastures species, such that they become more competitive and displace the weeds
- Mowing and slashing pastures during early spring before the weeds have set seed, which reduces the weed burden the following year

Table 17: The average establishment (percentage of seedlings) of native perennial shrubs at the Future Farm Industries CRC Enrich trial site in Marnoo, Victoria compared to the establishment at all Enrich trial sites (Source: Dr Jason Emms, South Australian Research and Development Institute and Future Farm Industries CRC).

Plant species	Average establishment (%) at Marnoo, Victoria	Average establishment (%) across all Enrich trial sites.
River saltbush	98	67
Coastal saltbush	55	57
Old man saltbush	94	80
River Murray saltbush	98	90
Creeping saltbush	88	85
Bladder saltbush	92	81
Nitre goosefoot	96	77
Australian bindweed	84	64
Ruby saltbush	98	88
Tree medic	93	58
Fleshy leaved saltbush	82	67
Mealy saltbush	84	86
Mallee saltbush	67	75
Spiny saltbush	96	75

Cattle grazing

- Selective herbicide applications when the weed species is in the vegetative growth phase (usually during autumn and winter)
- Spraying weeds with sub-lethal rates of herbicide to sweeten the weeds (usually during autumn and winter) and then crash grazing the weeds
- Spray topping weed seed heads (usually during spring) with low rates of herbicide to prevent the weed setting viable seed, this reduces the weed burden the following year.

When using herbicides to control weeds always read and follow the label directions.

Conversely, pasture plants like Kikuyu Grass (Pennisetum clandestinum) and Phalaris (Phalaris spp.) are considered serious environmental weeds in remnant vegetation and along roadsides when they escape from pastures. Buffers along boundary fences near roadsides and remnant vegetation should be kept clean of pasture plants. Land managers must work to keep weeds out of their pasture paddocks, and to keep the introduced pasture species in the paddock, as they can cause weed problems elsewhere. This is not an issue when the main grazing species are native pastures.

Grazing management

Grazing management plays a crucial role in pasture persistence, plant production and animal performance. By managing the timing, intensity and frequency of livestock grazing, land managers can manipulate the composition, quality, persistence and quantity of pasture produced. This has flow-on benefits for livestock production, as feed quality is improved and the reliance on costly supplementary feed is reduced.

The most effective way of managing pastures in this way is to employ rotational grazing, whereby paddocks are rested between grazings. The period of rest is usually dictated by the growth stage of the pasture and/or its growth rate. For example, rest periods are shorter during spring when plants are rapidly growing and longer during winter when cooler temperatures reduce pasture growth rates. Land managers should aim to graze the pasture when it reaches 2,500 to 3,000 kg green dry matter (DM)/ha and remove livestock when pastures reach 1,000 kg green DM/ha. Research also indicates that soil health and pasture productivity can be improved by:

- Maintaining 100% groundcover (pasture plants and litter) all of the time
- Ensuring the most desirable plant species (e.g. perennial pasture plants) have fully recovered from the previous grazing and have produced standing pasture litter before re-introducing livestock
- Using rotational grazing to supply feed for both livestock and soil organisms, that is, grazing results in the root pruning of pasture plants, which supplies organic matter for soil organisms.

To increase the rest periods between grazings, large paddocks can be subdivided into smaller paddocks using temporary electric fences and livestock can be grouped into large mobs. Paddocks may also be removed from the rotation for hay or silage production to allow more efficient grazing of the remaining paddocks during periods of high pasture growth. If paddocks aren't ready to be grazed again at the end of the rotation, livestock can be supplementary feed in a sacrifice area or

Aerial image of crops near Boort

holding yard. For example, during summer when hot and dry conditions stress pastures. Land managers should develop a grazing plan to manage seasonal plant growth and avoid feed shortages.

As well as rotationally grazing paddocks, land managers can rotate more than one species of livestock, either at the same time or at different times. For example, cows, sheep and chickens. This can increase the persistence of the pasture, as different livestock species have different grazing behaviours and preferences. It can also provide a number of animal health benefits by reducing toxic plants and/or removing insects. Multi-species grazing allows land mangers to stack more than one livestock enterprise on the farm, which can increase farm productivity per hectare. Land managers that don't want to purchase multiple livestock species could consider **agistment**, leasing or joint ownership of livestock.

Growing broadacre crops

Crops are grown throughout north central Victoria for grain, hay and silage production. Production levels fluctuate greatly due to variable weather conditions. Broadacre cropping is dominated by **cereal** production, although legume and oilseed production has increased significantly over the past three decades. As well as the grain or forage produced, crops can also provide a number of co-benefits such as weed control and improved soil health (e.g. legume crops increase soil nitrogen levels).

To compete on the global market, adapt to changing weather conditions and remain profitable, crop producers need to maintain or increase yields whilst reducing production costs. Land managers are adopting a number of farming practices and strategies to achieve this, including conservation tillage, precision agriculture and pasture cropping.

Crop type

Crops grown in north central Victoria can be broadly characterised as winter or summer crops. Winter crops include wheat, oats and canola and dominate cropping systems across the region. Summer crops include sorghum and soybeans and are grown in irrigation areas in the north of the region. Within these two broad categories crops can be grouped as cereals, legumes or **oilseeds**. Cereals are annual grass crops and are grown for grain, forage or grazing. Legume crops belong to the *Fabaceae* family and able to fix soil nitrogen through symbiotic bacteria attached to their roots. Oilseeds are broadleaf plants that produce seeds with high oil concentrations that can be used in vegetable oils and high quality livestock feeds. Legumes and oilseeds play an important role in crop rotations as they break cereal disease cycles whilst improving soil health.

Land managers need to consider a number of factors when selecting the type and variety of crop to grow. These factors include:

- Climate – rainfall, frost risk, temperature, growing season length, seasonal forecast
- Soil – fertility, pH and any constraints (e.g. nutrient toxicities and waterlogging)
- Weeds – populations, control options and any herbicide residues and/or resistance
- Disease – disease burdens, control options and crop variety disease resistance levels
- Paddock history – previous crop rotation
- End use – grain, feed, grazing or forage
- Markets – access, value and risk
- Sowing and harvesting equipment – own or rely on contractors.

Careful consideration of each of these factors will reduce the risk of crop failure, minimise input costs and help plan crop management strategies, such as fertiliser, herbicide and pesticide inputs. Laboratory testing can be carried out to measure soil characteristics, such as fertility, pH, pesticide residues and disease levels.

For best results planning should begin a year before the crop is sown, so there is time to correct any soil constraints and reduce weed populations. *Table 18* on Page 75-78 describes 17 crops that can be grown in north central Victoria and broadly outlines the characteristics and uses of each crop. Land managers can engage agronomists (soil and crop scientists) to provide paddock-specific advice on crop selection and management.

Table 18: Common crop types grown in north central Victoria.

Crop Species	Crop Type	Sowing window*	Characteristics	Uses
Wheat	Winter cereal	May – early July	• The most widely grown cereal crop • Yield benefits if grown after legumes • Range of chemical weed control options available	• Grain – bread, biscuit or durum • Livestock feed grain • Dual purpose
Barley	Winter cereal	Late April – mid July	• Good tillering capacity and weed-competing ability • Shorter growing season then other cereals • Useful at the end of the crop rotation cycle as it tolerates low fertility • Doesn't tolerate soils prone to waterlogging, low soil pH or high boron levels • Don't sow malting barley varieties after legume crops, as nitrogen levels will reduce grain quality	• Malting • Livestock feed grain
Oats	Winter cereal	Late April – mid July	• Tolerant of frost and waterlogging • Limited chemical weed control options • Useful as a hay crop to control herbicide resistance weeds	• Milling • Livestock feed grain • Hay • Grazing
Triticale	Winter cereal	Late May – early June	• Tolerant of acid, alkaline, waterlogged, sodic, high boron and low trace element fertility soils • Tall growth habit makes it useful for rocky paddocks • More susceptible to frost than wheat • Narrow growth habit means it can be used as a cover crop when undersowing lucerne or other pasture species.	• Livestock feed grain • Cover crop when under-sowing lucerne or medics.

* Sowing window should be used as a guide only. Optimal sowing time will vary depending on the variety selected, soil type and the season.

Crop Species	Crop Type	Sowing window*	Characteristics	Uses
Cereal Rye	Winter cereal	Late April – June	• Stabilises drifting soils as its drought resistant, can withstand sand blasts and provides long-lasting stubble cover • Tolerant of cold temperatures and limited waterlogging • Low yielding • Provides early livestock grazing if sown in March • Not suitable for hay production	• Grain – bread • Livestock feed grain • Grazing
Sorghum	Summer cereal	Soil temperature 16–180˚C and rising (November – early December)	• Require summer irrigation and warm conditions • Intolerant of waterlogging • Can cause animal health risks when grazed • Relatively drought tolerant and high water use efficiency • High nitrogen and phosphorus requirement	• Grain • Ethanol production • Livestock feed grain • Grazing
Maize	Summer cereal		• Require summer irrigation • Sensitive to high temperatures and moisture stress • Most suited to slightly acid to neutral pH • Avoid poorly drained soils • Determine market specifications before planting	• Grain • Livestock feed grain • Silage
Millet	Summer cereal	Late October onwards	• Require summer irrigation • Fast growing, high yielding • Requires large amounts of phosphorus and nitrogen • Not as drought tolerant as sorghum • Can be double cropped with winter crops	• Hay or silage • Grazing
Lupins	Winter legume	May – early June	• Hardy break crop • Increase soil nitrogen levels • Narrow leaf varieties tolerate acid soils (pH 4) • Require manganese, phosphorus, nitrogen, zinc and sulphur • Intolerant of frost, high temperatures and free lime • Grow poorly on hard setting or shallow soils	• Grain • Livestock feed grain • Green manure crop

Crop Species	Crop Type	Sowing window*	Characteristics	Uses
Field Peas	Winter legume	Mid-May – June	• Hardy break crop • Increase soil nitrogen levels • Sensitive to waterlogging, frost and sulfonylurea herbicide residues • Select paddocks with good drainage and flat soil surface • Don't choose a paddock prone to wind erosion • Don't graze stubbles as this can lead to soil erosion	• Grain • Livestock feed grain • Green manure crop
Chickpeas	Winter legume	Mid May – early July	• Useful break crop in cereal rotations • Increase soil nitrogen levels • Poor competitors with weeds, especially during early growth stages • Limited broadleaf chemical weed control options • Sensitive to frost during flowering • Prefer warmer conditions	• Grain • Green manure crop
Faba Beans	Winter legume	Late April – late June	• Useful break crop in cereal rotations • Increase soil nitrogen levels • Stubble provides highly nutritious livestock feed • Tolerates waterlogging and acid soils better than the other grain legumes • 400 mm annual rainfall • Cooler temperatures during spring increase yield • Excellent competitors with weeds	• Grain • Green manure crop
Lentils	Winter legume	Mid May – mid June	• Useful break crop in cereal rotations • Increase soil nitrogen levels • Highly sensitive to saline, boron and sodic soils • 350-550 mm annual rainfall • Intolerant of waterlogging	• Grain • Green manure crop

Crop Species	Crop Type	Sowing window*	Characteristics	Uses
Vetch	Winter legume	Late April - mid July	• Useful break crop in cereal rotations • Increase soil nitrogen levels • Low to mid rainfall zones above 300 mm • Intolerant of waterlogging • Prefers alkaline soils but will tolerate pH 6 to 9 • Stubbles shouldn't be grazed to prevent soil erosion • Alternative to field peas	• Livestock feed grain • Hay • Green manure crop
Canola	Winter oilseed	Late April - early June	• Useful break crop in cereal rotations • Utilises different chemical weed control options to cereals • Requires large amounts of sulphur and nitrogen • Effective at crowding out weeds	• Vegetable oil • Concentrated livestock meal
Forage Brassica	Winter and summer oilseed	Spring - Summer depending on the variety	• Opportunity forage crop • High quality feed • Fast growing • Reduce the incidence of soil-borne diseases • Avoid shallow, waterlogged and highly acid soils • Require phosphorus, nitrogen and sulphur • Can be double cropped with annual winter crops or pastures	• Grazing
Soybean	Summer oilseed/ legume	Mid-November - December	• Increase soil nitrogen levels • Require summer irrigation • Can be double cropped with winter cereals • Intolerant of waterlogging, salinity and acidity • Pre-watering is required for successful sowing and establishment • Very vigorous crop which can compete with weeds • High phosphorus requirement	• Vegetable oil • Biodiesel • Concentrated livestock meal

Canola in flower

Crop management

A detailed crop management plan should be developed by farmers to outline crop rotations, sowing times, weed and disease control strategies, soil improvements and fertiliser applications. Some of the management strategies outlined in the plan will be fixed, whilst others will be flexible depending on the season and market conditions. Crop rotations that include legumes, oilseeds or a pasture phase, as well as cereals, are critical in reducing weed and disease cycles and increasing soil health. If the same crop is grown year after year, diseases will build up in crop residues and weed control options will be limited, which increases the chance of herbicide resistance. Alternatively, some land managers are adopting pasture cropping whereby winter crops are sown into summer-active perennial pastures, which combines grazing and cropping enterprises, maintains groundcover and utilises summer rainfall.

Sowing time is critical to crop growth and yield, as for every day a crop is sown late yield decreases significantly. Each crop type has an ideal sowing window, with farmers deciding to sow dry or after the seasonal break within this window. There is usually a trade-off between sowing early and risking frost damage during flowering and sowing late and risking heat damage during flowering or grain fill. Although heat damage is usually a higher risk then frost damage.

For best results, farmers should prepare early for sowing, beginning with summer weed control and soil testing to determine soil amendments (e.g. lime and gypsum) and fertiliser applications followed by variety selection and sowing time. Other decisions such as in-crop fertiliser and pesticide applications can be made once the crop is growing, when more information is known about nutrient deficiencies, seasonal outlook, weed pressures and markets. Decision support tools such as moisture monitoring, plant tissue testing and crop production models, such as Yield Prophet, can also be used by farmers to weigh up a range of management options and minimise risks.

The most recent advances in crop management include conservation tillage and precision agriculture. Conservation tillage incorporates minimum or no tillage, stubble retention and crop rotations to minimise soil disturbance, maintain groundcover and utilise a range of crop species. It has improved soil structure, fertility and organic matter levels whilst increasing crop yields. These benefits have been increased with the introduction of precision agriculture, whereby farmers utilise GPS guidance to control all machinery traffic to the same tracks and measure crop yield and growth variability across the paddock. This information can then be used to manage different zones of the paddock differently, which improves efficiencies. For example, fertiliser rates may be increased for the better-performing zones. This improved accuracy of fertiliser and pesticide applications has reduced input costs and the impact of over-application on the environment.

Horticulture production

Horticulture is an important industry in north central Victoria, with a variety of crops grown throughout the region, particularly in the irrigation areas and near major population centres. The Australian horticultural industry was valued at $8.74 billion per annum in 2010-11, with Victoria contributing $2.64 billion per annum. Most businesses are concerned with the production of fruit, nuts, grapes and vegetables. Although flowers, ornamentals, turf and olives are also grown.

The majority of Australian horticultural produce is sold domestically through direct contracts with major retailers, through wholesale contracts and through fresh produce markets (to wholesalers and consumers). Export markets are also a significant market for Australian produce, which is renowned for its high quality right across the supply chain. Australia does lack a critical mass in the global market so efficient and flexible supply chains are essential.

The horticultural industry is labour intensive, as many crops are harvested by hand and involve significant on-going management (e.g. pest and disease control, irrigation, and pruning). The industry is mostly made up of small-scale family farms, although the number of medium to larger scale operations is increasing as businesses try to improve efficiencies. Some of the major challenges facing the industry include: the high cost of labour relative to international competitors, maintaining and improving quality assurance and food safety to meet consumer specifications, and continually improving productivity to maintain profits despite increasing costs of production.

Establishing a successful horticultural enterprise

Horticulture is a great option to diversify farm businesses, which doesn't require large tracts of land. To be successful however it does require careful planning and research, intensive management, significant up front capital investment (e.g. grapes and apples) and in some cases long payback periods.

There are number of factors that should be considered when planning a new horticultural enterprise, or expanding an existing one, to ensure that the right type of crop is selected for the property, landholder objectives are met and appropriate management and marketing strategies are put in place. These factors include:

Land capability and site selection:

- Water availability – water resources (rainfall, irrigation or **groundwater**) and reliability
- Climatic conditions – rainfall, temperature and frost
- Soil conditions – type, fertility, drainage, limiting facts and remedial actions required (e.g. fertiliser, lime or organic matter)
- Aspect – strongly influences patterns of sun and shade, temperatures and wind exposure.

Crop selection and management:

- Must be well suited to the land capability and site conditions
- Market conditions – demand, value and access
- Management requirements – establishment, irrigation, pruning, rotation, fertiliser applications and pest, disease and weed control

Geese hunting insect pests in a biodynamic vineyard

Vineyard near Harcourt

- Harvesting and post-harvest management – harvested by hand or machinery, time of harvest, cooling and storage requirements, equipment and infrastructure needs, and transport to market
- Planting material – variety selection, quality and authenticity of seed, root pieces, seedlings or transplants, **Plant Breeders Rights** (PBR) and royalty payments required.

Long-term vision

- Set objectives and a long term vision for the enterprise
- Start in a small way to test ideas, concepts and skills
- Allow room for expansion when planning infrastructure requirements
- Regularly record, monitor and evaluate management strategies, crop growth and yields, inputs and markets.

Skill set

- What skills are required to grow and market the crop?
- Identify knowledge and skills gaps, and training requirements
- Build networks with other farmers and industry specialists
- Bring in specialist advisors, contractors or farm workers as required.

Understand your market and product

- Conduct market research – demand, access, quality specifications, risk and value
- Clearly define your product (e.g. bulk olives, preserved olives or olive oil)
- Clearly define your service – delivery (e.g. farmers markets, direct to wholesalers or supermarkets), product information and other value adding services (e.g. order products online, cellar door, preserving classes or 'pick your own')
- Product differentiation (competitive advantage) – quality versus price, niche markets, farming system (e.g. organic or biodynamic) or service.

"Strive for continuous improvement – increased efficiencies, improved management systems (crop production, processing and marketing) and better risk mitigation strategies."

Potato harvest

Agroforestry

Agroforestry (or farm forestry) is the integration of trees and shrubs into farming landscapes for conservation and profit. It allows farmers and land managers to use trees to improve the environmental, social and economic values of their land. The strategic establishment of trees can help control soil **erosion**; solve salinity problems; improve productivity by providing shade and shelter for livestock and crops; diversify farm income; provide **wildlife** habitat; enhance property values; and improve the aesthetic living environment.

The tree species to be considered for any agroforestry plantation in north central Victoria should be chosen based on how well the species matches rainfall (which may be highly variable), soil type, frost tolerance, and the desired end product (e.g. sawlog, firewood, craft wood), along with any planned **biodiversity** benefits. Ground preparation, weed management, fire breaks, row orientation (north-south or east-west), row spacing and tree spacing are other important considerations. With the right design, establishment and management, agroforestry plantations can diversify farm income while enhancing the productivity and resilience of agricultural enterprises.

One group whose membership is drawn from north central Victoria and which focuses on low-rainfall (<500mm/year) agroforestry is the Northern United Forestry Group (NUFG). Formed in 1998, NUFG is a local community group that offers information and support to farmers interested in developing dryland farm forestry on their land as a commercially viable enterprise, generating environmental services, community benefits, and a diverse range of forest products including firewood, essential oils, seed and timber.

NUFG's priority species found in member plantations are Sugar Gum (*Eucalyptus cladocalyx*); Red Ironbark (*Eucalyptus sideroxylon and E. tricarpa*); Swamp Yate (*Eucalyptus occidentalis*); Eumong (*Acacia stenophylla*) and Cooba (*Acacia salacina*). All three eucalypt species produce high quality firewood. Even in low-rainfall environments, both well-managed Sugar Gum and Red Ironbark plantations can produce excellent sawlogs that have a range of uses as structural timbers (e.g. flooring) or in fine furniture. In the higher rainfall areas of the upper **catchments** of north central Victoria landowners have successfully established plantations of high value species including Shining Gum (*Eucalyptus nitens*) and Spotted Gum (*Corymbia maculata*).

Firewood

Many households in north central Victoria rely on wood to heat their homes, as natural gas is not readily available. Farmers and land managers can grow firewood to meet or supplement their needs and provide habitat for native animals at the same time. There are also a number of things homeowners should consider when using firewood to heat your home: some wood types burn better than others, there are techniques for burning wood effectively and you can minimise your impact on **biodiversity** when you collect firewood.

Growing your own firewood

Farmers and land managers can cost effectively grow their own firewood whilst improving the property's appeal and providing valuable habitat for wildlife. One firewood tree requires five square metres and a two hectare plantation should provide one household with a lifetime's supply of firewood. Preparation is the key to good, early growth and survival, which may include: weed control before planting and deep ripping to a depth of at least 50 centimetres during autumn before the soil becomes too wet. Planting is best carried out in autumn when soil temperatures are still warm and rainfall is adequate during early growth. However if the area is severely waterlogged or frost-prone during winter, planting should be carried out in spring.

Plantation design is also important. Rows should be spaced 3.5-5 metres apart to allow tractor access for slashing and extraction. In the rows, spacing between trees should be 2.5-4 metres. Plantations should be thinned once they reach ten to 15 years of age to provide some fuel and allow the remaining trees to grow faster. Tree guards may be necessary during establishment if rabbits or hares are a problem. Plantations should be fenced to exclude livestock and damage to young trees.

A variety of native species can be grown for firewood, such as Red Ironbark, Sugar Gum and Black Wattle. Local indigenous plants are also being trialled across north central Victoria, for example, Blackwood, Candlebark, Messmate and Manna Gum. Growing locally indigenous species can improve the success of the planting and enhance its biodiversity values.

Productivity of farm forestry

NUFG has recently conducted an investigation into the productivity of its own plantations on saline land at Kamarooka. In addition to drawing down the highly saline watertable, and dramatically improving the **carrying capacity** of the land, tree measurement data indicates that on average, each hectare planted with Eucalyptus species is growing an additional 2.8 m^3 of wood per year, since establishment in 2005. That is woody biomass that can be used, when suits, for the production of firewood, fence-posts, sawn timber or biochar.

Note that this amount of wood equates to an annual carbon sequestration rate of around 4.5 tonne per hectare (CO^2-e).

Land managers simply cannot get the most from their land - soil, water or animals - without the strategic use of trees. Deep-rooted perennial plants can access soil, water and nutrients that would otherwise be lost, or remain outside your production system and unavailable. They also protect your assets, while becoming a valuable asset in their own right.

For best results, farmers and land managers should seek advice from experienced tree growers, nurseries and/or the DEPI. Advice should also be sort from local council to ensure the plantation meets planning scheme requirements and conforms to the Code of Practice for Timber Production. If a planning permit is not required and a plantation is being established for the first time, farmers and land managers should lodge a Plantation Development Notice with their local council (prior to commencement of site preparation) so that they don't need to apply for a permit to harvest the tree crop.

Collecting firewood

Since European settlement, vegetation clearing has caused a shortage of hollow-bearing trees. Hollow logs, standing dead trees and large old trees provide important habitat for native animals. Most native trees require at least 100 years to produce suitable hollows for birds and mammals to use as habitat. Be selective when collecting firewood and leave hollow logs alone, whether they are standing or lying. Instead try to collect small diameter solid pieces of wood and leave some timber behind. If there is very little timber around, leave it and search elsewhere. Alternatively, source plantation timber, old building materials or fence posts for firewood. Do not collect firewood from endangered **woodland** communities, as they are declining and are protected by State and Federal legislation, so penalties apply to firewood collecting.

Collection of firewood for domestic use is allowed in *designated firewood collection areas* in State forests. These areas are clearly identifiable on the ground and are marked with official signs. Permits aren't required to collect domestic firewood from these areas, although a number of rules must be followed. For example, firewood can only be collected during collection seasons, which are generally during autumn and spring. DEPI conducts regular patrols and surveillance of collection areas and significant penalties apply for illegal activity. For further information contact DEPI or visit their website.

Management of roadside vegetation is the responsibility of the road management authority, usually VicRoads or local councils. Collection of firewood from roadsides is under their management. VicRoads and many local councils do not currently allow firewood collection on roadsides. Again penalties apply if firewood is collected illegally.

Which wood is best?

Avoid buying wood sourced from valuable remnant stands of native forest, such as Grey, Red, Yellow and White Box, Ironbark and Red Gum firewood, as they are extremely vulnerable and are better left to provide habitat. Instead look for a firewood supplier who sources wood exclusively from plantations or coppiced woodlots. If you buy wood to use immediately, always buy dry, seasoned, untreated wood. Unseasoned wood can have up to 50% moisture content. This wood is hard to ignite, slow to burn, and produces more smoke and less heat. You can save money by buying unseasoned firewood in the early spring and storing it undercover, in a criss-cross pattern until the following winter.

Heating your home

To maximise efficiency and reduce costs, good insulation is essential. An average house with reasonable insulation and an efficient wood heater uses about six to ten tonnes of firewood per year for heating, where as an uninsulated house can use up to 20 tonnes. Homeowners can also incorporate simple design techniques when building or renovating to capture the heat of the sun in winter and shade the house in summer, reducing heating and cooling costs. For example, house orientation, window and floor coverings and plants surrounding the house can increase home energy efficiency.

A number of things should be considered when buying a wood heater including: the area you want to heat, how long you want to heat that area, where you will source the wood and its cost. Open fires are up to five times more polluting than wood heaters that meet the Australian Standard (AS/NZS 4013:1999). All wood heaters made and sold in Victoria must meet this standard. If possible, consider replacing an open fire with a wood heater that meets the standard or an alternative form of heating that is energy efficient. Ensure wood heaters are installed by a licensed plumber.

Wood heaters need to be maintained and serviced to keep them burning efficiently and cleanly. Check your heater and flue before winter and look for cracks or changes to the surface. If necessary, have it checked by a qualified service person, and have your flue or chimney professionally cleaned at least once a year. Do not burn: unseasoned wood, household rubbish, garden clippings, painted or treated timber, wet or damp wood, particle board or plastic.

Smoke from domestic wood heaters and open fires is the main source of air pollution in Victoria in autumn and winter. When wood is burned, particles and other chemicals are released into the atmosphere, which affect air quality and can affect our health and quality of life. Wood smoke can exacerbate respiratory and cardiovascular illnesses such as asthma and can affect people's ability to enjoy their homes and the outdoors. Prevent or minimise the air pollution problems associated with wood heating by doing the following:

- Burn dry, seasoned, untreated wood.
- Get a hot fire going quickly with plenty of paper and small kindling.
- Keep the air controls set high enough to keep your fire burning brightly.
- Never leave your wood heater to smoulder overnight. Doing this starves the fire of oxygen, producing more smoke and air pollution.
- Never overload your wood heater by placing too much wood in the fire.
- Check your chimney or flue for smoke at least once every evening.
- Consider your neighbours' well-being.
- Ensure your chimney or flue is higher than your neighbour's roofline. This will prevent smoke from your fire entering your neighbour's home.

Agroforestry plantation

Firewood

Sustainable gardening

Sustainable gardening can be defined as garden design and management that maximises human well-being and environmental benefits. It can involve a broad range of activities that aim to reduce the consumption of water, energy and materials or increase local food production and **biodiversity**. *Table 19* outlines creative design and management techniques that can be employed to achieve a more sustainable garden.

“Sustainable gardening can make a valuable contribution to the environment whilst providing enjoyment and recreation.”

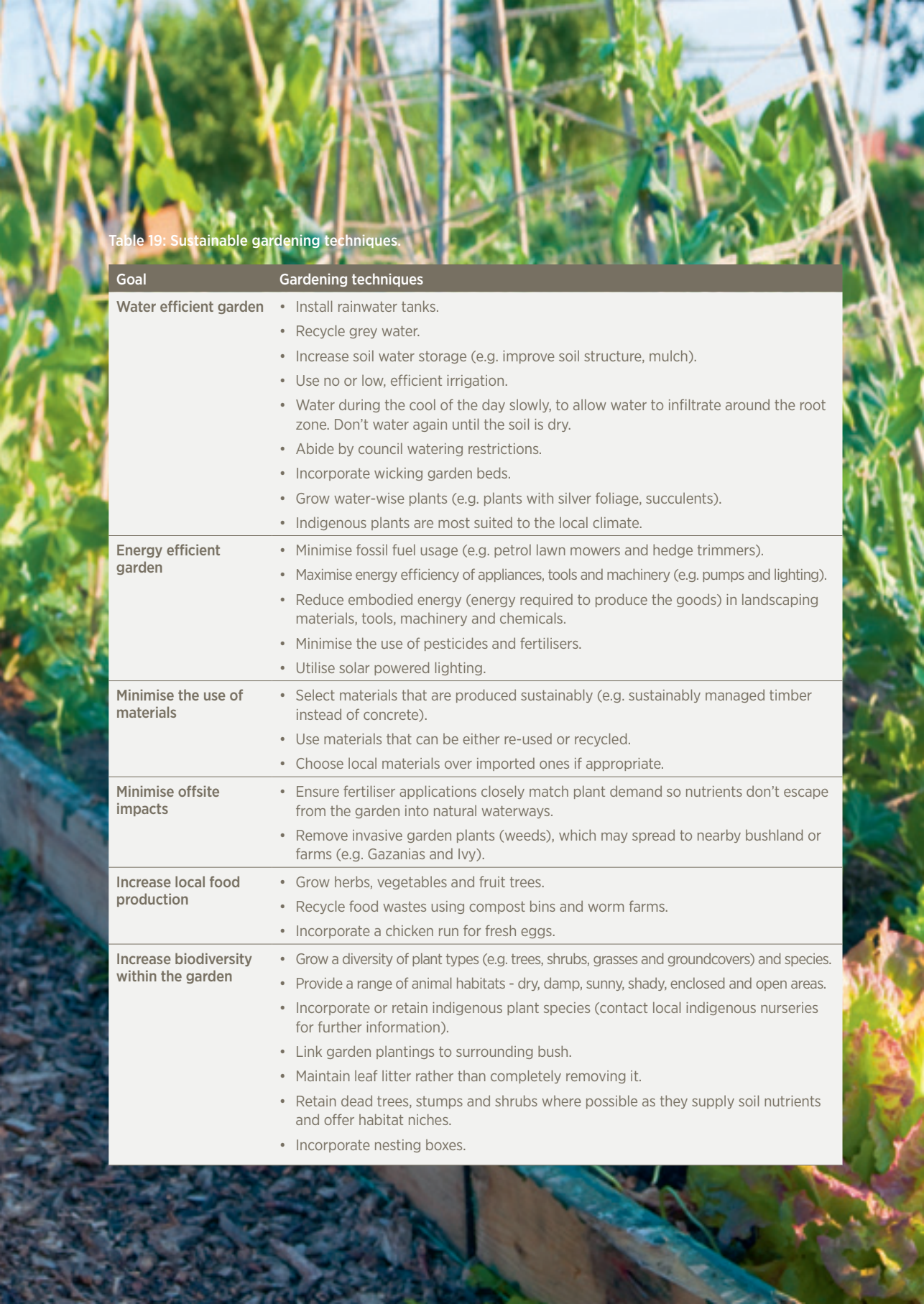


Table 19: Sustainable gardening techniques.

Goal	Gardening techniques
Water efficient garden	• Install rainwater tanks. • Recycle grey water. • Increase soil water storage (e.g. improve soil structure, mulch). • Use no or low, efficient irrigation. • Water during the cool of the day slowly, to allow water to infiltrate around the root zone. Don't water again until the soil is dry. • Abide by council watering restrictions. • Incorporate wicking garden beds. • Grow water-wise plants (e.g. plants with silver foliage, succulents). • Indigenous plants are most suited to the local climate.
Energy efficient garden	• Minimise fossil fuel usage (e.g. petrol lawn mowers and hedge trimmers). • Maximise energy efficiency of appliances, tools and machinery (e.g. pumps and lighting). • Reduce embodied energy (energy required to produce the goods) in landscaping materials, tools, machinery and chemicals. • Minimise the use of pesticides and fertilisers. • Utilise solar powered lighting.
Minimise the use of materials	• Select materials that are produced sustainably (e.g. sustainably managed timber instead of concrete). • Use materials that can be either re-used or recycled. • Choose local materials over imported ones if appropriate.
Minimise offsite impacts	• Ensure fertiliser applications closely match plant demand so nutrients don't escape from the garden into natural waterways. • Remove invasive garden plants (weeds), which may spread to nearby bushland or farms (e.g. Gazanias and Ivy).
Increase local food production	• Grow herbs, vegetables and fruit trees. • Recycle food wastes using compost bins and worm farms. • Incorporate a chicken run for fresh eggs.
Increase biodiversity within the garden	• Grow a diversity of plant types (e.g. trees, shrubs, grasses and groundcovers) and species. • Provide a range of animal habitats - dry, damp, sunny, shady, enclosed and open areas. • Incorporate or retain indigenous plant species (contact local indigenous nurseries for further information). • Link garden plantings to surrounding bush. • Maintain leaf litter rather than completely removing it. • Retain dead trees, stumps and shrubs where possible as they supply soil nutrients and offer habitat niches. • Incorporate nesting boxes.

Controlling weeds

Weeds cost the community millions of dollars each year in lost productivity and have a significant impact on the natural environment. All land managers have a responsibility to manage weeds on their land, irrespective of whether the land is public or private land. As a land manager, it is important to be able to identify weeds that may pose a threat to your land or neighbouring land. Early identification will enable you to implement management plans that prevent weed establishment or spread.

What is a weed?

A weed may be defined as a plant growing in the wrong place or an aggressive plant that thrives when natural environments are disturbed or inappropriately managed. They can be introduced plant species or plants native to Australia but growing outside their natural range. Weeds are introduced to an area through deliberate spread by humans (e.g. gardens and exotic tree plantings), accidental spread by humans (e.g. weed seeds or plant pieces carried on farm machinery or brought in with grain or fodder) and/or natural spread by wind, water, birds or animals (e.g. seed eaten by birds). Weeds negatively impact farm productivity, the environment, the economy, human health and amenity.

Noxious weeds

Under the *Catchment and Land Protection (CaLP) Act 1994* certain plants are declared as **noxious weeds** in Victoria and are classified as State Prohibited, Regionally Prohibited, Regionally Controlled or Restricted. In addition, as part of the National Weeds Strategy some weeds are also classified as *Weeds of National Significance* and require coordinated action across the country. Noxious weeds may negatively impact agricultural productivity and/or the natural environment. *Table 20* describes each of the noxious weed classifications and the associated land manager responsibilities. Land managers that fail to comply with the responsibilities outlined in the CaLP Act may be issued with a Directions Notice and/or a Land Management Notice by the DEPI, outlining the measures that must be undertaken for the control or eradication of the noxious weed species on their land. If works aren't carried out, the land manager maybe liable for prosecution and severe fines, and/or DEPI may enter the property and carry out the works at the owner's expense.

Environmental weeds

In addition to the noxious weed classification system, weeds can also be identified as **environmental weeds**. Environmental weeds are plant species that predominately invade natural areas and compete with, or choke out, native plant communities. They cause damage to native plant communities by competing with naturally occurring vegetation for moisture, nutrients and light. Native animal populations can also be affected by the change in vegetation due to replacement of their natural food source and habitat with exotic species. Weed species also tend to provide harbour for pest animal species and some can be poisonous to livestock and other animals.

Some environmental weeds may have been introduced accidentally, for example, as a contaminant of imported grain or fodder, however most have been introduced as a garden or decorative plant and then have 'escaped' into the environment. The most common methods of spread are from dumped garden waste containing bulbs, seed or root pieces, deliberate planting in inappropriate areas and from birds or animals spreading seed. Some common environmental weeds include Cootamundra Wattle *(Acacia baileyana)* and Gazania *(Gazania linearis)*. Land managers can help reduce the impacts of environmental weeds by controlling these weeds on their land and preventing their spread to other areas.

Weed identification

The first step in successful weed management and control relies on early detection and accurate identification. Routine property inspections are important in identifying new weed outbreaks, preventing weed spread and monitoring weed control strategies. Inspections should occur throughout the year, as different weed species have different lifecycles and may be more noticeable at certain times of the year. For example, annual winter weeds typically germinate after the first autumn rain (the 'break').

Once an unusual plant or unknown weed is detected, land managers should identify the species as soon as possible to determine whether it is a weed and apply appropriate control measures. A number of measures can be used to identify the weed species, including:

Table 20: Legislative requirements of weed management in Victoria.

Noxious weed classification	Description	Example
State Prohibited Weeds	Do not occur in Victoria, or it is reasonably expected that they can be eradicated from the state. DEPI is responsible for the management of these species where ever they occur throughout Victoria, whether it is on public or private land. Reporting these species to DEPI will ensure that treatment and removal are carried out in a safe and timely manner. If you suspect a State Prohibited Weed is on your property please contact DEPI immediately on 136 186.	• Hawkweeds • Horsetails • Knotweed • Parthenium Weed
Regionally Prohibited Weeds	Are not widely distributed across north central Victoria but are capable of spreading further. It is reasonable to expect that these weeds can be eradicated from north central Victoria. Control is the responsibility of both public and private land managers on their land and VIC Roads on Declared Roads under the Victorian Transport Act 1983.	• Boneseed • Scotch Thistle • Soldier Thistle
Regionally Controlled Weeds	Exist in north central Victoria and are usually widespread. Continued control measures are required to prevent further spread to clean land. Control is the responsibility of both public and private land managers on their land and VIC Roads on Declared Roads under the Victorian Transport Act 1983.	• Silverleaf Nightshade • St John's Wort • Cape Tulip
Restricted Weeds	Seriously threaten primary production, Crown Land, the environment or community health in another state or territory and have the potential to spread into and within Victoria. If sold or traded in Victoria there would be an unacceptable risk of it spreading within Victoria and to other states and territories. There is no requirement for land managers to control restricted weeds on their property. However, they cannot be traded or transported within Victoria.	• Spear Thistle • Chilean Needle Grass • Black Willow
Weeds of National Significance (WONS)	As part of the National Weeds Strategy, 32 WONS have been identified, which require coordinated action across all states and territories to reduce their impact on Australia's productive capacity and natural ecosystems. The weeds are determined according to their: invasiveness, impact, potential to spread and socioeconomic and environmental values. Control is the responsibility of land managers as per the Victorian categories of noxious weeds described above.	• Parthenium Weed • Silverleaf Nightshade • Black Willow

- Submit specimens for identification to a weeds officer or agronomist at the local rural merchandise store, government department or botanical gardens herbarium
- Use a weed identification guide or website to narrow down species options before checking with a professional weeds officer or agronomist
- Seek advice from a neighbour, farmer or Landcare member.

Identification is easier if the plant has a flower, seed head or fruiting body.

Collecting weed specimens

If collecting a weed specimen for identification, the plant should be stored in a sealed plastic bag in the fridge or a cool, dark place where it will remain fresh for one to two days. If the time between collection and identification is going to be longer then this the specimen should be preserved. Guidelines for collecting and preserving weed specimens include:

1. Take a photograph of the weed before collection.

2. Choose a healthy specimen and keep it in a cool, dark place until it is pressed.

3. Collect as many plant parts as possible (e.g. flowers, fruit, roots and leaves in position).

4. Ensure the specimen is clean and free of dirt and insects.

5. Preserve the specimen as soon as possible by:

- Labelling the specimen with field and location notes (e.g. plant habit, number of plants)
- Placing the specimen between sheets of newspaper
- Pressing the specimen between flat boards of masonite, plywood or similar
- Weighing the specimen with bricks, books, straps or ties.

6. Change the paper every couple of days for a week, especially for moist, fleshy or bulky specimens. Most samples will be dry enough after a fortnight of pressing.

Some weeds change dramatically as they mature so collecting specimens or photos at different growth stages can help with identification.

Weed management

There are various means of managing and controlling weeds, ranging from hand weeding to chemical treatment to biological control. Successful weed management typically involves a management plan, integrating a number of control techniques and persistence over many years. The management plan identifies the characteristics and weaknesses of the weed and matches the problem with a range of control techniques. The management plan also considers whether **revegetation**, pasture **regeneration** or crop establishment is necessary, once the weed has been removed, to prevent re-infestations, increase farm productivity and/or improve the quality of native vegetation. Regular monitoring and follow up management is required to prevent weed re-growth and control new germinations and infestations. For example, a Capeweed (*Arctotheca calendula*) plant growing under favourable conditions can produce up to 4,330 seeds, while Wild Radish (*Raphanus raphanistrum*) seeds can survive in the soil from six to more than ten years. Best results are often seen where neighbours or communities work cooperatively to control weed species over a broad area.

Gorse control an example of integrated weed management

Gorse (*Ulex europaeus*) is an erect shrub to four metres tall that was introduced as a garden hedge and is highly invasive. Integrated weed management is critical to successful weed control:

Year 1 – Manually 'cut and paint' large isolated bushes. Cut and paint is just that: cut the large bush down and paint the stump – particularly the green growing layer under the bark – with herbicide. Engage a contractor to 'groom' (cut and mulch) large clumps, and spray small isolated bushes with selective herbicide.

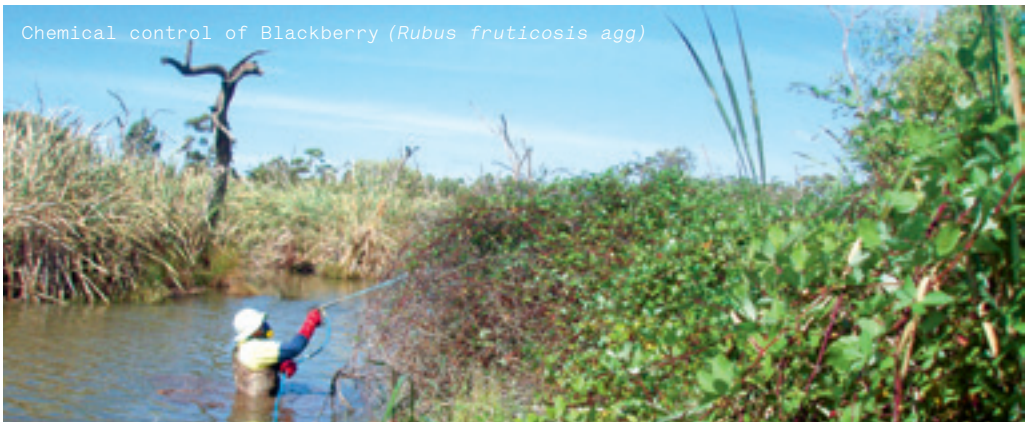
Year 2 – Spray the groomed areas and any gorse regrowth from last year's spraying or cut and paint work.

Year 3 – Burn all the treated areas to germinate the seed bed and following the burn, spray all the seedlings with a selective herbicide.

Year 4 – Spot spray any regrowth. If the area is a steep slope or waterway, fence and revegetate to provide shade and competition.

Year 5 and beyond – Continue to spot spray any regrowth gorse as it appears, and never allow any gorse to set seed.

This example of integrated weed control uses five control methods to address one weed species: cut and paint, grooming, chemical control, competition and fire. Any investment in weed control must be matched with follow-up works, or the original investment may be wasted. In many situations weeds cannot be eradicated and instead can only be kept at low levels. This requires weed control to be part of an annual maintenance program.


Chemical control of Blackberry *(Rubus fruticosis agg)*

Environmental management

Environmental management aims to alter the conditions required by a particular weed. It includes the use of fire, moisture and nutrient control, over-planting and/or grazing management to reduce the competiveness and survival of the weed.

Fire

Fire is a complex weed control method and requires detailed planning, such as installing fire breaks, and organising personnel and equipment. It should only be used by those with the necessary experience and the necessary permits and approvals must be obtained. Some weeds are fire-sensitive and when used carefully fire can destroy mature weeds, exhaust seed banks and stimulate the growth of indigenous plant species. Fire can also be used to open up larger areas infested with woody weeds or to spot-burn smaller invasive weeds. The use of fire must be closely considered, as in some cases weeds may benefit from fire (e.g. stimulate weed seed germination) or it may cause other problems such as soil erosion.

Moisture and nutrient control

Some weeds require specific moisture and/or nutrient levels and by altering these levels, through mulching, soil amendments or changes to soil water levels, weed populations can be reduced. Overlaying weeds with mulch reduces light levels, which can prevent weed germination and growth. It can also preserve soil moisture and improve the organic matter in the soil. A range of mulches can be used including wood chips, straw, newspaper and plastic. Although care should be taken to ensure mulches are free of weed seeds before application. Furthermore, don't mulch where there are indigenous ground storey plants, as it smothers them and prevents germination. Another weed control technique involves altering soil properties (soil acidity, drainage or fertility) to manipulate plant populations and growing conditions. For example, improving drainage can eliminate plants such as Dock *(Rumex species)* that prefer waterlogging.

Over-planting

Over-planting weeds with native species or agricultural crops and pastures can reduce weed populations through competition for light, nutrients and moisture. Often weeds are more of a problem in areas that have been disturbed by grazing or earthworks and re-establishing desirable plant species can improve farm productivity and/or environmental conditions whilst out-competing weeds. When re-establishing pasture species, ensure rotational grazing regimes are employed so that desirable pasture species have ample recovery time.

Chemical control

Chemicals designed to control weeds are called herbicides. When used correctly, they are a highly effective weed control strategy. They control weeds either by speeding up, stopping or changing the plant's normal growth patterns by defoliating the plant or drying out its leaves or stems. Herbicides can be specific, meaning they target a particular type of plant, or non-specific, meaning they have the potential to kill any type of plant. Land managers should take great care when using herbicides as incorrect use can cause a number of problems, such as damage to non-target species, spray drift, soil residuals and health risks involved in their handling and storage.

Patterson's Curse (*Echium plantagineum*).
© Stephan Ridgway

Herbicide selection

Each particular herbicide has its own mode of action and associated safety procedures. Instructions are clearly spelt out on the label. They should explain the chemical's application rates and methods, withholding period, the time it takes to break down, and its suitability for use in certain soil types or near water, horticultural crops and native vegetation. **Land managers must read and follow the herbicide label**. For clarification on any points contact the chemical company, refer to the material safety data sheet or contact the retailer from which you bought the herbicide. Legally, some herbicides can only be handled by the holder of an Agricultural Chemical Users Permit (ACUP) or someone under the direct supervision of an ACUP holder. Accurate written records of the use of these chemicals according to the regulations must be kept for at least two years. To qualify for an ACUP you must complete a Farm Chemical Users Course or a recognised equivalent. The ACUP is valid for ten years.

For optimal weed control, it is important to choose the right herbicide, the right rate and the right application method. Always apply the recommended application rate, as slight variations can significantly impact results. There is a broad range of application methods available, including:

- Spot spraying with a backpack or handheld spray applicator
- Broad-scale foliar application using a vehicle mounted boom sprayer
- Cutting woody weeds at ground level and painting the stem with herbicide
- Soaking a wick or rope in herbicide from a reservoir and then wiping or brushing the wetted wick over the weed
- Injecting the stem with herbicide.

Herbicide application

Before applying herbicides, land managers need to consider the risks associated with the application and take steps to prevent spray drift, off-target damage and unacceptable residues in produce. Land managers should consider a number of factors when planning herbicide applications, including: equipment set up, weather conditions and legal obligations. Appropriate equipment (such as nozzles) must be used to ensure the correct application rates and droplet sizes are used, equipment must also be regularly calibrated to maintain accuracy. Weather conditions should be observed and monitored before and during herbicide applications. As a general rule, ideal spraying conditions include:

- A steady wind of 3–15 km per hour blowing away from sensitive areas
- No surface temperature **inversion layer** present
- A Delta T reading between 2 and 8°C, and not greater than 10°C. Delta T is an indicator of evaporation and droplet lifetime.

This information can be found on sites such as the Bureau of Meteorology or land managers can purchase a portable, pocket-sized Kestrel weather meter, which gives you real-time weather readings. There is also a range of mobile phone applications available that land managers can use to identify the ideal tank mixing order and record data on the products sprayed, location and weather conditions.

Land managers should be aware of Agricultural Chemical Control Areas (ACCAs) across Victoria, which are established to protect sensitive crops such as grapes. Legislation restricts the use of certain chemicals in these areas either by type or application method. To find out more about ACCAs contact DEPI. It is also a good idea to talk to your neighbours about your intentions to spray, especially if you are planning to spray near a sensitive crop, such as grapes or annual grain crops.

Land managers should also be mindful of herbicide resistance when planning weed control techniques, as over-reliance on herbicide control can lead to resistant weed populations. Herbicide resistance is the inherited ability of a plant to survive and reproduce following exposure to a dose of herbicide normally lethal to the wild type. Herbicide resistance can be prevented by employing integrated weed management plans that use a range of different weed control strategies, for example, mechanical, chemical and environmental management.

Agronomists and/or weed control contractors can be engaged by land managers to plan weed management strategies and ensure the right herbicide, rate and method of application is used. They will have the knowledge, qualifications, equipment and experience required for your area. If employing a contractor, land managers should check that

the contractor has followed hygienic weed practices and is not accidentally introducing more weeds to the property from their vehicle or equipment.

Mechanical control

Mechanical weed control refers to physical activities that inhibit weed growth by removing or damaging the weed. It includes hand weeding, slashing, mowing, grooming, felling and cultivation. Mechanical weed control often involves the use of machinery or powered tools so machinery hygiene is critical to prevent the spread of weed seeds or plant parts between sites or properties.

Physical removal

The simplest form of weed control for small or scattered weed infestations involves physical removal by hand or using machinery, such as a tractor and chain, bobcat or excavator. It is important to remove the entire plant, including its roots, before it sets seed otherwise the plant may re-shoot from its roots or seeds left in the ground. Plants should be disposed of carefully by either burning or composting to prevent re-infestations. It is illegal to transport noxious weeds off the land manager's property. Before undertaking physical weed removal, land managers should check for the presence of hazards such as underground cables and minimise any problems that may arise such as soil erosion and disturbance of native vegetation, cultural heritage sites or waterways.

Slashing and mowing

Slashing or mowing using a whipper snipper, lawnmower or tractor is another type of mechanical weed control, which keeps weeds under control by limiting their growth and preventing fruits or seeds from developing. Timing is important when employing this strategy, as slashing must occur before the weeds have dropped their seeds.

Grooming and mulching

Grooming or mulching is a similar method used for larger, woody weeds whereby the plants are cut off at ground level and processed to a fine mulch using a tractor or excavator-mounted mulcher, hammer mill or groomer. The mulch can then be used to suppress the germination of seedlings, although follow up weed control is usually necessary.

Cultivation

Cultivation is another popular form of mechanical weed control whereby plants, typically seedlings and regrowth, are destroyed by disc ploughs, harrows or deep rippers turning the soil to a depth of at least 15 centimetres. Cultivation must occur before the plant sets seed and as part of an integrated weed management strategy using other weed control techniques. It is not a suitable control method for weeds that spread vegetatively as small plant parts can re-shoot. Care should also be taken to ensure cultivation doesn't cause soil erosion, degrade soil structure or disturb native vegetation, cultural heritage sites or waterways.

Biological control

Biological weed control uses another living species, usually other plants, insects, fungi or pathogens (diseases), to inhibit the growth of the weed species. It can be a lengthy process that doesn't eradicate the weed but reduces its population and spread. For example, Bridal Creeper Leafhopper can be used to biologically control Bridal Creeper, *Myrsiphyllum asparagoides*. For best results biological weed control should be used as part of an integrated weed management program involving other weed control strategies. It is useful in situations where land managers want to avoid chemical or physical control and in 'hard to access' locations.

Resources and further information

Apple and Pear Australia Limited: www.apal.org.au

Australian Agroforestry: www.agroforestry.net.au

Australian Blueberry Grower's Association: www.abga.com.au

Australian Herbicide Resistance Initiative: www.ahri.uwa.edu.au

Australian Table Grape Association: www.australiangrapes.com.au

Australian Pesticides and Veterinary Medicines Authority: www.apvma.gov.au

Australian Processing Tomato Research Council: www.aptrc.asn.au

Australian Society of Agronomy: www.regional.org.au/au/asa

Australian Wine Research Institute: www.awri.com.au

Badgery, W and Millar, G (2009) Primefact 875: Pasture Cropping. New South Wales Department of Primary Industries, Orange. Available for download at: www.dpi.nsw.gov.au/primefacts

Birchip Cropping Group: www.bcg.org.au

Bureau of Meteorology – Water and the Land: www.bom.gov.au/watl

Cross, R and Spencer, R (2008) Sustainable Gardens. CSIRO, Collingwood, Victoria.

Department of Agriculture: www.daff.gov.au

Department of Environment and Primary Industries (2012) Domestic firewood collection on public land. Department of Environment and Primary Industries, Melbourne. Available for download at: http://www.depi.vic.gov.au/forestry-and-land-use/forest-management/firewood.

Department of Environment and Primary Industries (2013) Establishing a successful small horticulture enterprise. Available for download at: www.dpi.vic.gov.au/agriculture/horticulture/horticulture-and-business.

Department of Environment and Primary Industries 'Horticulture' webpage: www.depi.vic.gov.au/agriculture-and-food/horticulture.

Dried Fruits Australia: www.driedfuritsaustralia.org.au

EverGraze – more livestock from perennials: www.evergraze.com.au

Flowers Victoria – A division of Victorian Farmers Federation: www.flowersvic.com.au

Fruit Growers Victoria: www.fgv.com.au

Future Farm Industries Cooperative Research Centre (2011) Perennial forage shrubs providing profitable and sustainable grazing: key practical findings from the Enrich project. Future Farm Industries CRC, South Australia. Available for download at: www.futurefarmonline.com.au/LiteratureRetrieve.aspx?ID=88398.

Future Farm Industries Cooperative Research Centre (CRC): www.futurefarmonline.com.au/index.htm

Gecko Clan Pasture Cropping project: http://goulburnbroken.landcarevic.net.au/mgbclan

Grains Research and Development Corporation: www.grdc.com.au

Horticulture Australia Limited: www.horticulture.com.au

Horticulture Industry Network: www.hin.com.au

McGillion, T and Storrie, A (eds) (2006) Integrated weed management in Australian cropping systems – A training resource for farm advisors. CRC for Australian Weed Management, Adelaide, South Australia.

Murray Valley Citrus Board: www.mvcitrus.org.au

Murray Valley Winegrowers: www.mvwi.com.au

National Herbarium of Victoria: www.rbg.vic.gov.au

National Horticultural Research Network: www.hin.com.au

New South Wales Agriculture (2003) The Grazier's Guide to Pastures. New South Wales Agriculture, Orange.

New South Wales Department of Primary Industries: www.dpi.nsw.gov.au

North Central Catchment Management Authority (2012) Weeds Identification Guide – North Central Victoria. North Central CMA, Huntly, Victoria.

Northern United Forestry Group: http://nufg.org.au

Nursery and Garden Industry Victoria: www.ngiv.com.au

Otway Agroforestry Network: http://www.oan.org.au/

Pasture Cropping and No Kill Cropping: www.pasturecropping.com

Raspberries and Blackberries Australia Inc: www.arga.com.au

Sindel, B and Coleman, M (2010) Weed Detection and Control on Small Farms – A Guide for Owners. University of New England, Armidale, New South Wales.

Summerfruit Australia Ltd: www.summerfruit.com.au

Sustainable Gardening Australia: www.sgaonline.org.au

Victorian Cherry Association Inc: www.cherries.org.au

Victorian Department of Environment and Primary Industries: www.depi.vic.gov.au

Victorian Department of Primary Industries (2011) Native Pasture Management. Department of Primary Industries, Hamilton. Available for download at: www.evergraze.com.au/_literature_100957/DPI_Native_pasture

Vegetable Growers Association: www.vgavic.org.au

Victorian No-Till Farmers Association: http://vicnotill.com.au/

Victorian Resources Online: www.dpi.vic.gov.au/vro

Victorian Strawberry Industry: www.vicstrawberry.com.au

Weeds Australia: www.weeds.org.au

Yield Prophet – online decision support tool that provides grain growers with real time information about their crops: www.yieldprophet.com.au

ANIMALS

“Animal health and welfare is extremely important. It is essential that land managers provide livestock and pets with the appropriate care, food, water, shelter and management (e.g. exercise).”

Chapter 6
Animals

Livestock

Livestock play an important role in commercial farm businesses and lifestyle properties. They produce a range of products including meat, wool, milk and eggs, and in grazing systems can be used to manage productive pastures. Livestock can also be grown for enjoyment or recreational purposes. With livestock ownership comes a number of responsibilities regarding animal health and welfare, failure to meet these responsibilities can lead to prosecution.

Animal health and welfare

Animal welfare

Animal health and welfare is extremely important. It is essential that land managers provide livestock with the appropriate care, food, water, shelter and management (e.g. exercise). There are a number of reasons for this including:

- Poor animal welfare impacts on animal production and reproduction
- Poor animal welfare can result in loss of market access
- Legislation requires livestock owners to care for the welfare of their animals
- Livestock are capable of feeling pain and having a desire for a pleasurable life
- Land managers that do not comply with animal health and welfare regulations risk severe penalties.

There are some basic guidelines to ensure the welfare of livestock:

1. Regular surveillance of livestock: check livestock health, feed, water and shelter access regularly. Regular surveillance enables rapid identification of changes in livestock welfare. For intensively housed livestock it is recommended that animals are inspected at least one to two times per day. For extensively housed livestock it is recommended that inspections occur at least once every one to two days.

Young horses

2. Ensure housing and husbandry practices are met: Codes of Practice are available for all livestock industries and peripheral industries, such as saleyards and transporting livestock. Land managers should ensure that they at least meet the minimum requirements set out in the relevant Codes of Practice.

3. Understand animal behaviour: research has shown that inappropriate handling of livestock can lead to a fear of humans and in turn, depending on the regularity of contact and handling, chronic stress responses. This can result in up to 20% decrease in livestock productivity, reproduction and product quality. Low stress livestock handling techniques should be employed when handling animals and designing livestock yards. For example, design handling facilities to minimise the risk of injury and to take advantage of natural livestock behaviour.

Auditing materials and standards have been developed between industry bodies and animal welfare research scientists. The advantage of using auditing materials to monitor the welfare of your livestock is that the auditing material provides you with step-by-step guidelines for monitoring, identifying and developing strategies to improve animal welfare. The goal of these programs is to maintain or improve productivity, reproduction and product quality. Many industries have developed or are developing animal welfare auditing materials for farms, transporters and abattoirs.

Livestock transport

The possibility of either injury or illness to livestock should be reduced to a minimum during road or rail transportation. The 'Code of Practice for the Welfare of Animals during Transportation' guides people who are involved in transporting livestock. It emphasises the responsibilities of the owner of the livestock (or his/her agent) and of the driver, attendant or the appropriate railway official. It is intended to encourage the efficient and considerate treatment of livestock so that transport, stress and injury are minimised at all stages of the transport operation. Transportation by road and rail requires careful planning to reduce any adverse effects on livestock.

To protect Victoria's livestock and livestock industries, there are controls on the introduction of livestock from other states and territories in Australia. These controls are governed by the *Livestock Disease Control Act 1994*. Prior to moving livestock into Victoria, owners must certify the health of their animals by completing prescribed certificates, vendor declarations and health statements and delivering these to the receiver of the livestock. These records must be kept for a specified period of time. Other states and territories also have requirements for transporting livestock. Visit the relevant state or territory's Department of Primary Industries or Agriculture website for information and requirements.

There is also a Code of Practice for the Welfare of Animals at Saleyards, which aims to minimise stress to all livestock by encouraging efficient and considerate treatment and handling. The code covers aspects of unloading, pre- and post-sale handling, the provision of feed, water, shelter and general care of livestock at saleyards.

National Livestock Identification Scheme

The National Livestock Identification System (NLIS) is Australia's system for identification and traceability of livestock. It was introduced in 1999 to meet European Union requirements for cattle exports. Since then it has expanded to enable cattle, sheep and goats to be traced from property of birth to slaughter with the purpose of protecting the reputation of Australia's livestock industry as a supplier of 'clean' meat and dairy products, thereby providing a competitive advantage in domestic and export markets. The NLIS requires an electronic identification ear tag to be applied at

Livestock transport

an early age and before the animal leaves the property. NLIS Ltd operates the central NLIS Database on which the livestock movements must be recorded. If a disease outbreak was to occur, the NLIS could be used to quickly isolate the disease.

Vendor Declarations

When a farmer is selling livestock, he or she must complete a National Vendor Declaration and Waybill (NVD/Waybill), which indicates that the producer is declaring compliance with Livestock Production Assurance, the industry's food safety program. The NVD/Waybill is the main document upholding Australia's meat and livestock food safety reputation. It enables important information regarding livestock history to be transferred through the supply chain to the end consumer so that they can be confident that the meat product is safe.

Animal health

Animal diseases can significantly impact animal health, welfare and productivity. Diseases can be caused by infections from bacteria, viruses or fungi, parasitic infestations, nutritional deficiencies, excesses or imbalances, or metabolic disorders.

Farmers should take a proactive approach to managing herd health by:

- Learning about the common animal diseases in their local area
- Aiming for prevention rather than cure
- Developing a disease management plan (include preventative treatments and strategies to reduce disease exposure)
- Improving animal nutrition to prevent nutritional diseases and boost immune systems

- Monitoring herd health and welfare regularly
- Quarantining sick or dead animals quickly to prevent or reduce disease spread
- Treating sick animals as quickly as possible
- Seeking veterinary advice for unexplained health problems.

Farmers have a duty of care to regularly review and update their property's animal health plan, incorporating the latest research results where appropriate.

The major infectious diseases of cattle, sheep and goats include: bovine respiratory disease (mostly feedlot cattle), calf scours, cheesy gland, clostridial diseases (e.g. pulpy kidney), footrot, Johne's disease, Leptospirosis, Ovine Brucellosis, Pestivirus, pinkeye, three day sickness, Trichomoniasis and Vibriosis. Many of these infectious diseases can be prevented by vaccines. Some infectious diseases are also classed as *notifiable diseases*, whereby the farmer must report any suspected or confirmed cases of an animal displaying symptoms of a notifiable disease to a veterinary or contact the Emergency Animal Disease Watch Hotline on 1800 675 888. Lists of notifiable diseases are available on the Department of Agriculture website.

The major nutritional diseases of cattle, sheep and goats include: bloat, grass tetany, Hypocalcaemia (milk fever), pregnancy toxaemia, grain poisoning (lactic acidosis) and mineral deficiencies (copper, selenium, cobalt and phosphorus). Many of these nutritional diseases can be prevented by assessing the risk levels in the local area, seeking information from veterinarians and animal nutritionists, following industry guidelines and understanding animal nutrition requirements and nutrient levels in pasture and feed stuffs.

Livestock marketing

Farmers must decide which market(s) they wish to target when planning their livestock enterprise, as different markets have specific requirements that must be met if the producer is to attract the best price. Australian meat is produced for both the domestic and export markets and specific market details for each industry are described in the sections below. There are a number of steps involved in the supply of meat products from the farm to consumers. *Figure 11* below shows the process of meat production from paddock to plate.

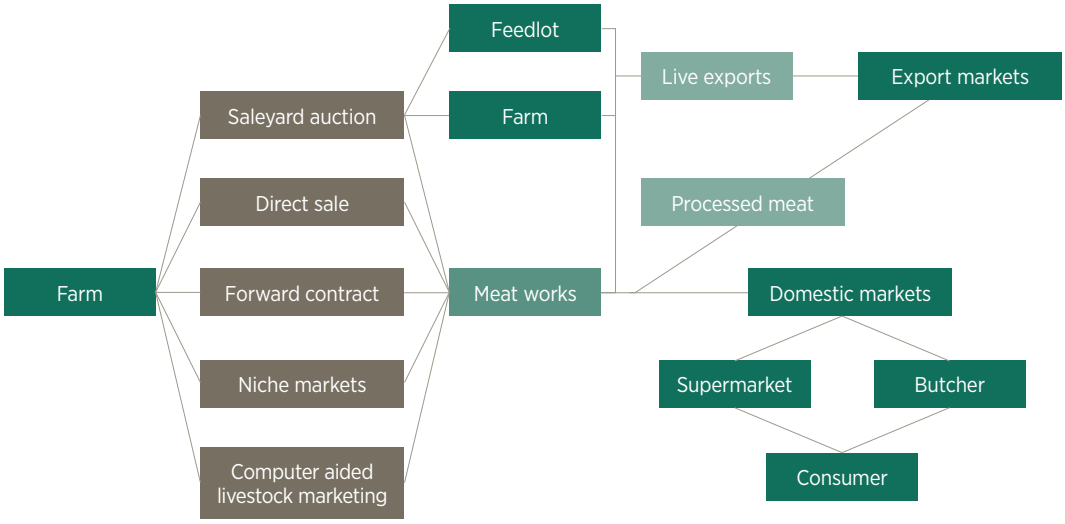


Figure 11: Meat production from paddock to plate.

Once the farmer has produced livestock of the right weight and quality for a specific market there are several different ways they can be sold:

1. Saleyard auction – the traditional way of livestock selling whereby the livestock are trucked to a central saleyard, where they are weighed and penned before being sold by auction to buyers. Livestock are sold at either a price per head or a liveweight price (cents per kilogram of animal weight at the saleyard).

2. Direct sale – the buyer purchases the livestock directly from the farmer at an agreed price, usually a price per head or cents per kilogram after processing / Hot Standard Carcase Weight ('over the hooks'). Price penalties do occur for livestock that don't meet market specifications, e.g. fat content. Livestock are transported directly to the meatworks, sent live to export markets or go to another farm or a feedlot.

3. Forward contract – the farmer agrees to supply livestock at an agreed weight and quality on a set date. The price is set at the time of signing the contract and payment is made as price per head or cents per kilogram after processing. Price penalties do occur for livestock that don't meet market specifications, e.g. fat content. Livestock are transported directly to the meatworks, sent live to the export markets or go to another farm or a feedlot.

4. Internet – livestock are traded online through **Auctions Plus Pty Ltd**. Buyers can view the descriptions of the mobs for sale and then bid in online auctions. The livestock remain on the farm until they are sold. People are trained to assess the livestock to provide accurate and consistent descriptions on the network. Wool can also be sold online through Auctions Plus Pty Ltd.

Livestock agents play an important role in the sale of livestock by bringing the buyer and seller together to get the best possible price for the livestock. They are skilled at judging livestock quality and often help the farmer select which livestock should be sold to different markets.

Beef cattle

North central Victoria is home to 311,590 head of cattle (as of June 2011), which is approximately eight per cent of Victoria's cattle population and one per cent of the national cattle population. Beef cattle production is usually part of a mixed farming operation in north central Victoria, supplying both domestic and export markets. The majority of cattle graze native and improved pastures, converting grass to weight and subsequently beef. Supplementary feeding of hay, grain or silage maybe required when pasture growth is low in order to maintain animal growth. A small percentage of cattle are finished on grain and forage rations in feedlots, which are designed to supply meat of a consistent quality all year round. The main objective of beef cattle production is to produce as much lean meat as possible in the time available. Farmers can sell their cattle at different ages, targeting different markets, which include: vealer market (calves sold off the mother at nine months of age), yearling market (12 months), feedlot market (18 months) or the grass-fed market.

Competitive international markets, increasing demand for beef and rising input costs are increasing the pressure on farmers to improve the productivity of beef cattle enterprises. Productivity can be increased through improvements to pasture productivity, increased use of genomics to better select and utilise good breeding animals earlier and the adoption of animal feed intake indicators that allow farmers to select animals that are very efficient at converting grass to weight. For example, improving pasture growth and quality through the adoption of rotational grazing will in turn increase stocking and/or animal growth rates.

Herd management

The timing of operations strongly influences the productivity of pasture-based beef cattle enterprises, as animal growth and weight gain depends on the seasonal pattern of rainfall and pasture growth. The time of calving is the most critical element with all other activities based around this. Cows have a nine-month gestation period, which means they need to be mated in summer for a spring calving or in winter for an autumn calving. Feed supply at calving is essential in meeting the requirements of the lactating cow, as the early growth rate of the calf is determined by the amount and quality of the milk produced by the cow. Feed supply is also critical as the calf begins to eat grass and is

Hereford calf

eventually weaned, as this also impacts growth rates. In higher rainfall zones, calving in autumn (provided adequate winter feed is available) can result in higher weaning weights, as calves are feeding on the spring feed supply rather than the summer and autumn feed. Other herd management techniques such as stocking rates, rotational grazing and pasture agronomy also strongly influence productivity. Refer to *Chapter 5* for more information on pasture improvement.

Breeding and genetics

Selecting the right breed and genetics can have a major impact on farm productivity and profitability. There are over 40 different cattle breeds in Australia, which fall into two broad categories: *Bos indicus* and *Bos taurus*. The *Bos indicus* breeds originated in the tropical climates of Africa, Asia and southern Europe and are distinguished by the presence of a hump and a pendulous dewlap (fold of skin hanging from the neck). They are most suited to the hot temperatures of northern Australia and include breeds such as Brahman and Santa Gertrudis. The *Bos taurus* breeds originated in the cooler temperate climates of Europe (in particular Britain) and are humpless. They make up the majority of the cattle herd in southern Australia and can be further broken down into British and European breeds.

British breeds are generally earlier maturing allowing them to fatten on less feed, they also have high fertility, good eating quality and make excellent mothers. British breeds include Angus, Hereford and Shorthorn. European breeds are generally later maturing and produce more muscle then British breeds, with some European breeds also displaying strong maternal traits. European breeds include Charolais, Limousin and Simmental. Many producers cross European bulls over British breed cows to produce high yielding, fast growing crossbred calves. Crossbreeding allows producers to match the good points of two or more breeds, for example, maternal crossbred cows of small to medium size and optimum milk production are crossed with a terminal sire, which has fast growth rates and high quality carcases. *Table 21* on Page 101 describes some of the characteristics of the main *Bos taurus* breeds in southern Australia.

Once the breed or breeds of cattle have been selected, the farmer must source the right genetics when purchasing new cattle or selecting calves to retain as breeding stock. Genetics can be assessed using visual appraisals and Estimated Breeding Values (EBVs). EBVs calculate a genetic description of an animal across a number of traits by considering the animal's own performance, the

Table 21: Characteristics of some of the main beef cattle breeds.

Cattle Breed	Breed Group	Features	Market Suitability
Angus	• Bos taurus • (British)	• Black or red coat • Polled	• Vealer, steer and bullock production • Maternal/rotational place in crossbreeding programs.
Brahman	• Bos indicus	• Light to dark grey, red or black coat • Horned or polled	• Feeder steer production and live export market • Maternal /rotational place in crossbreeding
Charolais	• Bos taurus • (European)	• White or cream coat • Polled or horned	• Suited to bullock production. • Terminal sire in crossbreeding programs
Hereford	• Bos taurus • (British)	• Red coat with white face and underline • Polled or horned	• Vealer, steer and bullock production • Maternal/rotational place in crossbreeding programs
Limousin	• Bos taurus • (European)	• Rich gold coat and new genetics display a black coat. • Horned or polled	• Vealer and steer production • Maternal/rotational/ terminal place in crossbreeding programs.
Murray Grey	• Bos taurus • (British)	• Dun grey coat • Polled	• Vealer, steer and bullock production • Maternal/rotational place in crossbreeding programs
Santa Gertrudis	• Bos indicus	• Red coat • Polled or horned	• Steer or bullock production • Maternal/rotational/ terminal place in crossbreeding.
Shorthorn	• Bos taurus • (British)	• Red, roan or white coat • Polled or horned	• Vealer, steer and bullock production • Maternal/rotational place in crossbreeding programs
Simmental	• Bos taurus • (European)	• Red coat with broken white markings and white face • Polled or horned	• Suited to vealer, steer and bullock production. • Maternal/rotational/ terminal place in crossbreeding programs.

performance of known relatives, the heritability of each trait and the relationship between the different traits. They are expressed in the units of measurement for the particular trait (e.g. kg) and are shown as plus or negative differences between the individual animal's genetics and the genetic base to which it is being compared. For example, a bull with an EBV of +40 kg for 200-Day Weight is estimated to have genetic merit 40 kg above the breed base of 0 kg. Thus particular animals can be viewed as above or below breed average. BREEDPLAN is the Australian and international scheme that evaluates and records beef cattle performance to produce EBVs.

Dairy

The Victorian dairy industry is one of Australia's modern agricultural success stories, as it has doubled milk production per cow over the past 20 years and now produces around two-thirds of the nation's total dairy production. In 2011, Victoria had around 4,556 dairy farms and more than one million dairy cows producing 6.2 billion litres of milk. Farm numbers have declined over time, while herd sizes have more than doubled in an effort to improve the efficiency and profitability of dairy farms. Dairy farms are located in the south west, Gippsland, northern irrigation and the north east regions of Victoria. In north central Victoria the majority of dairy farms are located in the Torrumbarry, Loddon Valley and Rochester-Campaspe irrigation areas in the northern part of the region. A major advantage of irrigated dairy farms is their relatively secure water supply, which gives them a high degree of control over the amount of pasture and forage produced on farm. This is particularly beneficial during summer and autumn when pasture growth in rain-fed systems is low.

Dairy farms produce a variety of high-quality products including: fresh milks, custards, yogurts, cheese, creams and ice cream. They are also manufactured into longer shelf life products, such as cheese, milk powder and specialised milk products. Around 60% of dairy products are sold domestically, while the remainder are exported overseas to mostly Asian markets. Due to the large proportion of Australian dairy products exported the Australian milk price is closely linked to world dairy product prices and exchange rates. International demand for Australian dairy products is expected to increase in coming years, especially in south-east Asia, the Middle East, China and Africa.

Similar to other livestock industries, dairy production is essentially the conversion of pasture to milk. Consequently, farmers must aim to maximise pasture production and utilisation, in order to increase stocking rates and milk production levels. Supplementary feeding of hay, grain or silage maybe required to maintain milk production. Strategic supplementation programs or diets also provide important nutrients in concentrated form to balance the nutritional needs of the cow at different stages of the lactation cycle. A stable and consistent diet is also important to maintain the quality of milk production, such as the fat and protein levels. Farmers are paid for the milk based on a range of incentive and penalty payments relating to milk quality, productivity and out of season supply. This varies depending on which processor the milk is being sold to. Price is generally based on a cents per litre (cents/litre), or a dollars per kilogram of milk solids ($/kg milk solids).

Dairy cows ready for milking

Holstein Friesian dairy cows

Table 22: Characteristics of the main dairy cattle breeds.

Dairy Cattle Breed	Features
Aussie Red	• Developed in Australia. • Medium sized, mainly red colour with white markings. • Hardy breed. • High protein content and medium milk fat content.
Ayrshire	• Originated in Scotland. • Light to deep cherry red, mahogany, brown or a combination of these colours with white. • Alert, vigorous animal with mild temperament.
Brown Swiss	• Originate from Switzerland. • Solid brown colour varying from very light to dark. • Strong feet and legs. • Quiet temperament. • Milk ideal for cheese production.
Dairy Shorthorn	• Originated in Great Britain. • Dual purpose meat and milk breed. • Big, strong framed cattle. • Red, white, red and white, or roan coat colour. • Hardy constitution, calve easily and great longevity. • Quiet temperament and adaptable to all climates.
Guernsey	• Originate from the Isle of Guernsey in the English Channel. • Intermediate size, shade of fawn with white markings. • Milk is a distinctive golden colour, high in butterfat and protein. • Typically produce 22 litres per day. • Excellent temperament. • Calve with ease.
Holstein Friesian	• Originate from the Netherlands. • Large frame, mainly black and white, with sharply defined colours rather than blended. • Most popular dairy cow in the world. • Produce large quantities of milk.
Illawarra	• Developed in Australia. • Produce large quantities of milk, more than 40 litres per day. • Moderate fat and high protein milk yield. • Adapted to a wide range of climatic conditions. • Calve with ease.

Other important aspects of dairy production include: breeding for improved production and efficient use of fertilisers. It is expected that the industry will continue to consolidate in coming years, with herd sizes increasing as farmers strive for improved economies of scale.

Herd management

Dairy cattle typically graze pastures between milkings, which generally occur in the early morning (5 am) and mid-afternoon (2 pm). Traditionally, dairy cows produce a calf every year and are then milked for approximately 300 days before they are dried off for the two months leading up to calving. Calf production plays an important role in dairy herds, as it stimulates milk production and allows the farmer to breed replacements, which can enter the herd at a later date. The calf rearing season is an intensive period and requires attention to hygiene and diet to raise healthy female replacements that are ready to join at the optimal age. In north central Victoria dairy farmers aim to calve in August and September so that production is maximised when pasture quality and quantity is high. Dairy farmers are trialling a number of innovative practices to increase production and profitability, including extended lactations, automatic milking systems and increased milking frequency.

Breeding and genetics

The dairy industry is heavily focussed on genetic improvement in order to improve animal performance and the value of milk production. Breeding decisions have a permanent and compounding effect on a dairy herd, and making those decisions can be complex. As a result the vast majority of dairy farmers use artificial insemination and Australian Breeding Values (similar to EBVs used in the beef cattle industry described earlier) to carefully select genetic traits for breeding and to improve their herd. The Australian Dairy Herd Improvement Scheme provides data that farmers can use to select superior animals to breed their herd's next generation. Improved animal genetics has provided 30% of dairy farm productivity gains since 1989.

The dominant breed of dairy cow in Australia is the Holstein Friesian, accounting for some 70% of all dairy cattle in Australia. Jersey's are the second most popular breed in Australia and their milk is ideal for butter production. Other breeds include the Aussie Red, Illawarra, Brown Swiss, Guernsey and Ayrshire. The majority of dairy herds in northern Victoria are solely or predominantly Holstein Friesian, with some farmers maintaining pure Jersey herds. Refer to *Table 22* for a description of the major dairy cattle breeds features.

Sheep

North central Victoria is home to 2,795,931 sheep (as of June 2011), which is approximately 18% of Victoria's sheep population and almost four per cent of the national sheep herd. It is the second largest sheep producing region in Victoria, behind the Glenelg Hopkins CMA region. Sheep are grown for meat and wool production and are usually part of a mixed farming operation in north central Victoria. The majority of sheep graze native and improved pastures and may be supplementary fed if pasture growth is low. Feeding lambs in an intensive finishing system, such as a feedlot, has increased in recent years as a result of strong lamb export markets. Both large, permanent feedlots and small, on-farm opportunity feedlots exist, with the latter more common during drought conditions.

Farmers in north central Victoria usually produce sheep for the prime lamb, sheep meat and/or wool markets. There are three main types of sheep enterprises:

1. Prime lamb or sheep meat producers who specialise in producing lambs for meat. The wool and mutton is the secondary form of income.

2. Wool growers who specialise in wool production where the meat is the secondary form of income.

3. Live export producers who raise lambs and sheep for export to other countries.

Sheep meat is classified by age, with younger animals attracting higher prices. Sheep meat classifications include:

- Milk fed lamb – 0 permanent incisor teeth and no eruption of permanent upper molar teeth
- Lamb – 0 permanent incisor teeth
- Hogget (two tooth) – 1-2 permanent incisor teeth
- Mutton – 4 permanent incisor teeth.

“ Selecting the right time to lamb is critical to optimising stocking rates and increasing productivity. ”

Ewe and lamb

Most of the lamb production is sold on the domestic market to supermarkets and butchers, with the remainder sold to export markets as fresh, frozen or chilled lamb. Key lamb export markets include: United States, South Africa, Europe, Mexico, the Middle East, Asian Countries and the Pacific nations. The meat from older sheep is usually exported to the Middle East, South Africa, North Asia and South East Asia as fresh, frozen or chilled mutton. In some cases, wool producing sheep that aren't used for breeding are sold at two to three years of age for the live export market.

Most of the wool produced in north central Victoria is exported in its greasy, unprocessed form to manufacturers in China, India or Italy. Specialist wool producers breed Merino sheep, which produce a much finer wool (15–24 microns) than other breeds. Fine wool attracts a higher price as it's suited to the manufacture of high quality fashion apparel. Wool from crossbred sheep, in prime lamb or sheep meat production systems, is a lot coarser and attracts a lower price, as it's more suited to interior applications such as carpet, blankets, upholstery and furnishings. There has been significant adjustment in the wool and the sheep meat industries over the past 20 years and the number of sheep farms has dropped by around 50% over that period. The decreasing farm and sheep numbers have largely been caused by low returns for wool, low profitability and seasonal conditions. Many farms that once concentrated on wool production have shifted towards sheep meat production, particularly prime lamb.

Herd management

The key to profitable prime lamb, sheep meat and/or wool production is lambing at the right time and optimising stocking rate. Selecting the right time to lamb is critical to optimising stocking rates and increasing productivity. The best lambing time balances your pasture growth pattern, supplementary feeding requirements and lamb growth rates. The ideal time varies for different enterprises but guidelines include:

- Self-replacing Merino flocks producing replacement stock and selling surplus lambs at 12 months or older should lamb three months before the end of the growing season.
- Merino or crossbred flocks producing lambs for sale between the ages of four and six months should lamb four months (light trade or store lambs) or five months (heavier lambs) before the end of the growing season.

Profitability is maximised by increasing the amount of wool or meat produced per hectare, whilst minimising feed and other input costs. Profit is not increased by simply producing the heaviest lambs or attracting the highest price.

In southern Australia only 20–40% of total pasture produced is consumed by livestock. Increasing pasture utilisation can have a huge impact on the profitability of sheep enterprises. Pasture utilisation can be increased by optimising stocking rates.

Selecting the optimal stocking rate needs to consider the economic, production and environmental risks and should aim to convert as much pasture to meat or wool whilst maintaining 70% groundcover and adequate litter (refer to *Chapter 5* for more information on pasture management). Critically, peak livestock feed demand periods should closely match peak pasture growth periods. This involves understanding average pasture growth throughout the year and timing lambing, stock numbers and livestock sales to optimise stocking rate and thus control livestock feed demand. A risk management plan should be developed to identify production risks (e.g. late autumn break, drought) and risk management options (e.g. purchase grain, apply fertiliser or sell stock).

Breeding and genetics

Selecting the right sheep breed(s) and genetics is crucial when planning a prime lamb, sheep meat or wool growing enterprise. Sheep breeds can be classified according to their endpoint: maternal breeds, dual purpose breeds and terminal (meat sire breeds), refer to *Table 23* on Page 107 for a description of the main sheep breeds grown in Australia. Wool breeds can be further classified by the length or type of wool produced. The majority of sheep grown in Australia are pure-bred Australian Merinos, which have been selected for their bright white and extremely soft fleece. Merinos can be classified into four distinct classes based on the type of wool produced: superfine, fine, medium and strong. The strong wool Merino breeds are not common in north central Victoria.

Table 23: Characteristics of some of the main sheep breeds grown in Australia.

Sheep Breed	Features
Border Leicester	• Developed in Britain. • Large-framed, polled, long-wooled sheep. • Distinctive Roman nose and bare points (no wool on head and legs). • Strong hybrid vigour, easy lambing, fast growth rates, and good carcase quality. • Wool used for carpet and heavyweight garment manufacture. • Used as a maternal sire to produce first cross ewes for prime lamb production.
Cheviot	• Developed in Britain. • Bare points (no wool on head and legs). • Hardy, good mothering abilities, easy lambing, high fertility and rapid maturity. • Wool used tweed and carpet industries. • Used as a maternal sire to produce first cross ewes and/or terminal sire to produce prime lambs.
Corriedale	• Developed in Australia and New Zealand. • Large-framed, polled with thick, stapled wool. • Long lifespan, high fertility, impressive mothering abilities and good carcase. • Wool 24.5 to 31.5 microns, ideal for hand spun items. • Dual purpose breed, primarily crossed with terminal sires to produce prime lambs.
Dorper	• Developed in South Africa. • Two breeds: Dorper (black head) and White Dorper (white head). • Hardy, fast growing and tolerate hot conditions. • Naturally shed their wool reducing management costs (e.g. shearing, flystrike treatments, etc). • Lean, meaty carcass suitable for prime lamb production, especially organic lamb.
Merino	• Originated from Spain. • Most popular sheep breed in Australia. • Medium-sized, polled or horned, with white faces and legs. • Fine, crimped, soft wool, typically less than 24 microns. • Primarily bred for wool, carcase tends to be smaller in size than sheep bred for meat production.
Poll Dorset	• Developed in Australia. • Long, lean square body, polled and pink skin. • High fertility, good mothering abilities and rapid growth. • Quality, lean carcase. • Clean, white and spongy wool of around 30 microns used in the manufacture of bed linen, furnishings and coats. • Used as a terminal sire to produce prime lambs.
Suffolk	• Developed in Britain. • Large-framed, polled and black head and legs. • High fertility, longevity, easy lambing and fast growing. • Quality, lean carcase. • Used as a terminal sire to produce prime lambs.
Wiltipoll	• Established in Australia using Wiltshire Horn stock. • Large-framed, polled and short white fleece that sheds annually. • Easy lambing, fertile and lean carcases. • Used as prime lamb mothers or as terminal sires.

Prime lamb producers typically use a second-cross breeding method in order to increase growth rates and improve meat quality. With this method, first cross ewes, which are a cross between a Merino and a British breed ram (such as a Border Leicester) are used to mother high quality prime lambs by crossing them to a terminal meat sire breed (usually another British breed, such as the Dorset). The second-cross prime lambs are all sold for consumption. There are numerous alternatives in the breeding system, for example, dual purpose, Merino-derived breeds such as the Polwarth, Corriedale and Comebacks can be used as prime lamb mothers instead of first cross ewes.

Another popular breeding system used in sheep meat enterprises in recent times is the use of shedding or cleanskin sheep breeds, which shed their wool naturally removing the need for shearing, crutching and mulesing. Breeds include Dorper, Wiltipoll, Damara and Wiltshire Horn. These sheep are bred specifically for lamb or mutton production for both domestic and export markets. The rams can also be crossed with Merino ewes in prime lamb production systems. Shedding sheep breeds are extremely popular on small properties as they don't require shearing, crutching or mulesing and can be grown on poor quality pasture not suitable for cattle.

Once the breed or breeds of sheep have been selected, the producer must source the right genetics when purchasing or selecting breeding stock. Genetics can be assessed using visual appraisals and Australian Sheep Breeding Values (ASBVs). ASBVs describe a sheep's breeding value across a number of traits, for example, fleece and body weight, and express the relative breeding value of sheep across different breeding flocks of that breed (or for terminal breeds across breeds). They are equivalent to Estimated Breeding Values (EBVs) used in the beef cattle industry. For example, a ram with a body weight ASBV of two will be two kilograms heavier than the average of that breed. Sheep Genetics is the national genetic information and evaluation service for the sheep meat and wool producers delivered as LAMBPLAN and MERINOSELECT.

"Shedding sheep breeds, such as Dorper, shed their wool naturally removing the need for shearing."

Sheep, Merin Merin Swamp

Piggery

Hens feeding

Intensive animal industries

Pigs

The pork industry is an intensive animal industry that is generally located close to grain producing areas, reliable water supplies and domestic markets. Victoria contributes just over 20% of the total Australian pork production of 344,266 tonnes. North central Victoria has the highest concentration of pigs in the state. Piggeries sell direct to wholesalers, abattoirs, smallgoods manufacturers and retailers. The most recent drivers of supply and demand for pork have been fluctuating world grain prices, changing sow herd sizes, herd productivity and the level of domestic consumption of fresh pork. Australia currently imports a significant amount of frozen pork legs from Canada and the USA, and frozen pork middles from Denmark which are then processed here. It is estimated that around 70–80% of ham and pork consumed in Australia is made from imported pork meat.

The profitability of pork production is largely determined by feed costs, reproduction rates, conversion of feed into meat and the rate of lean meat growth. Feed costs, particularly the price of grain, account for approximately 70% of pork production costs so any breeding or management strategies that improve the conversion of feed into meat and/or growth rates will increase profitability. Many piggeries use cross-breeding programs of Large White and Landrace pig breeds to reap the benefits of hybrid vigour. As pigs are raised intensively, housing, environment and disease control are extremely important. For example, an infection in one pig can have disastrous results, as diseases quickly spread throughout the piggery.

Poultry

Chicken meat production

Poultry farmers are normally either egg or chicken meat producers but not both, as these are very different operations and there are very strict regulations and standards specific to each operation. Victorian chicken meat production accounts for around 27% of Australia's total production. Most of the Victorian production is located around Melbourne (64%) with approximately seven per cent in north central Victoria. Australia's only fully integrated regional poultry processor, Hazeldene's, is located near Bendigo in north central Victoria.

Almost all chicken meat production is consumed domestically and the industry is entirely Australian-owned. Domestic consumption of chicken has increased significantly since 1960, as the competitive cost of chicken has improved and consumers recognise chicken meat as a consistent, healthy and versatile meat choice. A number of factors have contributed to the growth of the industry including improved bird nutrition, the adoption of superior genetics and more effective management practices, which have increased bird growth, performance and feed conversion. Chicken meat producers have also adopted a number of programs focusing on food safety, animal welfare, environmental sustainability and disease risk management.

The Australian chicken meat industry is characterised by vertical integration, whereby companies own or control most aspects of supply and production. Large chicken meat operations may include:

- Breeder farms – produce fertile eggs to produce the next generation of meat chickens (generally referred to as broilers).

- Hatcheries – incubate the fertile eggs until the chicks hatch.
- Broiler farms – grow day old broilers to maturity. There around 800 independent farmers in Australia who are contracted to grow broilers on behalf of processors, 200 of these are in Victoria.
- Processing plants – slaughter birds and prepare chicken meat products for sale, generally located near broiler farms to minimise transport distance and bird stress.
- Feed mills – produce animal feed to meet specific nutritional requirements.
- Laboratories – contribute to food safety and quality control and managing animal health risks
- Research and development – ensures ongoing improvement of industry practices.

In 2011, around 491 million chickens were processed in Australia and 131 million of these were processed in Victoria. In 2009–10, the gross value of Victoria's chicken meat industry was $487 million.

Chicken meat production occurs in a number of production systems – conventional sheds, free range and organic, giving consumers plenty of choice. Each system has different requirements and standards particularly in relation to stocking densities and the use of purpose-developed feed and antibiotics.

Egg production

Eggs are recognised as an excellent source of protein, easy to prepare and relatively inexpensive in relation to other protein sources like red meat. Until recently egg consumption was declining in Australia, due to concerns regarding egg cholesterol levels and links to heart disease. These concerns were not scientifically justified and subsequently egg consumption has increased and is now around 192 eggs per person, per year. In 2009-10, Victoria produced approximately 76 million dozen eggs from a flock of around 3.2 million birds. Most egg production in Victoria occurs around Melbourne, although north central Victoria has a relatively high density of layer farms compared to other regions, with the majority around Bendigo.

More than 80% of eggs are consumed domestically and are mostly sold through retail chains. The remaining eggs are processed and sold to the domestic food service sector or exported. Fluctuations in domestic egg demand have huge impacts on the profitability of egg producers, as there is a long lead time before chickens are able to produce eggs, which limits the ability of producers to respond to short-term changes in consumer demand.

Historically, eggs were marketed and production targets set by state-based statutory boards. The industry was deregulated in Victoria in the early 1990s and has resulted in the formation of private companies that grade, pack and market eggs from their own farms or from independent or contracted suppliers. There are now a few large egg producers and many small and medium-sized producers.

In the past decade or so, there has been more product differentiation of egg products according to different production methods creating opportunities for growers and more choice for consumers. Egg production systems include:

- Intensive caged systems – accounted for 63.5% of supermarket sales in 2010, hens are housed in controlled environment sheds in wire cages that satisfy the minimum standards for animal welfare. This system is very efficient with modern systems incorporating automated feeding, manure removal and egg collection.
- Barn laid systems – accounted for 7.6% of supermarket sales in 2010, hens are housed in automated deep litter systems and are free to move within the shed but not outside. This system is relatively new and the efficiency of management techniques and equipment could be improved.
- Free range systems – accounted for 26.6% of supermarket sales in 2010, hens are able to move around in both indoor and outdoor areas. This system is more costly due to the greater area of land and labour required per hen.
- Organic systems – accounted for 2.2% of supermarket sales in 2010, hens are housed in a free range system, are only fed organic foodstuffs and are not given any chemical treatments. This system is more costly due to the greater area of land and labour required per hen. Disease risk management is also essential in these systems.

The operation and profitability of the alternative systems (barn laid, free range and organic) relies on attracting a premium price over intensive caged system eggs.

Horses

Owning a horse is a rewarding experience, as they make excellent companions and can be kept as pet or used for pleasure riding and competition. They are however a long-term commitment, can be expensive and require regular care, exercise and health checks (e.g. hoof trimming, teeth checks, worming and vaccination).

Horse care basics

Like all pets and livestock, horses require access to adequate feed, water, shelter and exercise. A horse requires 1-2 kg of pasture, hay or chaff per 100 kg of bodyweight each day. Depending on the quality and quantity of feed available, horses may require supplementary feeding to maintain body condition. For example, salt and mineral lick blocks may be needed to meet pasture nutrient deficiencies. A constant supply of clean, fresh water must always be available and regularly checked. This is particularly important during summer, when horses can drink between 25-45 litres per day. Dams and self-filling troughs are ideal. Bath tubs and buckets can be used but must be re-filled daily and tied down so they can't be tipped over.

Horses require access to shelter, in the form of trees or walk-in sheds/stables, to protect them from the extremes of rain, wind and sun. A three-sided shed, with the back wall facing the prevailing wind, is ideal and should be large enough to fit all horses together. Horses also require enough space to run around otherwise they must be exercised daily. Tethering of horses is unacceptable for long periods of time and should only be used for short periods and under regular supervision and inspection.

Regular health care is another important component of horse ownership and involves:

- Hoofing trimming every 6-8 weeks to prevent the horse's hooves becoming chipped, too long or uncomfortable. Shoes are only required when the horse is to be ridden on hard or rocky ground.
- Dentist check-ups at least once a year.
- Worming every 6-8 weeks as per the directions on the product.
- Vaccinations for tetanus, viral respiratory diseases and strangles as per your veterinary's advice.
- Monitor body condition to prevent your horse from becoming too fat or thin. Ideally ribs should be felt but not seen.

If you can no longer care for your horse you must arrange for someone else to care for it, sell it or have it put down. It is much kinder to put a horse down than let it suffer from neglect.

Grazing management for horses

Horses create problems that need to be closely managed so the land is not damaged and there is no ripple effect on nearby land and waterways. Your intention with any land grazed by horses should always be to care for the soil, to encourage pastures to grow and remain viable, and to discourage weeds.

Horses are herd animals, and if you keep one by itself it can fret, get bored, and suffer from 'walk the fence' syndrome, which causes soil compaction and erosion. Horses kept by themselves are also more likely to panic during storms and run into fences, and to strip bark from trees. Stallions are not suitable companions, as they are difficult to manage and should be de-sexed (gelded) unless they are to be used for breeding. Breeding horses should only be carried out by, or under the advice, of experienced people as it requires special facilities, is expensive and time consuming.

Areas near gates, feed containers and shelter can become bare, compacted, and boggy in wet weather. It is far easier to prevent a paddock from becoming 'horse-sick' than to try to repair the damage afterwards. Horses are selective grazers, undergrazing can change the composition of the pasture, as the more palatable species are grazed while the less palatable species become tall and rank. Conversely, if pastures are overgrazed they become bare and susceptible to infestation with weeds such as capeweed.

You may decide to use rotational grazing, using several smaller paddocks rather than one large one. By shifting horses around you give one paddock the opportunity to recover while the horses graze elsewhere. The optimum seems to be to let them graze pastures down to about five centimetres, then let the pasture recover to 15 centimetres before the horses graze again. To maintain good production you can also graze rotationally with other livestock. Sheep and cattle eat a much greater range of plants than horses do, and will graze areas horses have avoided. As horses will not graze near their manure, you will need to pick it up regularly. Removing it will reduce blowflies, and you can help break the worm cycle. It also makes good fertiliser for your vegetables and fruit trees.

Other animals industries

Goats

Goats are grown for meat, fibre and milk production. Victoria has about a quarter of Australia's goat population with more than 600 agricultural businesses involved in the goat industry; the majority involved in goat meat production. Traditionally, goat production was run in conjunction with sheep and/or cattle, but there are now more specialist producers who have invested in having the appropriate infrastructure to manage goats.

The Victorian goat meat industry has grown significantly since the mid 1990s with the number of animals slaughtered increasing from 849 in 1996 to around 626,800 in 2011, although this included some rangeland goats from NSW and Queensland. About 95% of Australian goat meat production actually comes from rangeland goats that live in NSW and Queensland, whereas in Victoria most goat meat comes from specialist meat breeds. Refer to *Table 24* on Pages 113-114 describes some of the characteristics of the popular goat breeds. Australia is the world's largest goat meat exporter. Major markets for exports include the United States, Chinese Taipei, Singapore and Malaysia. Live goats are also exported, although this has decreased since 2002 following the loss of the Saudi trade.

Goats can also be grown for fibre, with either mohair or cashmere produced. Angora goats produce mohair, a very long, lustrous, wool-like fibre that is used for the manufacture of suits, coats and rugs. They are shorn every six months, with the fibre becoming coarser as the goats age. Australian mohair production is relatively small on the global scale, contributing less than five per cent of the world total. The industry declined during the 1990s but is slowly increasing with improved meat and fibre prices. Cashmere is the other main fibre produced from goats and is recognised as one of the world's premium fibres, as it luxuriously soft, light and warm. Cashmere goats produce a downy undercoat (cashmere) beneath coarse guard hair that is largely worthless. The Australian Cashmere industry is relatively small, with only about 75 producers in 2006, however world demand outstrips supply so there is plenty of room for industry development.

Dairy goat production is a niche market, with only about fourteen goat dairies in Victoria. They produce fresh milk for human consumption, yoghurt and speciality cheese manufacture. Goats milk can be substituted for cow's milk, as it's easier to digest and can be consumed by some people that have allergies to milk proteins in cow's milk. Raising goats for dairy production involves costly infrastructure and a high labour requirement. Producers must follow strict regulations regarding the production and sale of dairy milk and have access to milk-processing facilities.

Herd of goats

Table 24: Characteristics of some of the main goat breeds grown in Australia.

Goat Breed	Primary Purpose	Features
Anglo Nubian	Dairy	• Friendly, dual purpose milk and meat breed. • Popular milk breed due to high average fat content. • Large frame with long, broad and pendulous ears. • Horn or hornless. • Suited to hot conditions.
Angora	Fibre	• Produce mohair, a very long (15 cm), lustrous and resilient luxury fibre. • Small frame with heavy and drooping ears. • Horned with a white fleece. • Require protection from cold weather during kidding and after shearing. • Grown in higher rainfall or grain producing areas were fibre vegetable contaminants (e.g. burrs) are reduced.
Australian Brown	Dairy	• Developed in Australia from goats with Saanen, Toggenburg and British Alpine backgrounds. Officially recognised in 2006. • Consistent type, tall, rangy and robust. • Docile natured making them easy to milk • Long lactations, large milk volume and good butterfat content
Australian Cashmere Goat	Fibre	• Developed in Australia from rangeland goats. • Fleeces from these goats have no commercial value; however the fine, downy undercoat known as cashmere is highly valuable. • Have retained the fertility and hardiness of wild and rangeland goats. • Horned with a white or coloured fleece.
Australian Melaan	Dairy	• Black goat developed in Australia. • Placid natured and intelligent. • Hardy, disease resistant and highly productive. • Suited to variable climatic conditions from cold to subtropical.
Australian Rangeland	Meat	• Marketing term to describe a composite breed of goats that that have become naturalised throughout Australia's rangelands. • It is a mixture of Angora, Cashmere, Anglo Nubian, British Alpine, Saanen and Toggenburg goat breeds. • Hardy and suited to low rainfall zones, maintaining fertility in dry conditions. • Suitable for the export goat meat and live export markets. • Exhibit hybrid vigour when crossed with other meat breeds.

Goat Breed	Primary Purpose	Features
Boer	Meat	• Recognised as the World's premier meat breed. • Short, white, reddish brown to all red coat with black, brown or red markings around the head and shoulders. • Horned, large framed goat. • Hardy, adapting to a broad range of climatic conditions. • High growth rates, allowing it to reach slaughter weights more quickly than other breeds. • High quality meat that's low in saturated fat and cholesterol. • High fertility and kidding per centage.
British Alpine	Dairy	• Black, short coat with white or cream markings on their face. • Tall, rangy, highly active breed. • Good milk producer with better than average butterfat. • Displays good winter milking, with an extended lactation period.
Kalahari Reds	Meat	• Developed in South Africa. • Short, solid dark red coat with long ears. • Tall, long frame. • Hardy, suited to hot climates. • Disease resistant making them suitable for organic meat production. • High fertility, mothering ability and milk production. • Fast growing producing tender meat.
Saanen	Dairy	• Large framed with erect ears. • Fine, short hair with a uniformly white coat. • High milk yields and long lactation periods. • Most common dairy goat breed in Australia. • Docile temperament.
Toggenburg	Dairy	• Comparatively small breed. • Solid, light to dark brown coat with white ears, two white stripes down the face and predominantly white legs. • Excellent milk production. • Hardy with a placid temperament.

Bees

The Australian bee keeping industry is estimated to have a gross value of $65 million producing a variety of products including honey, paid pollination services, beeswax, queen bee and package bee domestic and export sales, and pollen. Honey accounts for the majority of production, with 20,000 and 30,000 tonnes produced annually and approximately 15-19% of this from Victoria. One-third of production is exported and Australia is currently the world's tenth largest exporter of honey. In recent years, honey production has been reduced due to the combination of drought and bushfires.

The gross value of honey products and pollination services makes it a relatively small agricultural industry, however through the economic value of the pollination services it provides, the industry has an enormous impact on the rest of Australian agriculture. Pome and stone fruit, and almond growers are the largest purchasers of pollination services, which are primarily located in Victoria and South Australia.

In 2009, there were around 9,600 registered beekeepers in Australia with around 500,000 hives. More than 70% of these hives are operated by commercial beekeepers, with each beekeeper typically operating between 400 and 800 hives. A commercial beekeeper with around 20 bee sites would require a foraging area of native **flora** of around 16,000 hectares per annum. This demonstrates the dependence of beekeeping on native flora on public and private land. In Victoria, anyone who wants to keep one or more hives of bees is required to register with DEPI as a beekeeper. Registration enables DEPI to conduct disease prevention and control programs.

Alpacas

Alpacas are a domesticated species of camelid and are native to the high altitude areas of South America. They were first introduced to Australia in 1858 however the project failed and none of the alpacas survived. They were re-introduced in the late 1980s and there are now more than 150,000 alpacas in Australia. Alpacas are grown for their fine fleece, although they can also be used as guard animals for sheep and goats. They are easy to manage, as they tolerate harsh conditions, are relatively disease resistant and make doting mothers. Furthermore, fencing suitable for sheep is more than adequate for alpacas are they're not inclined to wander.

Alpacas must be shorn annually, normally in spring and require occasional teeth and toenail clipping. They don't require crutching, tail docking or mulesing, as cases of flystrike are extremely rare. Alpacas should be vaccinated regularly against colostridial diseases with the use of 5-in-1 vaccinations and faecal sampling should be carried out before drenching if internal parasites are suspected. They are herd animals and should be kept in groups of more than one or kept together with other livestock such as goats, sheep or horses. They are content to feed on low protein hay or pasture, including native grasses, but may require some additional feed in winter or in the late stages of pregnancy. There are two main types of alpaca, the Huacaya and Suri, refer to *Table 25* below for the characteristics of each breed.

Alpaca fibre is very soft and fine but also quite strong. Currently most alpacas grown in Australia are not commercially viable on fleece production alone, as there are large variations in fleece qualities, as limited selective breeding has occurred. Other limitations include low fibre

Table 25: Characteristics of some of the two main alpaca breeds grown in Australia.

Alpaca breed	Features
Huacaya	• Most common alpaca breed. • Grows a bonnet of wool on its head • Fleece coverage is usually even, extending down the legs. • The fleece has a distinct waviness or crimp, which it gives the breed its teddy bear appearance.
Suri	• Fleece has a strongly defined staple. • It is covered in long, pencil fine locks, which hang straight from the body similar to dread locks. • The fleece has a lustre and feels more slippery and silky than that of Huacaya.

volumes and the subsequently high processing costs. The focus of this emerging industry in Australia is on selective breeding for improved fibre qualities and building up the total numbers.

Alpacas are also kept by farmers to guard sheep and goats against predators such as foxes and wild dogs. They are very alert, with excellent eyesight and are constantly on patrol. They make sure the flock or herd is kept together, signalling danger with a loud distress or warning call and chasing the predator off by approaching it with great speed, kicking, spitting and biting. Farmers have reported much lower lamb or kid losses when one or two alpacas are kept with sheep flocks or goat herds.

There are some small-scale alpaca meat processing operations in Victoria, South Australia and New South Wales, but generally speaking producers keep their animals until they die on the farm. There is a large meat and hide market in South America, and such markets may develop in Australia over time as herd numbers increase.

Deer

Deer are grown for a number of products, including venison, velvet antler, musk, hides and skins. In Australia deer farms are located in all states but are concentrated in south eastern Australia. In 2009 there were 196 deer farms in Australia with 43,856 deer, approximately 40% of total deer numbers were farmed in Victoria. Venison is a low-fat meat with a distinct but mild flavour, which is largely unaffected by the deer's diet. It is popular red meat option in Europe, with 85% of all venison produced in Australia exported, principally to Europe. Deer farmers typically sell their deer direct to processors who arrange the transport, slaughtering, boning, packaging and marketing of the deer.

Velvet antler is the other major deer product and refers to the velvet on the immature deer antler. It is widely used in traditional Asian medicine and the majority of Australian velvet is exported to Asia. In order to harvest velvet, antlers are removed before the mating season, usually in February to March, before the velvet skin on the antler is shed and the deer become too aggressive. Removing the antlers provides an alternative source of income for deer farmers and improves the safety of deer handling.

There are four major breeds of deer grown in Australia: Red, Fallow, Wapiti or Elk and Rusa Deer. Not all breeds can be interbred with other species. Deer are generally hardy compared to other farm or domesticated livestock and with good management remain healthy and relatively disease free. Good management practices include access to shade and shelter, adequate nutrition and appropriate parasite control programs (e.g. regular 5 in 1 vaccinations) must be maintained. The major challenge facing the Australian deer industry is the relatively small size, which makes it difficult to maintain breeding numbers when demand for products increases and young breeding females are sold for venison.

Pets

Pets are much loved companion animals for people, providing stress relief and unconditional love. They can also be lots of fun and teach children responsibility and nurturing skills. Victoria has one of the highest rates of pet ownership in the world. Responsible pet ownership involves selecting the right pet for your lifestyle, caring for your pet's health and welfare, complying with the law and ensuring that your pet doesn't cause any problems in the community. Local council and the RSPCA may become involved if there are complaints of noise, smell, other nuisance or cruelty.

Cats

Cats make great pets, as they are quiet, clean and they don't require lots of exercise or space. Compared to dogs, cats can cope much better when left alone during the day while their owners are at work. Responsible cat ownership involves:

- For multiple cat households ensure that each cat has its own food and water bowl, litter tray and cat bed, and space them out to avoid competition between cats.
- Don't allow cats to roam free as it increases the risk of the cat being hit by cars, injured in fights or contracting diseases. Furthermore, cats are instinctive hunters and will kill **wildlife** even if they are well-fed. Cats can be confined to the owner's property through cat enclosures and cat-proof fences, or by adopting a curfew whereby cats are enclosed (in the house, laundry or garage) from dusk until after sunrise. Some councils, such as the City of Greater Bendigo, apply cat curfews and impose fines for owners of cats caught outside during curfew hours.

- Learn about your cats ideal body shape and avoid overfeeding and unhealthy treats, which can cause serious animal health issues and even lead to animal death.
- Allow your cat to express natural behaviours by providing scratching posts and toys.
- Ensure you spend time with your cat every day.
- Regularly vaccinate against diseases and treat your cat for fleas and worms to prevent animal health issues.
- Microchip and register your cat with your local council once its three months of age and over. This will greatly increase the odds of the cat being returned if he or she is lost and it funds a range of important activities, such as animal shelters.

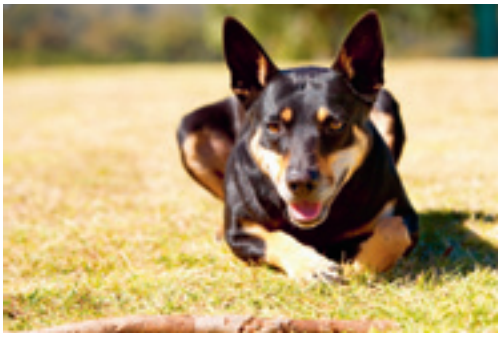
Dogs

Owning a dog can be lots of fun, providing companionship, affection and unconditional love. They also encourage owners to exercise regularly. Responsible dog ownership involves:

- Learn about your dogs ideal body shape and avoid overfeeding and unhealthy treats, which can cause serious animal health issues and even lead to animal death.
- Review your dog's treats and ensure you're not feeding him or her human foods that are toxic to dogs. If your dog is overweight limit treats and avoid unhealthy or fatty treats completely.
- Dogs are highly social animals and require lots of attention and stimulation. For dogs that are regularly left alone, owners should keep the dog busy by providing him or her with bones to chew, stuffing toys with food or freezing treats in a block of ice. Owners could also consider getting a second dog or another pet for company if their lifestyle or budget allows it.
- Make a commitment to walk your dog more often. Daily walks should be the ultimate goal but even one extra walk can make a huge difference to the dog's quality of life. Always remember to carry a plastic bag when walking your dog and remove any dog poo to prevent other people stepping in it. If possible, avoid walking dogs in bushland as native wildlife view dogs as predators, even dogs on leads, and walking dogs in bushland can cause unnecessary disturbance to wildlife.
- Don't allow your dog to roam freely when you're not at home, as it increases the risk of the dog being hit by cars, injured in fights or contracting disease. Furthermore most councils have local laws controlling domestic animals and dog owners can face severe fines if they don't abide by the regulations.
- Regularly vaccinate against diseases and treat your dog for fleas and worms to prevent animal health issues.
- Microchip and register your dog with your local council once its three months of age and over. This will greatly increase the odds of the dog being returned if he or she is lost and it funds a range of important activities, such as animal shelters.

Other pets

Other popular pets include birds, rabbits, guinea pigs, fish, ferrets, rats, mice, amphibians, reptiles, and horses. Similar to the responsibilities outlined above for cats and dogs, prospective pet owners must ensure that they choose a pet to suit their lifestyle and make sure they fully understand the management requirements for different types of pets. Don't assume pets such as birds or rabbits are cheap or low maintenance to own. Information on specific management requirements for different types of animals, including their care and welfare needs, can be obtained from the DEPI, RSPCA, veterinary practices and pet stores. Keeping animals such as horses, pigs, sheep, goats and poultry is usually considered on a case-by-case basis by local councils and will depend on the zoning of the property. Councils will not normally object to keeping a sheep or goat as a 'lawnmower' provided adequate arrangements are made for the safety of the animal (e.g. to protect it from attack by dogs), the appropriate animal care (e.g. annual shearing of sheep) and secure fencing.



Kelpie

Rabbit baiting warning signs

Impacts of rabbits on a hillside

Pest animals

Invasive pest animals have an enormous impact on the environment as they often out-compete and prey on native animals. They cause huge financial losses for farmers and cost the community millions of dollars each year. Invasive pest animals are introduced (non-native) species that are or have the potential to become established in the wild through escape from captivity, deliberate or accidental release and accidental or illegal importation. Established pest animals are a living reminder of the mistakes of history. Rabbits, foxes, deer and trout were brought to Australia by early European settlers for sport and food. Cats, dogs and goldfinches were pets that escaped and have established wild populations. Landowners can face severe fines if they do not control declared pest animals on their land.

Rabbits

Under the *Catchment and Land Protection Act 1994*, landholders are required to control rabbits on their land and legal action can be taken if they fail to do so. Rabbits are the most serious of Australia's pest animals. They compete with native wildlife for food and shelter and have contributed to the extinction of numerous native species. They also compete with livestock for food and damage native vegetation.

Rabbits graze selectively, feeding heavily on palatable grasses and herbs and avoiding unpalatable weeds. This leads to the loss of native species and the spread of weeds. They are prolific breeders and reproduce throughout most of the year. Under ideal conditions one pair of rabbits can increase to 180 rabbits in around 18 months. When the rabbits reach maturity they fan out from the family burrow, seeking new territory. Survival rates of young rabbits increase significantly when they have safe harbour.

The key to effective rabbit control is planning and persistence. It is best not to tolerate even small numbers of rabbits – one rabbit is too many. Landholders should take action to eliminate rabbits from their properties. Several of the following control methods outlined in *Table 26* on Page 119 should be used together for best results.

Foxes

Fox dens can be found in many different locations, for example, underneath buildings, creek banks and rubbish heaps. Foxes prey heavily on rabbits but about a quarter of their diet is native wildlife. Ground-dwelling mammals are easy targets, as are birds, possums, lizards, beetles and other insects. Researchers have estimated that one fox can eat around 32 kilograms of native wildlife each year and can range over 20–30 kilometres a night. With an estimated one million foxes in Victoria the impact is staggering. Foxes carry a variety of canine diseases and would be a prime carrier of rabies if it entered Australia.

Effective control should centre on making a property less attractive to foxes. Reducing rabbit numbers will affect foxes, but it will also force foxes to meet the rabbit shortfall with native species. For this reason it is critical to coordinate fox and rabbit control programs. Fox control methods include: baiting, harbour management where applicable, fumigation, shooting, exclusion fencing, animal husbandry and property hygiene.

Table 26: Rabbit control methods.

Control method	Description
Destroying harbour	Rabbits do not need burrows or extensive warrens to survive, and in some cases can find harbour above ground in places such as abandoned cars and blackberry thickets. Consider destroying potential rabbit harbour as part of an integrated pest control program.
Rabbit-proof fencing	Well-constructed and maintained fences can keep rabbits out of a property for the long term. Working with adjoining neighbours to fence a larger area can also be worthwhile. Rabbit-proof fences require special construction. A section of wire mesh must be buried under the fence or angled across the ground in the direction of possible rabbit entry. Once an area has been securely fenced other control methods (poisoning, fumigation, and warren destruction) must be used to remove rabbits in the fenced area.
Fumigation and warren destruction	Fumigation involves placing a poisonous fumigant in warrens and burrows and blocking all exits. Running dogs over the area or creating loud noise will scare rabbits into their burrows before fumigation. Every hole or burrow must be treated and then securely blocked. Fumigation of warrens can only be undertaken by someone with an Agricultural Chemical Users Permit (ACUP) who is allowed to handle the fumigant. To be ACUP-endorsed, landholders can complete an accredited training course or use a licensed contractor to carry out the fumigation. Destroying warrens after fumigation will prevent reinfestation. Warrens can be destroyed by digging them out with a shovel, mattock or pick. Backhoes are very useful but care must be taken to avoid excessive soil disturbance, which can cause erosion. Check the area regularly and close up any new burrows quickly.
Baiting	Oat baits laced with Pindone, an anti-coagulant poison, are effective to control large rabbit infestations, but there are some risks to native animals and pets. The safety and handling directions on the product label must be strictly adhered to. An antidote is available from veterinarians if pets accidentally eat baits. A baiting program must be carefully planned and neighbours should be notified and warning signs erected. Baiting is a complex and potentially hazardous procedure and is best carried out by a group of landholders working together, or a registered pest control contractor. Further information about baiting is available from your local DEPI office.
Ferreting	Ferrets are useful for clearing a few remaining rabbits once numbers have been reduced by other methods. Ferreting is effective inside fenced areas or under buildings where access is difficult. Care must be taken to ensure that any native animals using rabbit burrows are not threatened or injured by ferrets.

Feral cats

Feral cats are widely distributed throughout Victoria and are skilled hunters, threatening the survival of many native species including small mammals, birds and reptiles. They are thought to be involved in the extinction of some Australian native animals and have negatively impacted a number of endangered species reintroduction programs, for example, bandicoot. Researchers have estimated the home range of a male feral cat as 10 square kilometres (females have a smaller home range). Similar to foxes, rabbits are the major food item consumed by feral cats in Victoria and rabbit control will reduce feral cat populations. Recommended control methods for feral cats include confinement trapping, **habitat** manipulation and exclusion fencing.

Pest birds

The introduced House Sparrow, Common Starling and Common Indian Myna birds are economic and environmental pests. These birds compete for food and habitat with native birds, such as cockatoos and owls. For example, Common Starling and Indian Myna birds aggressively take over the hollows of native birds, destroying eggs and killing chicks in the process. It is almost impossible to stop these invasive birds from occupying a property where there are already large populations of these species in the area. Landholders can however make a property more attractive to native birds, by planting a variety of native plants and providing a range of habitat structures (e.g. hollow logs and nest boxes), which will in turn make the property less inviting to introduced bird species.

Aquatic pests

Aquatic pests threaten natural waterways and are the result of the careless disposal by aquarium owners or an ill-conceived, deliberate introduction for a specific purpose. The goldfish (*Carassius auratus*) was probably introduced to Australia in the 1860s and widely distributed by acclimatisation societies in the 1870s. The continuing spread is believed to have been assisted by anglers (using goldfish for live bait) and aquarists. Goldfish are found throughout the Loddon and Campaspe **catchments** and are members of the carp family.

The Eastern Gambusia *(Gambusia holbrooki)* is a good example of a well-intentioned action turning into an ecological disaster. Gambusia is native to the rivers draining the Gulf of Mexico, and has been distributed worldwide to control mosquitoes. It was introduced to Australia in the 1920s, but its introduction has proved to be disastrous because mosquito larvae form only a small part of its diet. The rest of its diet consists of native ants, flies, aquatic beetles, rotifers, crustaceans, molluscs and the eggs and fry of native fish species. Recent studies have also shown that gambusia have a preference for tadpoles over mosquito larvae, and scientists are worried that this is causing a serious decline in amphibian populations around the world.

Tips for effective pest animal control

- Identify and monitor pest numbers
- Create coordinated pest animal management programs with neighbours and/or local Landcare groups
- Combine several proven control methods, including the destruction of habitat
- Strictly adhere to the safety and handling directions on poisons
- Record and evaluate all methods and modify if necessary
- Continue to monitor pest activity after control
- Be vigilant and persistent. Pest control is time-consuming and there are no quick-fix solutions
- Keep cats inside at night and control other potential pests
- Control your dogs.

Resources and further information

Australian Alpaca Association: www.alpaca.asn.au

Australian Chicken Meat Federation Inc: www.chicken.org.au

Australian Dairy Farmers: www.australiandairyfarmers.com.au

Australian Dairy Herd Improvement Scheme: www.adhis.com.au

Australian Egg Corporation Limited: www.aecl.org

Australian Pork Limited: www.australianpork.com.au

Australian Wool Innovation Limited: www.wool.com

BREEDPLAN: http://breedplan.une.edu.au/

Dairy Australia: www.dairy.edu.au

Department of Environment and Primary Industries Horses webpage: www.dpi.vic.gov.au/agriculture/animals-and-livestock/horses

Department of Primary Industries – Welfare of horses: www.dpi.nsw.gov.au/agriculture/livestock/animal-welfare/general/dogs-horses

Feral.org.au: www.feral.org.au

Goat Industry Council of Australia: www.gica.com.au

Horse Rescue Australia: www.horserescue.com.au

Horse Riding Clubs Association of Victoria: www.hrcav.com.au

Invasive Animals CRC: www.invasiveanimals.com

Invasive Animals CRC (2013): Field Guide to Pest Animals Australia mobile phone application. Available for download at www.feral.org.au/mobile-phone-apps

Making More From Sheep: www.makingmorefromsheep.com.au

Meat and Livestock Australia: www.mla.com.au

Meat and Livestock Australia (2006) Going into Goats: Profitable producers' best practice guide. Available for download at www.mla.com.au/Research-and-development/Extension-and-training

National Centre for Equine Education: www.ncee.edu.au.

Project Hope Horse Welfare Victoria Inc: www.phhwv.org.au

Royal Society for the Prevention of Cruelty to Animals (RSPCA): www.rspca.org.au

Sheep CRC: www.sheepcrc.org.au

Sheep Genetics: www.sheepcrc.org.au

Victorian Department of Environment and Primary Industries: www.depi.vic.gov.au

CLIMATE

“ The weather a town or region experiences each year can vary considerably compared to the long term average. This natural variation can result in floods, droughts and heat waves, and is caused by a range of climate drivers. ”

Chapter 7
Climate

The climate of north central Victoria

The climate of north central Victoria is generally Mediterranean with cool moist winters and warm dry summers. The north and west of the region are substantially warmer and drier than the south and east. Annual rainfall varies considerably across the region, ranging from 350 mm per year in Swan Hill to over 1,200 mm per year in the far south-east. On average, there are 82 days each year where at least 1 mm of rain falls. Summer temperatures range from: warm in the elevated southern regions (average maximum temperatures less than 25°C) to hot in the north (more than 30°C). Maximum winter temperatures are usually around 12 to 15°C but increase from south to north. Frosts are common throughout the region.

Weather and climate drivers

The weather a town or region experiences each year can vary considerably compared to the long term average. This natural variation can result in floods, droughts and heat waves, and is caused by a range of climate drivers. These climate drivers have varying levels of impact in different regions, at different times of the year. The climate drivers that influence weather patterns in north central Victoria include: the sub-tropical ridge, El Nino Southern Oscillation, Indian Ocean dipole and the Southern Annular Mode. These climate drivers can then modify synoptic features in Victoria such as, frontal systems, cut-off lows, cloud bands and blocking highs.

Sub-tropical ridge

The sub-tropical ridge (STR) is a natural high pressure belt that sits across the southern parts of Australia. It can affect the passage of cold fronts across Victoria, which is a good source of moisture and potential rainfall. The position of the STR moves with the seasons, allowing cold fronts to pass over Victoria during winter and pushing them further south into the Bass Strait during summer. The intensity of the high pressure systems also affects rainfall, with higher pressure resulting in lower rainfall. Winters with stronger or more frequent blocking high pressure systems over southeast Australia don't tend to produce regular rainfall.

El Niño Southern Oscillation

The El Niño – Southern Oscillation (ENSO) describes the irregular, cyclical changes in the position of warm and cool water, the strength of winds and atmospheric pressures in the Equatorial Pacific Ocean region. It is a major influence on Victoria's climate, particularly in spring. There are three different phases of ENSO:

- El Niño (Southern Oscillation Index negative) – is associated with the extensive warming of the sea surface temperatures in the central and eastern tropical Pacific Ocean, near South America. Trade winds are weakened and may even reverse during an El Niño phase. This results in less atmospheric moisture available for rain in Australia. El Niño years have often been correlated with below average winter and spring rainfall over most of eastern Australia.
- La Niña (Southern Oscillation Index negative) – is associated with the extensive cooling of the sea surface in the central and eastern tropical Pacific Ocean and warm waters gather closer to the Coral Sea, off the north east coast of Australia. Trade winds are strengthened during a La Niña phase. This results in more moisture in the atmosphere and trade winds directing the moisture towards eastern Australia. La Niña years have often been correlated with above average winter, spring and summer rainfall across northern and eastern Australia.
- Neutral (neither El Niño or La Niña) – is associated with relatively cool sea surface temperatures in the central and eastern tropical Pacific Ocean and warmer sea surface temperatures closer to the north east coast of Australia. Trade winds travel east to west across the surface of the

tropical Pacific Ocean. These periods often coincide with the transition between El Niño and La Niña events. Rainfall patterns in Australia are near the long-term average during neutral ENSO phases.

Indian Ocean Dipole

This occurs when the Indian Ocean is warmer in the west (near the coast of Kenya) than it is in the east (near Sumatra).

The Indian Ocean Dipole (IOD) describes the irregular, cyclical changes in the position of warm and cool sea surface temperatures in the northern Indian Ocean, which impacts rainfall patterns across most of Australia. The IOD is determined by the difference in sea surface temperatures between two areas (or poles, hence a dipole): a western pole in the Indian Ocean, off the coast Kenya, and the eastern pole in the Indian Ocean, off the coast of Sumatra. There are three different phases of IOD:

1. Positive IOD – is associated with warmer than normal sea surface temperatures in the western Indian Ocean (near Kenya) compared to the east (near Sumatra). This reduces the cloudiness near north-western Australia, resulting in less rainfall in the Top End and southern Australia. IOD positive events can sometimes occur during El Niño events, which often results in more extreme reductions in rainfall than if the IOD and ENSO were out of phase.

2. Negative IOD – is associated with cooler than normal sea surface temperatures in the western Indian Ocean (near Kenya) compared to the east (near Sumatra). These warmer waters off Sumatra can increase northwest cloud ban activity. IOD negative events sometimes occurring during La Niña events, often resulting in increased rainfall over Victoria.

3. Neutral IOD – the stages in between a positive or negation IOD when sea surface temperatures aren't strongly displaying warmer or cooler than normal temperatures. The moisture sources in north western Australia are normal and other climate drivers are influencing Victoria's weather.

Southern Annular Mode

The Southern Annular Mode (SAM) describes the north-south movement of the belt of westerly winds (or low pressure systems) that circulate around Antarctica in the Southern Ocean. The changing position of the westerly wind belt influences the strength and position of cold fronts and storm activity, which influences rainfall in southern Victoria. There are two different phases of SAM, which can vary fortnightly:

- Positive SAM – the belt of westerly winds contracts towards Antarctica dragging frontal systems further away from southern Victoria. Positive SAM has different impacts on rainfall depending on the time of year. In autumn and winter, a positive SAM can mean cold fronts and storms are further south resulting in less rainfall and fewer storms in southern Australia.
- Negative SAM – the belt of westerly winds expands towards Australia, which allows frontal systems to move closer to southern Victoria. In autumn and winter, this can result in higher rainfall in southern Australia.

The Climatedogs

DEPI has created the 'Climatedogs' animation series to explain the climate drivers that influence Victoria's weather patterns and how these drivers are changing over time. The team of Climatedogs are Enso, Ridgy, Indy and Sam and each dog represents a key climate driver influencing Victoria's rainfall.
The short videos are available online at www.dpi.vic.gov.au.

Frontal systems

Frontal systems describe boundaries between two air masses of different temperatures, which can be moving or stationary. Moving frontal systems are named for the advancing air mass, such as cold or warm. Cold fronts are more relevant to southern Australia, moving from west to east across the Southern Ocean. They vary in speed and intensity, with slower moving fronts typically resulting in an extended period of rainfall; and more intense systems associated with heavier rainfall. Cold fronts can occur all year round in Victoria, however they are more frequent in winter and spring. They can impact rainfall right across the state but are especially important in the southern half of the state, where more than half of the rainfall maybe associated with frontal systems.

Cut-off lows

Cut-off lows describe an isolated low-pressure system that has broken away from the main low-pressure belt that lies across the Southern Ocean. The system extends vertically through the atmosphere and is sometimes not visible on surface charts. An uplift of moisture caused when a parcel of warm air slides over the cold air associated with a cut-off low stimulates rainfall. Cut-off lows typically travel from west to east across Australia and develop south and west of the continent. They generally result in extended periods of rainfall and can produce strong, gusty winds and high seas. They often occur in conjunction with a blocking high, which results in widespread rainfall. Cut-off lows are the dominant rain producing system over much of inland Victoria, contributing a higher proportion of rainfall than frontal systems and producing higher rainfall amounts during the growing season. Other processes maybe more important in the mountainous and coastal regions of Victoria.

Blocking highs

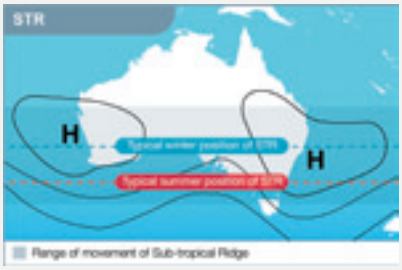
Blocking highs are strong high pressure systems that form further south than the usual STR and remain near-stationary for an extended amount of time. They block the progression of weather systems across southern Australia from the west to east. Blocking highs typically form in the Great Australian Bight or Tasman Sea, and impact weather patterns throughout Victoria, including fog and frost occurrence. If the blocking high forms in the Bight, cold and wet conditions generally occur in Victoria; while a blocking high in the Tasman usually results in hot and dry conditions particularly during summer.

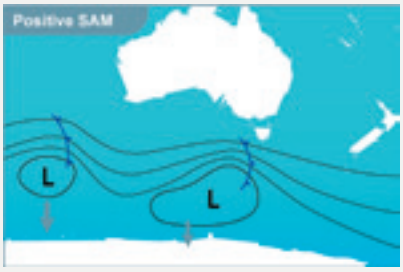
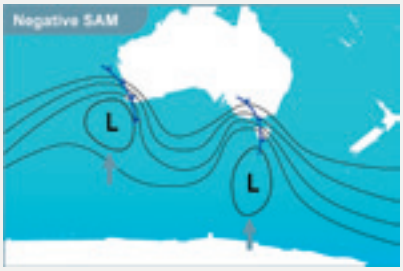
Cloud bands

Cloud bands describe an extensive layer of cloud that can stretch across Australia, typically from the north-west to south-east. They can form due to a trough of low pressure occurring in the upper atmosphere or as a result of IOD negative event (moist tropical air originating over the Indian Ocean moves towards the pole, generally in a south-eastward direction). They are most active from April to September. Cloud bands bring widespread, often heavy, rainfall to Victoria. However since 1997, there has been a significant reduction in the number of cloud bands bringing rainfall to Victoria.

Clouds building up over a paddock

Table 27: Features of Victoria's major climate drivers.

Climate driver	Period of most activity	Potential effect	Area of impact in Victoria
Sub-tropical ridge 	• Winter • Summer	• Cold fronts • Fine and dry	• Statewide
El Niño (Southern Oscillation Index negative) 	• May-November	• Less rain	• Almost all of Victoria
La Niña (Southern Oscillation Index negative) 	• May-November	• More rain	• Almost all of Victoria
Indian Ocean Dipole (Positive) 	• June-November	• Less rain	• Statewide

Indian Ocean Dipole (Negative) 	• June-November	• More rain	• Statewide
Southern Annular Mode (Positive) 	• Spring/Summer • Winter	• More rain • Less rain	• Southern and eastern Victoria • Mainly southern Victoria
Southern Annular Mode (Negative) 	• Winter	• More rain	• Southern Victoria

Climate change

Just as the weather changes from day-to-day so does the climate – from seasonal variations to major changes over geological time-scales, such as ice ages. The Earth's climate has changed over the last century and increases in average temperatures have been seen around the globe. There is evidence that most of this warming is due the increasing concentrations of greenhouse gases in the atmosphere, as a result of fossil fuel burning and other human activities. As well as increasing average temperatures, climate change will result in warmer and drier conditions in Victoria, with increased incidence of extreme events such as heatwaves, bushfires and storm surges.

The future climate of north central Victoria is expected to be hotter and drier than it is today. Climate change predictions for north central Victoria suggest annual warming of 0.3 to 1.6°C by 2030, ten to 50% increase in the number of hot summer days (over 35°C), reduction in annual rainfall by up to 15% by 2030 with droughts likely to become more frequent and longer (DSE 2008). Further changes are expected beyond 2030, for example, under a higher emissions growth scenario, Donald's temperatures and annual rainfall would resemble those of present day Balranald in New South Wales by 2070. In addition to hotter and drier conditions, the risk of fire in south eastern Australia is expected to increase whilst the incidence of frost will decrease.

Climate change has the potential to impact our environment, community and economy. *Table 28* lists some of the impacts of climate change on the environment, community, primary production and water supplies. Governments, industry, communities and land managers need to start preparing for and adapting to climate change now, in order to minimise the negative impacts of climate change and take advantage of any positive impacts. Farmers and land managers can adopt a range of management practices at the paddock, farm, business and **catchment** scales, in order to prepare and adapt to climate change. For example, utilising moisture monitoring to plan irrigation and improve water use efficiency; diversifying farm enterprises, locations; and/or regularly reviewing flood and bushfire management plans. Furthermore, farmers and land managers can also help reduce greenhouse gas emissions by adopting practices that store carbon or avoid greenhouse gas emissions on their land. These practices may also allow the farmer or land manager to earn carbon credits through participation in the Carbon Farming Initiative (CFI).

"Under a high emissions scenario Donald's climate would resemble that of present day Balranald by 2070."

Thunderstorm

Table 28: Climate change impacts on the environment, community, primary production and water supplies.

	Climate change impact
Environment	• Species may alter distribution, abundance, behaviour and the timing of events such as breeding. • Species may be at risk of population decline or extinction, particularly those with restricted or specialised habit requirements, poor dispersal abilities or small populations. • Increase direct impacts on biodiversity such as diseases, bushfires and droughts. • Alter the composition of natural ecosystems through changes in the occurrence of disturbances (such as bushfires, snow and floods) and water flows into rivers and wetlands.
Community	• Negatively impact human health due to the increase occurrence of heatwaves and bushfires. • Southward spread of tropical insect-borne disease, for example, Dengue. • Increase in the number of heat related deaths. • Essential infrastructure such as water, electricity, telecommunications and transport may be interrupted or at risk of damage. • Buildings and assets maybe exposed to sea level rises. • The design and performance of homes and buildings maybe affected, such as, increased need for summer cooling and/or occurrence of natural disasters such as flooding and bushfires.
Primary Production	• Higher levels of atmospheric carbon dioxide will enhance plant growth and water-use efficiency. • Reductions in rainfall and increases in average temperatures will generally reduce production levels. • For dryland agriculture, reductions in rainfall and increases in evaporation directly reduce soil moisture levels. • For irrigated agriculture, tighter constraints on water allocations may result in a more competitive water market. • Heavy rains and strong winds associated with increased occurrence of storms may result in crop damage, soil erosion or animal health issues (e.g. lamb deaths). • Indirect impacts due to changes to weeds, pests and international markets may also threatened agriculture production.
Water	• Decreases in rainfall and higher evaporation rates will reduce soil moisture levels and the amount of water in waterways and water storages. • Water quality in rivers and streams maybe reduced by lower flows and higher temperatures. For example, increased incidence of algal blooms. • Stressed urban water supplies. • Greater bushfire activity may lead to contamination of waterways with sediments and ash.

Preparing for weather emergencies

Emergencies can happen to anyone, at any time and have a big impact on your life. They can also have major implications for animal welfare and the financial viability of rural properties. Experience shows that people who plan and prepare for emergencies can reduce the impacts of the emergency and in some instances recover more quickly afterwards. Farmers and land managers also have a responsibility to ensure that property management and development plans incorporate strategies to ensure the safety of all persons, livestock and residential dwellings.

The following weather emergencies may impact urban and rural residents in north central Victoria:

- Thunderstorms with damaging winds, tornadoes, flash flooding or hail
- Flood
- Bushfire
- Mud slide or land slide resulting from heavy rainfall.

Everyone should have an Emergency Plan, which outlines what to do *before* the emergency to be ready, what to do *during* the emergency to keep safe and minimise the impacts of the emergency on people, livestock and property; and what to do *after* the emergency to access assistance, recover and return to normal life as soon as possible. The State Emergency Services (SES) and Country Fire Authority (CFA) have practical tools, information and templates available to assist homeowners and rural property owners develop an Emergency Plan. Emergency Plans are also useful for other types of emergencies such as, earthquakes and tremors, medical emergency, power, gas or mains water outages, industrial accidents or chemical spills

Risk assessment

The first step in developing an Emergency Plan for your property is to conduct a risk assessment, which identifies potential threats to the property and their possible consequences. Things to consider in your risk assessment include:

- **Location** – Is your property close to other homes or isolated? Check the historical records for the incidence of natural disasters in your area. Does your property border bush or **grasslands**? If so, what the implications for fire? Is your property close to watercourses prone to flooding? Is there easy access for emergency service vehicles and ordinary vehicles?
- **Topography** – Is your property on flat, low-lying and/or steep land? This will influence the speed and intensity of fire. Check the historical records for flood heights and the probability of these heights being reached again. Are there any natural refuge areas on the property or nearby?
- **Vegetation** – What type and amount of vegetation are on the property, adjacent or nearby? Such areas can increase the risk of fires or falling trees during storms. Furthermore, bushfires behave differently in different types of vegetation (e.g. grass or paddocks, forest and **woodland**, and bush and grassland fringes).
- **Weather** – What direction do the most common damaging weather patterns (e.g. storm fronts or strong winds) come from? What weather conditions are forecast? What is the Fire Danger Rating in your district (reported daily during the fire season)?
- **Local warning information** – Do you have access to reliable and regular official warnings? Do you know how these warnings relate to your property? For example, do you understand how the upstream and local river heights impact flood levels and areas on your property?
- **Farm enterprise type** – Does the nature of your enterprise restrict your ability to respond to an emergency? For example, calving or lambing during high risk periods increases the likelihood of major losses as it's difficult to evacuate livestock quickly compared to dry livestock.

Risk management

Home and property owners can reduce the risks and the impacts of emergencies, such as fire and floods, by preparing their property. Properties should be well prepared even if the owner plans to leave early on days of fire or flood risk, as this will reduce the level of damage to the property. Property owners can be well prepared for any emergency by undertaking the following actions:

- Create and regularly go over your Emergency Plan with members of your household.
- Put together a Home Emergency Kits – refer to information below.
- Find out as much as you can about emergencies that could affect you by attending community information sessions, reading brochures and checking websites. Learn in detail how to prepare and cope with each type of emergency.
- Understand what warnings you may receive, what they mean to you and how to respond.
- Check that your insurance policies are up to date, provide adequate cover and include the cost of debris removal and clean up.
- Learn how to turn off your power, water and gas at the mains safely.
- Decide early whether you are going to evacuate and when – late decisions can be deadly.
- Get to know your neighbours.

Specific risk management strategies should be undertaken to prepare for fire, floods and storms. *Tables 29-31* on Pages 133-136 outline the range of management actions that property owners can adopt before and during specific emergencies.

Home emergency kits

Home and property owners should put together a Home Emergency Kit, which contains everything you may need to cope in an emergency and/or if you need to relocate. It should be kept handy, regularly updated and be suitable for any emergency at any time. All household members should be aware of the kit, its contents and location. The kit should include:

- A copy of your Emergency Plan
- First aid kit
- Medicines, prescriptions and toiletries
- Portable radio and torch with spare batteries
- Mobile phone charger
- Food and water for three days
- Protective clothing, including strong shoes or boots, rubber gloves and strong leather gloves
- A change of clothes
- Wool blankets
- Any special items for young children, the disabled, infirm or elderly (e.g. an extra pair of glasses)
- Items for animals and pets – food, water, bedding, leash or harness, carry box, identification tags, etc.
- Important papers such as wills, passports and insurance policies
- Money, bank cards and identification cards (e.g. Driver's Licence)
- Contact details for your family, friends, doctor, dentist, local hospital, chemist, vet, council, gas, electricity and water suppliers
- Waterproof bag for valuables
- Favourite toy, game or book for children.

Please note, this is not an exhaustive list and you may also consider including gumboots, waterproof bags, laptop, sleeping bags or tents. Refer to the SES and CFA websites for further ideas.

Grassland fire

Preparing for fire

Preparing for fire

The Fire Danger Period poses significant threats to all those living, working or travelling in north central Victoria. South eastern Australia is one of the most fire-prone areas in the world and it only takes two weeks of hot, dry and windy weather to create dangerous fire conditions. Good preparation and planning ahead can save you and your family from being killed by fire. *Table 29* on Pages 133-134 outlines the risk management actions that can be taken to prepare for the fire season. All residents and visitors to north central Victoria should have a written Bushfire Survival Plan that they regularly review and update. For information, advice and support on developing this plan contact the CFA or visit the CFA website.

Residents and visitors should also be aware that fire restrictions are imposed during the Fire Danger Period, which restrict the use of fire in the community. This helps prevent fires from starting during high risk periods. The Fire Danger Period varies from year to year, depending on seasonal conditions, and is typically between November and April. Details of fire restrictions are available on the CFA website and are reported in local newspapers and on local radio. In addition, state forests, national parks and protected public lands are subject to a Prohibited Period whereby fire restrictions are in force all year round. Furthermore, a seasonal Prohibited Period may also be declared on all lands within 1.5 km of state forests, national parks and protected land. In north central Victoria, a seasonal Prohibited Period only applies to residents and visitors to Mitchell Shire Council (refer to the DEPI website for further information).

Preparing for floods

The **catchments** of north central Victoria include areas of flood-prone land, where flooding has historically caused substantial damage to both the natural and built environment. Floods are naturally occurring events, which have significant economic and environmental benefits, including the filling of water storages and wetlands. More than 500,000 hectares of rural and urban land across north central Victoria is subject to inundation by a 1 in 100 year flood. The January 2011 flood event was the largest on record for the majority of river systems in the region, inundating an estimated 780, 000 ha or 25% of the region.

When floods do occur it unfortunately provides those who live in flood prone areas with very little time to respond. For that reason, it is important that all residents are aware of their flood risk and of some of the basic measures they can take to avoid its effects. As with other emergencies, good planning is the key to minimising risk. With flooding the principle is simple: plan and develop valuable assets safe from flooding in the first instance. *Table 30* on Page 135 outlines a range of risk management actions that can be undertaken to prepare for flood. Property owners are encouraged to seek specific advice from the North Central CMA about the possibility of flooding on their property and to understand the potential risks. In addition, the SES has developed a number of flood guides and emergency plans to explain local flood risks for communities at risk and to advise on how to prepare for and respond to flood events. Contact the SES or visit their website for further information.

Preparing for thunderstorms

Thunderstorms regularly occur in north central Victoria, although they are more frequent between October and April when the weather is warmer. All thunderstorms produce lightening, which is dangerous itself, however not all thunderstorms are severe or are likely to cause damage. Thunderstorms are classified as severe when they produce any of the following:

- Hailstones with a diameter of 2 cm or more
- Wind gusts of 90 km/h or greater
- Flash flooding
- Tornadoes.

All of the above characteristics of severe thunderstorms can occur in north central Victoria. For example, in May 2003 a tornado with wind speeds of between 179 and 250 km caused damage to over 50 homes in Bendigo.

Severe thunderstorms are typically localised events, which impact a small area. For this reason, the threat they pose is typically underestimated by the community however they cause more damage than any other weather related emergency. They can damage trees, powerlines and buildings and have the potential to cause death and injury to community members. As with other emergencies, preparation is the key to reducing the risk and impacts of severe thunderstorms. Refer to *Table 31* on Page 136 for risk management actions that can be undertaken by property owners.

Loddon River and Serpentine Creek
in flood September 2010

Table 29: Risk management actions that can be taken to prepare for fire.

	Risk management actions
Before and during fire season	• Prepare your Home Emergency Kit and keep it in a handy spot. • Clean gutters and downpipes of leaves and rubbish. • Ensure roof and fences are in good repair and roofs are firmly fixed. • Ensure underfloor areas are enclosed or sealed. • Fix metal spark-proof screens to external vents. • Eliminate gaps in external eaves where burning embers might enter. • Ensure you have a hose that is long enough to reach every part of the house. • Consider installing a roof sprinkler system, preferably using a water source from a reticulated supply (e.g. diesel powered pump drawing water from a rainwater tank or swimming pool). • Consider installing non-combustible shutters, as when they're fully closed they can prevent windows breaking from flying debris and radiant heat. • Store fuels and chemicals away from the house. The pressure relief valves on LPG gas tanks should be directed away from the house. • Store wood away from the house. • Clear fine fuels from around the house (e.g. grass, bark and leaves) • Keep grass areas well trimmed and watered around the house, grass should be less than 10 centimetres high. • Reduce leave litter (dead leaves) to no more than one centimetre high around the house. • Remove or trim shrubs, there should be no shrubs over one metre next to or below windows. • Trim tree branches overhanging the house. • Ideally don't grow plants near your house that have a high content of volatile oil or resin, as they can burn fiercely (e.g. conifers, bottlebrushes and eucalypts). Instead keep plants away from buildings or utilise plants with a high moisture or salt content that maybe able to slow down a fire (e.g. fruit trees, succulents or saltbushes). • Install firebreaks by ploughing, applying herbicides or grading around the property or house block. They can provide access for surveillance or fire fighting activities. • Ensure key areas around building and stockyards are well grazed to reduce fuel loads. • Incorporate pasture rotations and grazing management to maintain short, green feed (e.g. lucerne or summer active perennials) are provided in key areas. • Prepare safe refuge areas for livestock by: – Cultivating, grading, slashing or applying herbicides – Eating out small paddocks with livestock grazing – Planting non-flammable tree lines that incorporate rapid, easy access to laneways and roads from grazing areas. • Maintain adequate stockyards and loading facilities. • Ensure you have a defendable emergency supply of feed that will meet your livestock's feed requirements for up to a week. Consider feed storages off-property if possible. • Consider all-steel fireproof fencing in key areas such as stockyards, boundaries and laneways.

	Risk management actions
When a fire is approaching	• If you are planning to Leave Early you should plan to leave early in the morning or even the night before during high fire danger periods. Leaving early means leaving long before the fire is in your area and long before you see flames. • Don't rely on mains water supply for sprinklers or home defence. Instead access water from rainwater tanks, dams or swimming pools. • Seal gaps, vents and roof spaces to prevent embers entering the house. • Close doors and windows, move doormats, outdoor furniture and other flammable objects away from the house. • Hose down the house walls, roof and garden (use sprinkler system if available). • Block downpipes and fill gutters with water. • Fill baths, sinks, buckets and other containers with water (for dousing fires that might be caused by embers entering the house). • Place wet towels and blankets against gaps in doors and windows. • Close curtains and shutters but don't take shelter in any part of the house where you can't see the fire's progress. • Keep informed via radio reports and keep your phone line free. • Wear loose fitting overalls or long-sleeved shirt and pants made from natural fabrics, not synthetics, which may melt and cause injury. Underwear and socks should also be of natural fibres. • Wear strong shoes or boots. • Wear safety goggles, gloves, a hat and smoke mask (or large, wet handkerchief over mouth and nose). • Restrain and confine small pets (cats, dogs and birds) so that you can easily find them and evacuate if the situation deteriorates. Ensure that pets can be identified if they become lost, including your contact details on the cage. If you decide to stay, put the pets in a room inside the house where they won't get in the way of your efforts protecting the property or livestock. Don't shut them in a shed, kennel or hutch outside as they will have no chance of saving themselves in a fire. • Move livestock to safe refuge areas (e.g. relatively bare paddocks, stockyards) or open all the internal property gates so that livestock have greater range of access on the property. Never leave an animal tethered or confined (e.g. stable) during a fire as they will have no chance of survival if a fire is approaching.
If you need to evacuate	• Complete the above if safe to do so. • Pack the car including your Home Emergency Kit. • Take pets with you if safe to do so. • Turn off mains power, water and gas. • Leave the front gate open so emergency services have easy access to your property.
During a fire	• If you plan to stay and defend your property refer to the CFA for advice on your personal capacity, property preparation, house design and construction, recommended equipment and resources and what you can expect to happen during a bushfire. You should develop a Bushfire Survival Plan and be aware that defending your home is very risky – you could be seriously injured, suffer psychological trauma or die. The safest option is to leave early.

Table 30: Risk management actions that can be taken to prepare for flood.

Timing	Risk management actions
Before a flood	• Prepare your Home Emergency Kit and keep it in a handy spot. • Use topographic maps and known flood levels to plan paddock layout and access laneways to higher refuge areas. • Where possible, install exit gates in fences at key locations to prevent livestock being isolated by floodwaters. • Prepare built-up feed pads to safe heights, you will need to determine the risk and cost benefit of events that have the probability of occurring once in 20, 50 or 100 years. • Maintain feed reserves in accessible storage above flood level. • Consider road access in flood times for ease of livestock evacuation. That is, you may have to walk or swim livestock to safety if road access isn't possible during a flood and livestock weren't relocated early. • Work with your neighbours to plan group strategies and to provide assistance during floods.
When a flood warning has been issued for your area.	• Listen to your local radio station for information. • Stack furniture and possessions above the likely flood level (e.g. on beds and in the roof). • Move garbage, chemicals and poisons to a high place. • Secure objects that float and may cause damage. • Move livestock to higher ground. • Check your car and fill it with fuel. • Check Home Emergency Kit and fresh water stocks. • Place important documents, valuables and medical supplies into a waterproof case in an accessible location.
If you need to evacuate	• Empty freezers and refrigerators, leaving doors open (to avoid floating and subsequent damage). • Collect and secure valuables (papers, money, photo albums, etc). • Take your pets with you if it is safe to do so, or provide adequate food and water and move them to a safer place. • Turn off mains power, water and gas. • Whether you leave or stay, put sand bags in the toilet bowl and over all laundry and bathroom drain holes to prevent sewage backflow into your home. • Take your Home Emergency Kit and mobile phone with you. • Lock your home and take recommended relocation routes for your area. • Do not drive into water of unknown depth and current.
During a flood	• Keep your Home Emergency Kit safe and dry. • Do not eat food which has been in contact with flood waters. • Do not drink flood water and boil all tap water. • Don't use gas or electrical supplies until they have been safety checked. • Beware of snakes and spiders which may move to the safety of your home. • Avoid wading as water may be contaminated. Do not drive or walk through flood waters of unknown depth or current. • Listen to the local radio and follow all warnings and advice.

Table 31: Risk management actions that can be taken to prepare for severe thunderstorms.

Timing	Risk management action
Before a severe thunderstorm	• Prepare your Home Emergency Kit and keep it in a handy spot. • Be aware of severe thunderstorm patterns in your area. • Regularly trim trees, remove branches overhanging buildings, and clear gutters and downpipes. • Regularly clear the yard of loose materials and rubbish. • Ensure buildings are well maintained (e.g. secure loose roof tiles). • Fit glass windows and doors with shutters or insect screens, and protect sky lights with wire mesh. • Check boats are securely moored or protected on land. • Maintain emergency feed reserves for livestock. • If you have intensively house livestock or dairy cattle ensure you have access to emergency power and suitable wiring connections for key machinery (e.g. water supply and milking equipment). • Install power failure and temperature alarm systems in fully enclosed intensive livestock sheds. • Install back-up storage facilities for effluent disposal systems to avoid contamination of waterways during power failures.
When a severe thunderstorm approaches	• Have your Home Emergency Kit ready. • Clear or secure loose objects from around buildings and the house yard. • Clean and check roof, guttering and down pipes. • Have plastic sheeting and large garbage bags available for rain protection; and masking tape for windows. • Listen to your local radio station for information. • Make sure pets and livestock are secure and have adequate shelter. • Move vehicles under cover or protect them with blankets and tarpaulins. • Disconnect electrical appliances. • Shut all doors and windows. • If outdoors, seek solid enclosed shelter. • If driving, stop clear of trees, power lines and streams. In a thunderstorm with severe winds or tornados don't stay in your vehicle, instead seek refuge in a building or if that's not possible lie flat in a ditch and protect your head.
During a storm	• Stay inside away from doors and windows, preferably in small interior room or stairwell on the lowest floor of the building. Ideally choose a room with walls that are reinforced with pipes (e.g. bathroom) or concrete. If possible crouch underneath heavy furniture and protect your head with a pillow or mattress. • Avoid using the telephone.

Environmental planting

Carbon Farming Initiative

The Carbon Farming Initiative (CFI) allows farmers and other land managers to earn carbon credits by storing carbon or reducing greenhouse gas emissions on the land. These credits, known as Australian Carbon Credit Units (ACCUs), can be sold to people and businesses wishing to offset their emissions. The CFI also helps rural communities and the environment supporting **sustainable** farming by creating incentives for landscape rehabilitation. Participation in the CFI is voluntary; farmers and landholders can choose whether or not to be involved.

The carbon market and carbon credits

In much the same way as financial markets trade in different currencies, carbon markets trade different types of carbon credits. For example, carbon markets trade different types of carbon credits. For example, carbon permits are generally issued by governments as part of a carbon pricing mechanism and carbon offsets are issued for abatement projects through schemes like the CFI. Each ACCU represents one tonne of carbon dioxide equivalents (CO^2-e). Abatement from all sorts of activities, including these that reduce methane or nitrous oxide emissions, can be measured in tonnes of CO^2-e. This standardisation allows the credits from different activities to be traded more easily. ACCUs can be traded and used to meet mandatory obligations and voluntary commitments on both the domestic and international markets. ACCUs do not have an expiry date and can be sold or banked for future use.

ACCUs can be traded both domestically and internationally in two major markets: the compliance and the voluntary markets. Compliance markets are those where buyers are obliged to offset their emissions by law, for example, energy companies and large industrial facilities. Voluntary markets are those where buyers purchase carbon credits because they want to reduce their emissions voluntarily and not so as to meet compliance obligations, for example, corporate carbon neutral programs or individual offsetting activities. Generally compliance markets attract higher prices than voluntary markets. These different markets have resulted in two different types of ACCUs:

1. Kyoto ACCUs can be sold to compliance or voluntary markets both domestically (can be surrendered under the carbon pricing mechanism) and internationally.

2. Non-Kyoto (voluntary) ACCUs can be sold to domestic (in accordance with the National Carbon Offset Standard) and international voluntary markets.

Before undertaking a CFI project, land managers should check which market the credits can be sold to and potential demand and incomes from different markets. For example, feral animal management activities generate Non-Kyoto (voluntary) ACCUs, which generally attract lower prices than Kyoto ACCUs.

Carbon farming opportunities

CFI projects can be broadly classified as a sequestration or emissions avoidance project. Sequestration projects generate carbon credits by removing carbon dioxide from the atmosphere and storing carbon in living biomass, dead organic matter or soil. Projects that avoid losses of vegetation or organic matter are also sequestration projects. Examples of sequestration activities include reforestation, **revegetation**, increasing soil carbon and protecting native forests or vegetation that is at imminent risk of clearing. Carbon stored in vegetation and soils can be released to the atmosphere, reversing the environmental benefit of the sequestration project. For this reason, all sequestration projects are subject to permanence obligations.

The second type of CFI projects are emissions avoidance projects which generate abatement by reducing or avoiding greenhouse gas emissions into the atmosphere. Greenhouse gases include methane (CH^4) and nitrous oxide (N^2O), although in some gases methane may be converted to carbon dioxide (CO^2) which is less potent greenhouse gas. Emissions avoidance projects can be further broken down into three main types of projects:

1. Agricultural emissions avoidance projects (for example, capture and destruction of methane from a livestock facility such as a dairy or piggery)

2. Introduced animal emissions avoidance projects (for example, controlling feral animal populations)

3. Landfill legacy emissions avoidance projects (for example, landfill gas flaring).

Broadly, the same rules apply for emissions avoidance projects as carbon sequestration projects, although the permanence obligation only applies to sequestration projects. *Table 32* below lists the approved CFI methodology determinations as of June 2013.

Table 32: Approved CFI methodology determinations as of June 2013.

CFI project type	Approved methodology determinations (as of June 2013)
Sequestration	• Environmental plantings • Human-induced regeneration of a permanent even-aged native forest • Quantifying carbon sequestration by permanent plantings of native Mallee eucalypt species using the CFI reforestation modelling tool. • Reforestation and Afforestation
Emissions avoidance	• Destruction of methane generated from dairy manure in covered anaerobic ponds • Destruction of methane from piggeries using engineered biodigesters • Destruction of methane generated from manure in piggeries • Savanna burning • Avoided emissions from diverting waste from landfill for process engineered fuel manufacture • Avoided emissions from diverting waste from landfill through a composting AWT technology • Capture and combustion of landfill gas • Capture and combustion of methane in landfill gas from legacy waste: upgraded projects

The integrity of CFI offsets

CFI projects must follow an approved methodology to ensure the abatement is measurable and verifiable. Methodologies set out the rules and instructions for undertaking projects, estimating abatement and reporting to the Carbon Credits Administrator. For example, the rules for setting project areas, baselines and monitoring requirements. A number of key concepts (*offsets integrity standards*) underpin the methodologies developed for CFI projects to ensure that the project results in abatement that would not have occurred in the absence of the scheme and that the abatement is permanent. *Table 33* outlines each of the key concepts underpinning CFI projects. Furthermore, before undertaking a CFI project there are a number of specific eligibility requirements that must be met, in addition to following an approved methodology, which include: the land is not subject to a carbon maintenance obligation, it does not involve the clearing of a native forest or using material obtained from the harvesting or clearing of native forest, and it is not a kind of project that is listed as an *excluded offsets project* in the CFI Regulations (known as the negative list). The negative list is a list of activities that are not eligible under the CFI, as the Australian government has determined that the kind of project poses a material risk to either the availability of water, **biodiversity** conservation, employment, the local community, or agricultural access. The negative list is regularly updated and is available online.

Undertaking a carbon farming project

Landholders can become involved in the CFI in a number of different ways, each with a different arrangement for sharing the costs, benefits and responsibilities for projects on your land. Management arrangements may include:

- Independently – the landholder undertakes a project themselves and are the Recognised Offset Entity (ROE)
- Cooperative – landholders form informal cooperatives to share knowledge and reduce costs, each landholder in the cooperative is a ROE.
- Multiple project proponents – when a couple or group jointly owns the land and/or right to undertake the project (multiple ROE).
- With service providers – landholders can use professional service providers to undertake any part of their project however the landholder is still the ROE, responsible for the project and receives the credits.
- Aggregators – landholders can engage a project aggregator who is responsible for some, or all, of the project, generally in exchange for a cut of the credits produced by the project. However the landholder is ultimately responsible for the project if something goes wrong, for example, the aggregator becomes insolvent.

It is the landholder's responsibility to ensure they are aware of their obligations under the CFI before consenting to a project, selling a carbon right or procuring professional services. Once it has been decided who will own and manage the CFI project there are a number of steps involved in undertaking the project, which are outlined in *Table 34* on Page 141.

Pig

Carbon farming project

Table 33: CFI offsets integrity standards.

CFI offsets integrity standard	Description
Additionality	The project must deliver reductions in carbon pollution that are additional or beyond what commonly occurs already, that is, reductions would not have occurred without the project having been implemented. The CFI includes an additionality test to ensure credits are only issued for additional abatement. Activities are placed on the positive list if they pass the additionality test and they are not required by law.
Conservative	Conservative assumptions, numerical values and procedures should be used to ensure that abatement and other claims are not over-estimated.
Internationally consistent	Estimation methods used must be consistent with the National Greenhouse Accounts and internationally agreed methodologies and reporting practices.
Leakage avoidance	Leakage occurs where an emissions reduction activity causes emissions to increase outside of the boundary of the project, thus neutralising the benefit of reducing emissions by the particular project. An example would be an avoided deforestation project that resulted in increased deforestation in another area of forest.
Measurable and verifiable	Emissions abatement need to be accurately measured or estimated to ensure each offset credit represents 1 tonne carbon dioxide equivalents (CO^2-e) of emissions reduction or removal. Methodologies set out in detail the technical requirements of measurements for specific projects. Projects should be verified by an independent, qualified third party auditor. CFI project proponents can choose when to submit a project report and receive carbon credits. A project report must be submitted at least once every five years and not within 12 months of a previous report. A report must also be submitted at the end of the crediting period.
Permanence	Permanence is only relevant to carbon sequestration projects and refers to the requirement that when emissions are taken out of the atmosphere and stored, they must not be re-released back into the atmosphere (otherwise the reduction in emissions will not be realised). The internationally accepted time frame at which biological carbon stores would generally considered permanent is 100 years. This is based on the estimated life of one tonne of carbon pollution in the atmosphere. Permanence requirements can impose ongoing obligations on lands that have hosted carbon sequestration projects however landholders can choose to cancel their project at any time by relinquishing (handing back) the carbon credits to the Carbon Credits Administrator. Under the CFI, five per cent of sequestration project ACCUs are withheld by the Risk of Reversal Buffer (a form of insurance to cover short term losses due to disturbance events).
Supported by peer-reviewed science	Methodologies used by the project will be underpinned by scientific evidence that must be peer-reviewed, or if based on peer-reviewed science, there must be independent and expert opinion validating the application of the approach or model in the relevant circumstances.

Table 34: Steps for participating in the Carbon Farming Initiative (CFI).

Planning a CFI project	• Check that a methodology determination exists for the activity. • Consider the legal, monitoring, auditing and financial aspects of the project.
Step 1	• Apply to become a Recognised Offsets Entity (ROE) by completing the Application for Recognition as an Offsets Entity Form. • Open an Australian National Registry of Emissions Units (Registry) account.
Step 2	• Apply for a project by completing the Application for Declaration for an Eligible Offsets Project Form. • The proponent must be responsible for carrying out the project, have the legal right to carry out the project and be a ROE. • The project area must not be used to meet a legal obligation to offset or compensate for the adverse impact of an action on vegetation. • For sequestration projects, the proponent must hold the applicable carbon sequestration right, have the consent of others with an eligbile interest in the land and agree to store the carbon in the project area for 100 years.
Step 3	• Undertake the approved project according to the applicable methodology determination and the requirements fo the Carbon Farming Initiative Act and regulations.
Step 4	• A project proponent can choose when to report and apply for credits. The first report is due within one to five years of the project being declared eligible and every one to five years thereafter. • The offsets report must be accompanied by an audit of the project by the National Greenhouse and Energy Auditor, which is paid for by the project proponent. Complete the Certificate of Entitlement Application including Offsets Report Form.
Step 5	• Applications for carbon credits are made at the same time as the project proponent submits their offsets and audit reports (Step 4) using the Certificate of Entitlement Application including Offsets Report Form.
Step 6	• The Clean Energy Regulator will assess applications and if a number of conditions are met a Certificate of Entitlement will be issued to the project proponent detailing them of the number and type of Australian Carbon Credit Units (ACCUs) that the project is entitled to recieve during that reporting period. • The ACCUs will be issued into the proponent's specified Australian National Registry of Emissions Units account.
Step 7	• Project closure occurs when the project's intended activities and timeframe are completed. • As participating in the CFI is voluntary, a project proponent can choose to withdraw from the CFI by notifying the Clean Energy Regulator at any time. If the project is a sequestration offsets project, all ACCUs issued or an equivalent number of eligible carbon units from other sources must be handed back to the Clean Energy Regulator.

Carbon farming case study: manure management

Intensive livestock industries produce large amounts of manure and greenhouse gas emissions. Under the CFI, manure management can generate carbon credits by reducing methane emissions. There are approved methodology determinations for the destruction of methane generated from both piggeries and dairies. Piggeries that use effluent lagoons to manage manure can cover these and install low-cost gas capture and combustion equipment. Gas from the lagoons can then be used to heat boilers, heat farrowing sheds (where piglets are housed) and also for generating electricity. This reduces the greenhouse gas emissions that would otherwise be released from the effluent ponds. Industry experts have estimated the carbon value of this activity alone is worth $2.50 to $3.50 per animal, without taking into account potential savings from generating electricity. Although, larger piggeries will have a faster payback period on the initial set up costs and it may not be financially viable for small piggeries.

Carbon farming case study: environmental plantings

Farmers and landholders can generate carbon credits from storing carbon in environmental planting sequestration projects. These projects involve establishing forests of native tree species on cleared land. Environmental plantings increase the removal of carbon dioxide from the atmosphere by sequestering (absorbing and storing) the greenhouse gas carbon dioxide (CO^2) as carbon, in the trees and tree debris. They also have a number of other benefits, such as enhancing water quality in **catchments**, providing protection for livestock (shade and shelter), improving biodiversity by providing **habitat** for birds and other **wildlife** and alleviating dryland salinity. Carbon sequestration in plantings can only offset emissions if it is stored permanently so they are subject to a 100-year permanence obligation. There is a tool to model carbon pools in forests (the Australian Government's Reforestation Modelling Tool) and a CFI mapping tool to help land managers map their project area and track progress over time.

Resources and further information

Australian CliMate iPhone and web application: www.australianclimate.net.au

Bureau of Meteorology: www.bom.gov.au

Bureau of Meteorology's Seasonal Outlooks: www.bom.gov.au/climate/ahead/

Carbon Farming Extension Providers' Portal: www.extensionprovidersportal.org.au

Clean Energy Future: www.cleanenergyfuture.gov.au

Clean Energy Regulator: www.cleanenergyregulator.gov.au

Climate Kelpie: www.climatekelpie.com.au

Dairy Australia's Climate Toolkit: www.dairyaustralia.com.au/Animals-feed-and-environment/Environment/Climate-redirect-page/MicroSite1/Home.aspx

Department of Agriculture Carbon Farming Initiative webpage: www.daff.gov.au/climatechange/cfi

Department of Agriculture 'Climate Change Communication and resources' webpage: www.daff.gov.au/climatechange/resources

Department of Industry, Innovation, Climate Change, Science, Research and Tertiary Education: http://climatechange.gov.au

Department of Sustainability and Environment (2008) Climate change in the North Central Region. Available from download at www.climatechange.vic.gov.au/regional-projections/north-central

Local climate tool: www.dpi.vic.gov.au/agriculture/farming-management/weather-climate/local-climate-tool

Managing Climate Variability: www.managingclimate.gov.au

Meat and Livestock Australia (2012) Carbon Farming Initiative Fact Sheet. Available for download at www.mla.com.au/News-and-resources/Publication-details?pubid=5993

Understanding Climate Change: www.climatechange.vic.gov.au

COMMUNITY

“ Regular communication and consideration of your neighbours is an important part of rural living and can even assist with property management. ”

Chapter 8
Community

Australian heritage

Australian **heritage** is all the things that contribute to Australia's identity, including both physical and intangible items. It includes our spirit and ingenuity, historic buildings and the natural environment. Australian heritage is a legacy from the past, which is part of our daily lives and that will be passed on to future generations. In north central Victoria, a rich trove of history and heritage survives from past eras.

Natural heritage

Natural heritage refers to places and living things of environmental significance that we believe should be kept for the future. It may be part of a river, mountain or bushland and include plants, animals, **ecosystems**, waterways or geological formations. It may be characterised by outstanding value from the point of science, conservation or natural beauty and/or by providing **habitat** for **threatened species** of animals and plants. Natural places may also have cultural significance as they are important to people for various regions. By conserving places of natural heritage communities are investing in human well-being, protecting the essence of Australia's unique character and securing an irreplaceable gift for future generations.

The National Reserve System is Australia's network of protected areas, conserving examples of our unique natural heritage (landscapes, plants and animals) for future generations. The system provides a natural safety net for the nation against environmental challenges, such as climate change and declining water resources. Protected areas are not locked away or isolated, rather they are actively managed and are a valued part of our landscape providing social, economic and scientific benefits. While national parks and reserves are the backbone of the National Reserve System, private landholders can also play an important role by protecting vulnerable plants, animals and critical habitats on their properties. This can be done by voluntarily placing perpetual covenants over parts of working properties, which helps protect valuable habitat and leaves the land better off for future generations. Landholders can receive government support (e.g. tax relief) and management advice by establishing conservation covenants on their properties. Many farmers have also used conservation covenants as a marketing advantage, as they badge their products as environmentally **sustainable**. For further information on protecting natural heritage on private property, contact Trust for Nature.

Aboriginal cultural heritage

Throughout north central Victoria, the landscape holds the imprint of thousands of generations of Aboriginal people that has created a rich cultural heritage for the region. European settlement had a profound impact on the land, **biodiversity** and water and has significantly affected Aboriginal people. The area now known as north central Victoria is the traditional land of the Dja Dja Wurrung, Barapa Barapa, Wamba Wamba, Wergaia, Wadi Wadi, Yorta Yorta and Taungurung people.

There are many important places for Aboriginal people across north central Victoria. These areas are important for various reasons including obtaining sustenance, expressing themselves artistically, passing on creation stories and cultural values, engaging in conflict, establishing alliances and social networks, trading goods, celebrating rites of passage and committing the departed to their final resting places. Underpinning these material aspects of Aboriginal cultural heritage are intangible places where there may be no physical evidence of past cultural activities. These include places of spiritual or ceremonial significance, places where traditional plant or mineral resources occur, or trade and travel routes. Information about such places may be passed down from one generation to the next or may survive in nineteenth century documents and records.

Traditional Owners and 'Country'

Traditional Owners often express being born from the land, that they belong to the land or that the land and people exist as one. Aboriginal culture is founded on respect and valuing all that exists in the world. Ancestral spirits have manifested everywhere in plants, animals and ecosystems. The concepts of spirit and identity are at the core of the Aboriginal connection to land. 'Country' can be described as the land, water (ground and surface water), all living things, the atmosphere and subterranean elements like soils and stone. 'Country' has an energy and life force which speaks and hears.

The physical health of 'Country', can affect the integrity of Aboriginal heritage. Poor environmental health has a direct impact on community health, a relationship that is well understood by Aboriginal people. Prior to European settlement, 'Country' was managed using a social structure and knowledge system that enabled a sustainable lifestyle over thousands of generations.

Aboriginal cultural heritage and land rights

Native title is the recognition in Australian law that some Indigenous people continue to hold rights to their land and waters, which come from their traditional laws and customs. It can however only be claimed on certain areas of land or water. For example, on vacant or unallocated Crown (Government) land but not on residential freehold land or public works like roads, schools or hospitals. Freehold land owners have exclusive possession of their land and having Aboriginal heritage on your property will not result in your land being taken from you. Residential, commercial and certain other types of leases also confer exclusive possession.

It is important however, that if you think places or items on your property may be considered Aboriginal heritage, contact The Office of Aboriginal Affairs Victoria (OAAV). The *Aboriginal Heritage Act 2006* requires all Aboriginal cultural heritage places or objects found on any public or private land in Victoria to be reported to OAAV. If suspected human remains are discovered, you must contact the Victoria Police and the State Coroner's Office immediately.

Donkey Gully ochre

Aboriginal rock well

Old tractor

Protecting and conserving Aboriginal cultural heritage

Aboriginal cultural heritage is a unique and irreplaceable part of Australia's national heritage and cultural identity. Protecting and conserving Aboriginal cultural heritage values and places is important if this cultural heritage and identity is to be maintained for current and future generations of Australians.

Many activities can unintentionally damage or destroy Aboriginal cultural heritage, for example, earthworks. Uncertainty about Aboriginal cultural heritage is not a valid excuse for proceeding with activities that may cause damage, instead land managers should use a precautionary approach until they are sure it is safe to proceed. Land managers can improve their awareness and understanding of Aboriginal cultural heritage by:

- Accessing the Victorian Aboriginal Heritage Register to determine whether their property has any recorded Aboriginal cultural heritage places or sites, such as scarred trees, occupation sites or places of burial.
- Utilising the Aboriginal Heritage Planning Tool if you are planning significant works on your property (e.g. stone extraction or removal, subdivision or dam construction). The tool will determine whether you require a Cultural Heritage Management Plan, Cultural Heritage Permit or cultural heritage agreement.

For further information land managers should contact OAAV or the North Central CMA.

Post European settlement cultural heritage

The physical remnants and intangible attributes of Australian history since European settlement are also important parts of Australia's cultural heritage. Physical remnants may range from old sheds to magnificent public buildings, works of art, collections of buried remnants, gardens, entire towns or places where significant events took place. These cultural heritage places can be found on public, agricultural, residential or commercial land. Laws and regulations apply to protect these areas. Intangible cultural heritage include folklore, knowledge and traditions.

North central Victoria is rich in cultural heritage, with one of the largest concentrations of listed cultural heritage in Victoria. This is in part due to the Victorian gold rushes of the mid-nineteenth century, which left a lasting legacy throughout the region, including ornate architecture, historic gardens and the region's rich Chinese heritage. Cultural heritage sites are also found along the Murray River, which played a critical role in the river traded that supported the pastoral boom in the late nineteenth century. Nationally recognised cultural heritage sites found within the region include the Castlemaine Diggings National Heritage Park and the Echuca Wharf. Landowners can learn whether a cultural heritage site occurs on their property by contacting local historical societies, museums and local councils or searching online. Information is also available regarding the protection and management of cultural heritage sites.

Being a good neighbour

Living in rural areas often means your nearest neighbour is quite some distance away. However how you manage vegetation, weeds, domestic animals, livestock, water, fire, fencing, machinery, vehicles and noise can significantly impact your neighbours and your relationship with them. Regular communication and consideration of your neighbours is an important part of rural living and can even assist with property management. For example, coordinating weed or pest control with neighbouring properties can be more effective and minimise the spread of invasive weeds and pests. When considering a move to a rural area, potential landowners should be mindful that although it may seem quite and picturesque, it could change through the seasons. Farming is a legitimate activity in areas zoned rural and noise, dust and smell may well be a part of life. For example, orchards may operate scare guns. Furthermore, slow heavy vehicles and livestock may occupy the roads.

Noise, dust and smoke

Landowners should avoid causing pollution (e.g. noise, dust, smoke and smell) wherever possible, especially when it affects your neighbours. If a noisy activity or one that produces dust, smoke or smell is unavoidable, it's best to advise your neighbours beforehand. Many of the disputes between neighbours relates to noise, such as motorbikes, barking dogs, generators or pumps. Where possible, landowners should plan their property so that noise is minimised along property boundaries. For example, situating kennels and animal enclosures away from your neighbours' homes or boundary and/or planting trees along the boundaries to buffer noises. If you are using motorbikes and 4WD on public land, all vehicles must be registered, and drivers must be licensed and comply with park regulations.

Unsealed roads and roadside verges are common throughout rural areas and can be slippery during all weather conditions. During dry periods they can produce a lot of dust, whilst they can be quite wet and muddy during rainy periods. It is important to drive to the road and weather conditions to prevent accidents and injury to the driver and other road uses. Drivers should slow down to reduce the dust produced, especially when houses are located close to the road. Slowing down also allows drivers to better anticipate **wildlife**, livestock and heavy vehicles that may be on the road.

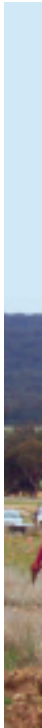
Landowners should be careful when planning to burn off paddocks or light bonfires, as you will be responsible for damage to neighbouring properties if the fire escapes. Fires shouldn't be lit between October and March and landowners should always check the fire danger ratings and fire restrictions before burning.

Boundary fencing

Responsibilities concerning boundary fence maintenance and construction are set out in the *Fences Act 1968*. Different responsibilities apply to different landowners. If your neighbour is a private landowner (person or company) fence maintenance and construction costs should generally be shared equally between neighbours. When constructing a new fence, landowners should get two quotes for materials and construction costs and discuss these costs and payment shares with their neighbour. If the fence is in good condition, the neighbour is not obliged to share the cost of a new, better looking fence. If your property borders state or federal government owned land (e.g. State forests or reserves) then you have to meet the full cost of fence construction and maintenance. Refer to the further information section below for more details. Landowners must keep their fences in good working order. Animals must not stray off your property onto your neighbour's property or the road. If they do and cause an accident or damage to your neighbour's property severe penalties may apply.

Organic farming

If you are planning to farm organically, let your neighbours know what this means. Plan suitable buffers between properties and try to work out an agreement if they need to alter their management practices to prevent pesticide drift onto your property. Reward your neighbours for helping you out. Organic farmers also need to advise water authorities, councils and public land managers who use pesticides for pest and weed control on roadsides and adjoining land.



Resolving conflicts

Problems often arise between neighbours when they don't understand what is happening and why. Avoid potential conflict by adopting a number of strategies such as:

- Get to know your neighbours and understand more about their farm and land management practices
- Be respectful of your neighbour's privacy, space and right to farm
- Control your pets and livestock so they don't stray onto the neighbouring property or harass other livestock. Notify your neighbours if their animals stray onto your property
- Be mindful that tree plantings may impact your neighbour's views and work cooperatively when managing vegetation on property boundaries
- Prevent pest, weed and disease spread onto your neighbour's property through appropriate preventive management strategies.

If a conflict does arise, try to reach a mutually agreeable solution through good communication as soon as the problem arises. Remember that you could be neighbours for some time and good relations will make things easier. Good communication strategies include: talking directly, choosing an appropriate time to meet, actively listening, talking it through and working through the solution(s). If you are unable to resolve the conflict seek mediation and advice from a third party, for example, your local council or government agency. Legal action should be a last resort, as it is often expensive and may not result in the desired outcome for either party.

Community groups

Joining a community group is a great way to get to know people in your local area. It also provides a number of other benefits, such as, opportunities to develop new skills and experience and make a contribution to the local community. There are a wide variety of different community groups in north central Victoria, such as Landcare, craft and sporting groups. If an existing community group doesn't meet your needs or interests it is also possible to create your own group.

Landcare planting day

Landcare

North central Victoria is home to many enthusiastic, capable and active community groups and individuals who are working to protect the region's natural environment. The Landcare movement started in north central Victoria 27 years ago, when in 1986 a group of local farmers from Winjallok formed the first Landcare group in Australia. North central Victoria is now home to more than 160 Landcare and community NRM groups, comprising of more than 4,000 volunteers (refer to *Figure 13*). Landcare networks comprising several Landcare groups and conservation management networks are also well established in north central Victoria. Groups undertake a variety of on-ground activities on both private and public land, including **revegetation**, fencing waterways, rabbit control, weed control, **erosion** control, installation of nest boxes and **remnant vegetation** protection. Groups also undertake a variety of other activities such as newsletters, bus tours, **flora** and **fauna** field days, working bees, community weed and pest animal days, preparing action plans and training days. To contact your nearest Landcare group, check http://northcentral.landcarevic.net.au/ or contact the North Central CMA.

Figure 13: Landcare groups in north central Victoria.

Resources and further information

Aboriginal Cultural Heritage in Victoria: www.dpcd.vic.gov.au/aboriginal-affairs/aboriginal-cultural-heritage

Bendigo Volunteers Resource Centre: www.bgovolunteers.org.au

Connecting Country – restoring landscapes around Mt Alexander: http://connectingcountry.org.au/

Conservation Management Networks: http://www.dse.vic.gov.au/conservation-and-environment/biodiversity/rural-landscapes/conservation-management-networks

Department of Sustainability, Environment, Water, Population and Communities - Australia's Heritage: www.environment.gov.au/heritage/

Fencing Quick Guide: The Layperson's Guide to Fencing Law: www.parliament.vic.gov.au/lawreform/inquiries/article/1659#government

Golding, F, Smith, T and Bowen, J (2002) Rural Law Handbook – A guide to the law for primary producers. Victoria Law Foundation, Melbourne, Victoria.

Junior Landcare: www.juniorlandcare.com.au

Landcare Australia: www.landcareonline.com.au

Landcare Gateway – North Central: http://northcentral.landcarevic.net.au/

Loddon Plains Landcare Network: www.lpln.org

Living Together in Rural Victoria – Good Neighbours: www.dpi.vic.gov.au/agriculture/environment-and-community/living-rural-victoria/good-neighbours

Our Community: www.ourcommunity.com.au/community/

The Australian Heritage Council: www.environment.gov.au/heritage/ahc/index.html

The Good Neighbour Program: www.dse.vic.gov.au/plants-and-animals/invasive-species/good-neighbour-program

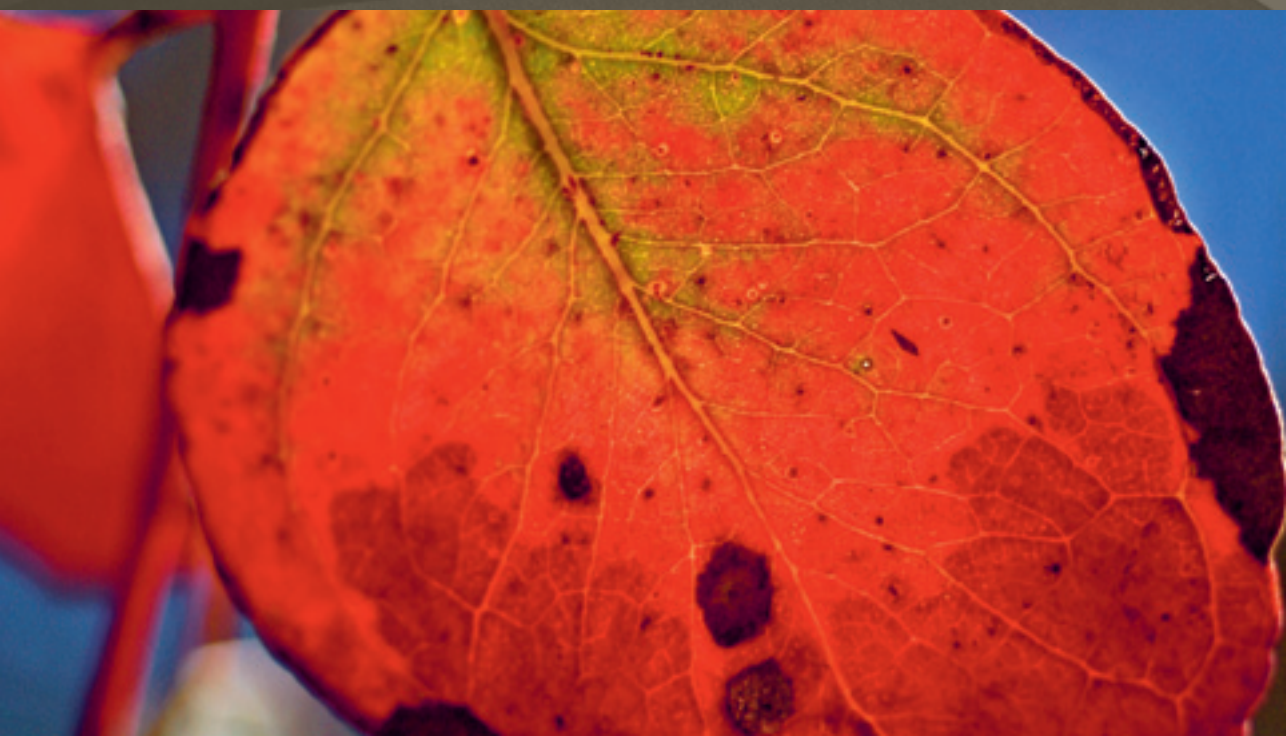
The National Trust of Australia: www.nationaltrust.org.au

Vic-Heritage iPhone Application: https://itunes.apple.com/au/app/vic-heritage/id481956934?mt=8

Victorian Department of Planning and Community Development – Heritage: www.dpcd.vic.gov.au/heritage

Victoria's planning schemes (refer to the Environmental Significance and Heritage Overlays): http://planningschemes.dpcd.vic.gov.au/

Victoria's Volunteering Portal: www.volunteer.vic.gov.au



Key contacts

Contact Name	Role
All Stake Supply 60 Princes St (PO Box 335), Riverstone, NSW 2765 1300 130 123 sales@allstakesupply.com.au www.allstakesupply.com.au	*Privately owned company supplying a broad range of products for erosion control and revegetation projects.*
Bendigo Regional Institute of TAFE PO Box 170, Bendigo VIC 3552 1300 554 248 info@britafe.vic.edu.au www.britafe.vic.edu.au	*Government owned technical and further education provider. Campuses are located in Bendigo, Castlemaine, Echuca, Kerang, Kyneton and Maryborough. The TAFE provides a broad range of courses, including agriculture, horticulture and land management courses.*
Conservation Volunteers Australia Greenhill Enterprise Centre, Corner of University Drive and Enterprise Grove, Mt Helen, VIC 3350 (PO Box 423, Ballarat, VIC 3353) 1800 032 501 info@conservationvolunteers.com.au www.conservationvolunteers.com.au	*A not-for-profit organisation, which aims to attract, manage and support volunteers to participate in projects that protect or enhance our environment and heritage.*
Country Fire Authority **District 18 Headquarters** 120 Curlewis St (PO Box 558), Swan Hill, VIC 3585 03 5036 2800 **District 2 Headquarters** 45 Chapel St (PO Box 3), Bendigo, VIC 3552 03 5430 2200 **District 20 Headquarters** 56 Fitzroy St (PO Box 152), Kerang, VIC 3579 03 5450 3406 **Victorian Bushfire Information Line:** 1800 240 667 www.cfa.vic.gov.au	*A volunteer and community based fire and emergency services organisation, which helps protect 3.3 million Victorians and more than one million homes and properties across the state.*
Country Women's Association of Victoria 3 Lansell Rd, Toorak VIC 3142 03 9827 8971 www.cwaofvic.org.au / www.cwaa.org.au	*A self-funded, non party political and non-sectarian organisation, which aims to improve the conditions for women and children and make life better for families, especially those living in rural and remote Australia.*
Department of Agriculture 7 London Circuit (GPO Box 858), Canberra ACT 2601 1800 020 504 www.daff.gov.au	*An Australian Government department that develops and implements policies and programs, which aim to ensure Australia's agricultural, fisheries, food and forestry industries remain competitive, profitable and sustainable.*

Department of Environment and Primary Industries (DEPI) 8 Nicholson St, East Melbourne, VIC 3002 (PO Box 500, Melbourne, VIC 3002) 136 186 www.depi.vic.gov.au **Regional Offices:** Bendigo: Corner of Midland Hwy and Taylor St, Bendigo VIC 3551 Daylesford: 14 Mineral Water Drive, Daylesford VIC 3460 Echuca: Corner of Annesley St and Ogilvie Ave, Echuca VIC 3564 Heathcote: 28 Herriot St, Heathcote VIC 3523 Kerang: 26 Wellington St, Kerang, VIC 3579 Maryborough: Office 2, 82 Alma St, Maryborough VIC 3465 Swan Hill: 324-330 Campbell St, Swan Hill VIC 3585	*The State government department focuses on boosting the productivity of Victoria's food and fibre sector. DEPI's responsibilities include:* • *managing land and water on public and private land* • *improving service delivery to regional areas* • *focus on jobs and investment* • *delivering better regulation* • *building and maintaining healthy, natural environments* • *managing our natural resources* • *responding to fire, flood and biosecurity emergencies.*
Department of Environment John Gorton Building, King Edward Terrace, Parkes, VIC 2600 (GPO Box 787, Canberra, ACT 2601) 1800 803 772 ciu@environment.gov.au www.environment.gov.au	*The department is responsible for implementing the Australian Government's policies to protect our environment and heritage, and to promote a sustainable way of life.*
Environment Protection Authority (EPA) Victoria 200 Victoria St, Carlton, VIC 3053 (GPO Box 4395, Melbourne, VIC 3001) 1300 372 842 contact@epa.vic.gov.au www.epa.vic.gov.au	*Government authority responsible for regulating pollution and reducing negative environmental impacts.*
Greening Australia 333 Bennets Rd, Norman Park, Qld 4170 1300 886 589 general@greeningaustralia.org.au www.greeningaustralia.org.au	*Non-government, environmental organisation, which aims to protect and restore the health, diversity and productivity of Australian landscapes. It provides trees and tree planting services, technical advice and education, volunteer coordination and funding for restoration projects.*
Landcare Australia Limited Level 10, Farrer House, 24-28 Collins Street, Melbourne, VIC 3000 03 9662 9977 enquiries@landcareaustralia.com.au www.landcareonline.com.au	*Private, not-for-profit company, which aims to raise corporate sponsorship for the Landcare and Coastcare movements and raise community awareness of the programs and brands.*
Local government **Buloke Shire Council** 367 Broadway (PO Box 1), Wycheproof, VIC 3527 1300 520 520 buloke@buloke.vic.gov.au www.ngshire.vic.gov.au **Central Goldfields Shire** 22 Nolan Street (PO Box 194), Maryborough, VIC 3465 03 5461 0610 mail@cgoldshire.vic.gov.au www.centralgoldfields.com.au	*Council activities are diverse and extensive. They maintain infrastructure, provide a range of services and enforce various laws for their communities. Infrastructure maintained by councils include: roads, bridges, drains, town halls, libraries, recreation facilities, parks and gardens. Services provided by councils include: property, economic, human, recreational and cultural services. Councils also enforce State and local laws relating to such matters as land use planning, environment protection, public health, traffic and parking and animal management.*

City of Greater Bendigo
195-229 Lyttleton Tce (PO Box 733), Bendigo VIC 3552
03 5434 6000
enquiries@bendigo.vic.gov.au
www.bendigo.vic.gov.au

Gannawarra Shire Council
Patchell Plaza, 47 Victoria St (PO Box 287),
Kerang, VIC 3579
03 5450 9333
council@gannawarra.vic.gov.au
www.gannawarra.vic.gov.au

Hepburn Shire
76 Vincent St (PO Box 21), Daylesford, VIC 3460
03 5348 2306
shire@hepburn.vic.gov.au
www.hepburn.vic.gov.au

Loddon Shire Council
41 High St (PO Box 21), Wedderburn, VIC 3518
03 5494 1200
loddon@loddon.vic.gov.au
www.loddon.vic.gov.au

Macedon Ranges Shire Council
129 Mollison St (PO Box 151), Kyneton, VIC 3444
03 5422 0333
mrsc@mrsc.vic.gov.au
www.mrsc.vic.gov.au

Mitchell Shire Council
113 High St, Broadford, VIC 3658
03 5734 6200
mitchell@mitchellshire.vic.gov.au
www.mitchellshire.vic.gov.au

Mount Alexander Shire Council
25 Lyttleton St (PO Box 185), Castlemaine, VIC 3450
03 5471 1700
info@mountalexander.vic.gov.au
www.mountalexander.vic.gov.au

Northern Grampians Shire Council
63-65 Main St (PO Box 580), Stawell, VIC 3380
03 5358 8700
ngshire@ngshire.vic.gov.au
www.ngshire.vic.gov.au

Pyrenees Shire Council
5 Lawrence St, Beaufort, VIC 3373
03 5349 1100
pyrenees@pyrenees.vic.gov.au
www.pyrenees.vic.gov.au

Shire of Campaspe
Cnr Hare and Heygarth St (PO Box 35),
Echuca VIC 3564
1300 666 535 (STD free within shire only);
03 5481 2200 (outside shire area)
shire@campaspe.vic.gov.au
www.campaspe.vic.gov.au

Swan Hill Rural City Council
45 Splatt St (PO Box 488), Swan Hill, VIC 3585
03 5036 2333
council@swanhill.vic.gov.au
www.swanhill.vic.gov.au

National Centre for Farmer Health
Western District Health Service, MacKellar House,
Tyers St (PO Box 283), Hamilton VIC 3300
03 5551 8533
www.farmerhealth.org.au

The Centre is a not-for-profit organisation providing national leadership to improve the health, safety and well-being of farm men and women, farm workers, their families and communities across Australia.

National Farmers Federation (NFF)
NFF House, 14-16 Brisbane Av, Barton, ACT 2604
(PO Box E10, Kingston, ACT 2604)
02 6269 5666
www.nff.org.au

The peak national body representing farmers and, more broadly, agriculture across Australia. It is one of Australia's foremost and respected advocacy organisations. It is a champion for issues affecting farmers and is dedicated to the advancement of agriculture. NFF's members are the state-level farmers' organisations, national commodity councils and other affiliated members.

Native plant nurseries

Native plant nurseries specialise in native plant propagation and can provide advice on species selection and revegetation projects.

A & B Trees
PO Box 245, Heathcote VIC 3523
03 5433 2236
a-btrees@netcon.net.au
www.a-btrees.com.au

Acres Wild Nursery
42 Anslow St, Woodend VIC 3442
03 5427 2788

Ballarat Wild Plants
435 Joseph St, Ballarat VIC 3350
03 5333 5548 or 0409 388 014
wildplants@ncable.net.au

Banyandah Nursery
PO Box 26, Donald VIC 3480
03 5497 1682
peterussell@iinet.net.au
http://www.members.iinet.net.au/~peterussell/BanyandahIndex.html

Forest Creek Nursery
4 Midland Hwy, Castlemaine VIC 3450
03 5472 3167

Gannawarra Trees
101 McMillians Rd, Cohuna VIC 3568
03 5456 4587

Goldfields Revegetation
230 Tannery Lane, Mandurang VIC 3551
03 5439 5384
info@goldfieldsrevegetation.com.au
www.goldfieldsrevegetation.com.au

Granite Ridge Indigenous Plants
PO Box 634, Lancefield VIC 3435
03 5429 1904

Ko-warra Native Grasses
PO Box 396, Moama NSW 2731
03 5480 9778
kowarra@bigpond.com
www.nativegrasses.com.au

McKindlay's Riverine Nursery
2220 Perricoota Rd (PO Box 32), Moama VIC 2731
03 5483 6240
info@mckindlyasrivernursery.com.au
www.mckindlaysrivernursery.com.au

Neangar Nursery
8 McClelland Drive (PO Box 166), Eaglehawk VIC 3556
03 5446 9260
neangarnursery@bigpond.com
www.neangarnursery.com.au

Newstead Natives
4 Palmerston St, Newstead VIC 3462
(By appointment only)
03 5476 2691
natives@newstead.vicmail.net

Rochester Native Nursery
A6708 Northern Highway, Rochester VIC 3561
03 5484 3777
www.rochesternursery.com.au

Swan Hill Native Nursery and Tree Planting
Lot 6 1085 Grey Rd, Waitchie, VIC 3544
03 5039 2254

Victorian Indigenous Nursery Cooperative
Yarra Bend (PO Box 24), Fairfield VIC 3078
03 9482 1710
info@vinc.net.au
www.vinc.net.au

Western Plains Flora
628 Wildwood Road, Wildwood VIC 3429
03 9740 3178
admin@wpflora.com.au

North Central Catchment Management Authority (CMA) 628-634 Midland Hwy (PO Box 18), Huntly, VIC 3551 03 5448 7124 info@nccma.vic.gov.au www.nccma.vic.gov.au	*The lead natural resource management (NRM) agency in north central Victoria, delivering programs in partnership with communities and other agencies to protect and enhance the integrity of the region's four river catchments: Campaspe, Loddon, Avoca and Avon-Richardson.*
Parks Victoria Level 10, 535 Bourke St, Melbourne, VIC 3000 13 19 63 info@parks.vic.gov.au parkweb.vic.gov.au	*Statutory authority that is responsible for the management of an expanding and diverse estate covering more than four million hectares (17%) of Victoria. This includes national parks, state parks, marine national parks, conservation reserves and Aboriginal cultural heritage places. The authorities primary responsibility is to ensure parks are healthy and resilient for current and future generations.*
Regional Waste Management Groups www.avrwmg.org.au **Calder Regional Waste Management Group** PO Box 303, Woodend, VIC 3447 03 5427 3479 crwmg@bigpond.com **Central Murray Regional Waste Management Group** PO Box 144, Wedderburn, VIC 3518 03 5494 3711 www.cmrwmg.vic.gov.au **Grampians Regional Waste Management Group** 38 Wimmera St, Stawell, VIC 3380 03 5358 5680 **Highlands Regional Waste Management Group** PO Box 1067, Ballarat MC, Ballarat, VIC 3354 03 5333 7770 http://hrwmg.vic.gov.au	*Regional Waste Management Groups are responsible for planning the management of municipal solid waste in Victoria. There are 13 regions and each one encompasses one or more municipalities.* *To coordinate and direct the waste management activities of its member councils, each Regional Waste Management Group produces a regional plan. The regions also play a key role in educating the community about waste and environmental issues.*

Rural Financial Counselling Service www.ruralfinancialcounselling.org.au **North Central Head Office** 58a Mundy St, Bendigo, Vic 3550 03 5442 2424 tgretgrix@rfcsvicnc.com.au **Murray Mallee Head Office** 139 Lime Avenue (PO Box 2824), Mildura, VIC 3500 03 5022 0799 admin@sunrcs.com.au www.sunrcs.com.au	*Locally managed, not-for-profit body of Rural Financial Counsellors, who provide independent financial assessments for farming families and small rural businesses faced with difficult decisions. The service is free and confidential.*
Seeding Victoria Inc www.seedingvictoria.com.au **Ballarat Region Seed Bank** La Gerche Gully, Sawpit Rd (PO Box 3), Creswick VIC 3363 03 5345 2200 dan@seedbank.com.au **Murray Mallee Seed Bank** PO Box 346, Nyah VIC 3594 03 5030 3166	*Seeding Victoria Inc manages a network of seedbanks to provide provenance based seed supply for revegetation projects throughout central, south west and north west Victoria. We are a community not for profit, charitable organisation with a central board and steering committees for each regional seedbank.*
Sunraysia Institute of TAFE PO Box 1904, Mildura VIC 3502 03 5022 3666 mildura@sunitafe.edu.au www.sunitafe.edu.au	*Government owned technical and further education provider. Campuses are located in Mildura, Ouyen, Robinvale and Swan Hill. The TAFE provides a broad range of courses, including agriculture, horticulture, animal and equine studies, conservation and land management courses.*
Sure Gro Unit 1, 42-44 Garden Boulevard, Dingley VIC 3172 1800 643 384 sales@suregro.com www.suregro.com	*Privately owned company providing land management, soil erosion control, revegetation, landscaping and nursery products nationwide.*
The Office of Aboriginal Affairs Victoria Level 9, 1 Spring St (GPO Box 2392), Melbourne, VIC 3001 1300 366 356 aboriginal.affairs@dpcd.vic.gov.au www.dpcd.vic.gov.au/aboriginal-affairs	*The Office of Aboriginal Affairs Victoria (OAAV) is responsible for ensuring a whole-of-government, coordinated and focused approach for Aboriginal affairs in Victoria. OAAV work focuses on reducing inequalities experienced by Aboriginal Victorians and providing advice on Aboriginal cultural heritage.*
Treemax 1800 550 000 www.treemax.com.au	*Privately owned company providing erosion and sediment control products, tree guards and associated products for erosion and revegetation projects.*
Trust for Nature Level 5, 379 Collins St, Melbourne, VIC 3000 1800 999 933 trustfornature@tfn.org.au www.trustfornature.org.au	*Trust for Nature is a not-for-profit organisation that works to protect native plants and wildlife in cooperation with private landowners. It does this through a number of tools including conservation covenants, purchasing private properties with high conservation values and/or managing private properties for conservation.*

Water Corporations

Water corporations provide a range of water services to customers within their service areas comprising water supply, sewage and trade waste disposal and treatment, water delivery for irrigation, domestic and livestock purposes, drainage and salinity mitigation services. A number of them also manage bulk water storages and designated recreational areas throughout Victoria and assist the Minister in operating the Victorian Water Register.

Central Highlands Water
7 Learmonth Rd, Wendouree, VIC 3355
(PO Box 152, Ballarat, VIC 3353)
1800 061 514
custenq@chw.net.au
www.chw.net.au

Coliban Water
37–45 Bridge St, Bendigo, VIC 3550
(PO Box 2770, Bendigo DC, VIC 3554)
1300 363 200
coliban@coliban.com.au
www.coliban.com.au

Goulburn Murray Water
40 Casey St (PO Box 165), Tatura VIC 3616
1800 013 357 (General enquiries) or
1800 064 184 (Emergencies – 24 hrs)
reception@g-mwater.com.au
www.g-mwater.com.au

Goulburn Valley Water
104–110 Fryers St, Shepparton VIC 3630
(PO Box 185, Shepparton VIC 3632)
03 5832 0400 (General enquiries) or
1800 45 45 00 (Emergencies – 24 hrs)
mail@gvwater.vic.gov.au
www.gvwater.vic.gov.au

Grampians Wimmera Mallee (GWM) Water
11 McLachlan St (PO Box 481), Horsham, VIC 3402
1300 659 961 (General enquiries) or
1800 188 586 (Service difficulties or faults)
info@gwmwater.org.au
www.gwmwater.org.au

Lower Murray Water
Swan Hill Area Office: 73 Beveridge St (PO Box 1447),
Swan Hill, VIC 3585

Kerang Area Office:
56 Wellington St (PO Box 547), Kerang, VIC 3579
03 5051 3400 (General enquiries, faults or emergencies) or 1800 808 830 (After hours faults or emergencies)
admin@lmw.vic.gov.au
www.lmw.vic.gov.au

Western Water
36 Macedon St, Sunbury, VIC 3429
(PO Box 2371, Sunbury DC, VIC 3429)
1300 650 422 (General enquiries) or 1300 650 425 (Faults and emergencies)
mail@westernwater.com.au
www.westernwater.com.au

Victorian Farmers Federation (VFF)
Farrer House, Level 5, 24 Collins St, Melbourne, VIC 3000
1300 882 833
members@vff.org.au
www.vff.org.au

The largest state farmer organisation in Australia, representing over 10,000 members and 6,000 farm businesses across Victoria. It is a political lobby group dedicated to the interests of farmers and making a difference to communities.

Glossary

Agistment	Taking in another person's livestock (e.g. sheep, cattle or horses) to be fed and/or grazed on your own property, for an agreed price and time period.
Agroforestry	A system of land use whereby harvestable trees and shrubs are integrated into farming landscapes, as a means of protecting the land's natural resources and enhancing productivity.
Annual plant	Plant that grows to maturity, sets seed and dies within one year.
Aquifer	A layer of rock or sediment that is able to hold or transmit water.
Aureole	A band of metamorphic rock surrounding a body of cooled magma.
Basalt	A hard, dense, dark gray, fine grained igneous rock, which is mostly made up of calcium-rich plagioclase feldspar and pyroxene. It is the most common type of solidified lava.
Biodiversity	The variety of all life-forms, the different plants, animals and micro-organisms, the genes they contain, and the ecosystems of which they form a part.
Bioregion	Areas that capture the patterns of ecological characteristics in the landscape, providing a natural framework for recognising and responding to biodiversity values.
Cambrian Period	Of or belonging to the geologic time, system of rocks or sedimentary deposits of the first period of the Palaeozoic Era, approximately 505-570 million years ago. It is characterised by desert land areas, warm seas and the diversification of marine invertebrates, from which almost all modern animal phyla arise from.
Catchment	An area of land where run-off from rainfall flows into a river system.
Carrying capacity	The number of livestock you can sustainably graze on an area of land or property.
Cereal	Term used to describe grasses (members of the Poaceae family) that are grown for their edible, mature, dry seed. E.g. wheat, barley and oats.
Corridor	A belt of land between two other areas, usually having a particular feature of giving access to a particular area. Vegetation corridors can form important links between areas of remnant vegetation. E.g. vegetation along roads and waterways.
Crediting period	The length of time set out in the CFI legislation that different activities can generate credits using an approved CFI methodology.
Discharge area	The area where there is upward movement of groundwater and where groundwater is discharged from the soil surface. Groundwater escapes via springs, evaporation, transpiration and surface drainage (see recharge area).
Ecological Vegetation Class	A type of native vegetation classification that is described through a combination of its floristic, life form, and ecological characteristics, and through its preferences for a particular environment.
Ecosystem	A term used to encompass all the organisms in a community, together with the associated physical environmental factors (living and non-living) with which they interact.

Ecosystem services	'Services' provided by nature, such as habitat for native plants and animals; erosion control; reduction of greenhouse gases; natural pest control; maintenance of the land's productivity; protection of good water quality; provision of shade and shelter for farm animals; and aesthetics.
Environmental weed	Plant species that predominantly invade natural areas and compete with, or choke out, native plant communities.
Erosion	Loss of soil by the action of wind and water.
Fauna	Animals.
Flora	Plants.
Geomorphology	The science of the physical features of the earth's surface in relation to its geological structures – their origin, evolution, form and distribution.
Gradational	Any process or change taking place through a series of stages, by degrees, or in a gradual manner.
Grassland	Area dominated by native grasses. Native grasslands are now a severely threatened plant community.
Groundwater	Water that collects or flows beneath the Earth's surface, filling the porous spaces in soil, sediment and rocks. Groundwater originates from rain, melting snow and ice and is the source of water for aquifers, springs, and wells. The upper surface of groundwater is the water table.
Habitat	The place or environment in which a plant or animal naturally occurs that contains everything it needs to live.
Heath	Natural area of land dominated by shrubs and other plants less than two metres tall. The plants generally have hard, thick leaves which reduce their water loss.
Herbivore	An animal that feeds on grass and other plants, for example, sheep, cows and horses. They do not eat other animals.
Heritage	Aesthetic, historic, scientific, cultural or social value for past, present or future generations.
Igneous rocks	Rocks formed by the cooling and solidifying of molten materials. They can form beneath the Earth's surface, or at its surface, as lava.
Indigenous plants	Plants native to a particular location.
Inorganic	Substances of mineral origin (e.g. rocks and their degradation products), as opposed to those of biological origin.
Inversion layer	A thin layer of the atmosphere in which there is a temperature inversion, whereby the normal decrease in air temperature with height switches to the air temperature increasing with height. This layer tends to prevent the air from below it rising, thus trapping any pollutants that are present.
Land Capability Assessment	A report, prepared by a suitably qualified person, which you may need to submit to your local council if you plan to use an on-site wastewater management system such as a septic tank system to treat wastewater on a residential development in an un-sewered area.
Land capability class	The evaluation and classification of agricultural land based on the biophysical, social and economic factors that may constrain agricultural production levels and/or land use options. In general terms, the fewer the constraints on the land, the greater its value for agriculture.

Large woody debris	Branches and whole trunks fallen onto the stream bank and into the river (snags).
Legumes	A plant from the Fabaceae family, or the fruit or seed from such as plant. E.g. Peas, beans or clover.
Metamorphic rocks	Rocks that are formed when igneous, sedimentary or other metamorphic rocks undergo a physical change due to extreme heat and pressure. These rocks often display banding or folded layers and they can cause pockets of precious minerals to form.
National Livestock Identification Scheme	Australia's system for the identification and traceability of cattle, sheep and goats. An electronic ear tag enables animals to be reliably identified and tracked from their property of birth to slaughter. The central database can also identify all the other animals an individual animal has interacted with. If a disease outbreak was to occur, the system could be used to quickly isolate the disease.
Native vegetation	Refers to plants that are indigenous, including trees, shrubs, herbs and grasses.
Noxious weeds	Under the Catchment and Land Protection (CaLP) Act 1994 certain plants are declared as noxious weeds in Victoria and are classified as State Prohibited, Regionally Prohibited, Regionally Controlled or Restricted. Noxious weeds may negatively impact agricultural productivity and/or the natural environment.
Oilseeds	A variety of plants grown primarily for their seeds, which contain edible oils. E.g. Canola and sunflowers.
Ordovician Period	Of or belonging to the geologic time, systems of rocks, or sedimentary deposits of the second period of the Palaeozoic Era, approximately 438-505 million years ago. This period was characterised by the appearance of jawless fish.
Ped	A naturally formed soil aggregate, such as a granule, a prism or a block.
Perennial plants	Plants that live for more than two years.
Plant Breeders Rights	Legally enforceable rights that give the owner(s) of new varieties of plants (that are distinguishable, uniform and stable) the exclusive rights to commercially use it, sell it, direct the production, sale and distribution of it, and receive royalties from the sale of the plant variety.
Provenance	The place of origin of a species, subspecies or variety.
Quartzite	A rock formed from the metamorphism of quartz sandstone.
Recharge area	An area that allows water to enter the aquifer.
Recognised offsets entity	An entity that has satisfied the 'fit and proper' test (examines whether the applicant has any prior criminal convictions etc) and is then eligible to apply to have projects declared as eligible offsets projects.
Remnant vegetation	Any patch of naturally occurring native vegetation around which most or all of the native vegetation has been removed. It may include corridors or islands of vegetation located on land being used for a variety of purposes.
Regeneration	The process of reintroducing vegetation to a site by natural regenerative processes, which may include human intervention but excludes planting.
Revegetation	Planting an area with its original species.

Riparian	Land that adjoins or directly influences a body of water, i.e. the river bank.
Road batter	A road batter is a constructed earth slope cut into the hillside or made of fill material. A track running across a slope will often have a cut batter on the upslope and a fill batter on the down slope.
Salinity	The concentration of salts in land and water, usually expressed in EC units.
Schist	A coarse grained metamorphic rock that consists of parallel layers of different minerals and can be split into thin irregular plates (e.g. flakes or slabs).
Sedimentary rocks	Rocks that have formed through the decomposition and solidification of sediment, which is often deposited in layers and often contains fossils. The sediment maybe transported by water, ice or wind. Limestone and sandstone are common types of sedimentary rocks.
Soil organic matter	Refers to all the living (e.g. plant roots and soil organisms) and decomposing plant and animal matter (e.g. leaves, manure and compost).
Soil sodicity	Soils in which sodium ions occupy more than six percent of the cation exchange sites. The sodium ions negatively impact soil structure by causing clay particles to disperse on wetting, which forms a crust on the soil surface on drying that reduces air and water movement within the soil profile.
Subsoil	The layer of soil immediately below the surface soil (topsoil) and overlying the bedrock. It predominantly consists of minerals, leached materials, humus remains and clay. Soil organisms spend little time in the subsoil layer hence it's low organic matter levels.
Sustainable	Activities that preserve and improve the long-term health of soil, water, vegetation, native animals and community.
Threatened species	A generic term for a plant or animal generally considered as vulnerable or endangered under various threatened species conservation laws. It is used to indicate that there is some level of threat to the species' viability in the wild.
Topsoil	The surface or upper level of soil, generally within 10 cm of the surface.
Tributary	A stream or river that feeds another larger one.
Tube stock	Plants in tubes.
Wildlife	Native animals (fauna).
Woodland	Natural area of land dominated by widely spaced trees.

Acronyms

ABVs	Australian Breeding Values
ACCAs	Agricultural Chemical Control Areas
ACUP	Agricultural Chemical Users Permit
ASBVs	Australian Sheep Breeding Values
CEC	Cation Exchange Capacity
CMA	Catchment Management Authority
CO2-e	Carbon dioxide equivalent
DEPI	Department of Environment and Primary Industries
DM/ha	Dry matter per hectare
EBVs	Estimated Breeding Values
ENSO	El Niño – Southern Oscillation
EVC	Ecological Vegetation Class
FFG	Flora and Fauna Guarantee
Ha	Hectare
IOD	Indian Ocean Dipole
NLIS	National Livestock Identification Scheme
NRM	Natural resource management
NVD / Waybill	National Vendor Declaration and Waybill
OAAV	The Office of Aboriginal Affairs Victoria
PBR	Plant Breeders Rights
ROE	Recognised Offset Entity
SAM	Southern Annular Mode
STR	Sub-tropical Ridge

Index

CARING FOR COUNTRY

A sustainable land management guide for rural living in north central Victoria

Crops, pastures, horses, salinity, revegetation...there are so many possibilities and potential obstacles associated with owning your own property that it can be overwhelming to know where to begin.

The Caring for Country land management guide aims to assist new and existing land managers, particularly those in the rural living zone, to protect the health of their land and the broader environment. It provides a starting point for information on a variety of topics related to sustainable land management.

It will help you care for your land – your soil, biodiversity, waterways, plants and animal life – so that it will be in better shape for the next generation.

NORTH CENTRAL Catchment Management Authority
Connecting Rivers, Landscapes, People

CARING FOR OUR COUNTRY

Victoria

Regional Landcare Facilitator

Landcare Victoria

CITY OF GREATER BENDIGO

MOUNT ALEXANDER SHIRE COUNCIL

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