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Wool industry river management guide:

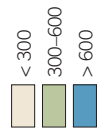
Sheep/wheat zones

SHEEP/WHEAT ZONES

Main agronomic zones for wool production based on average annual rainfall, 1980–1999

Primary key:

Average rainfall (mm)

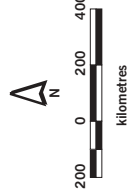


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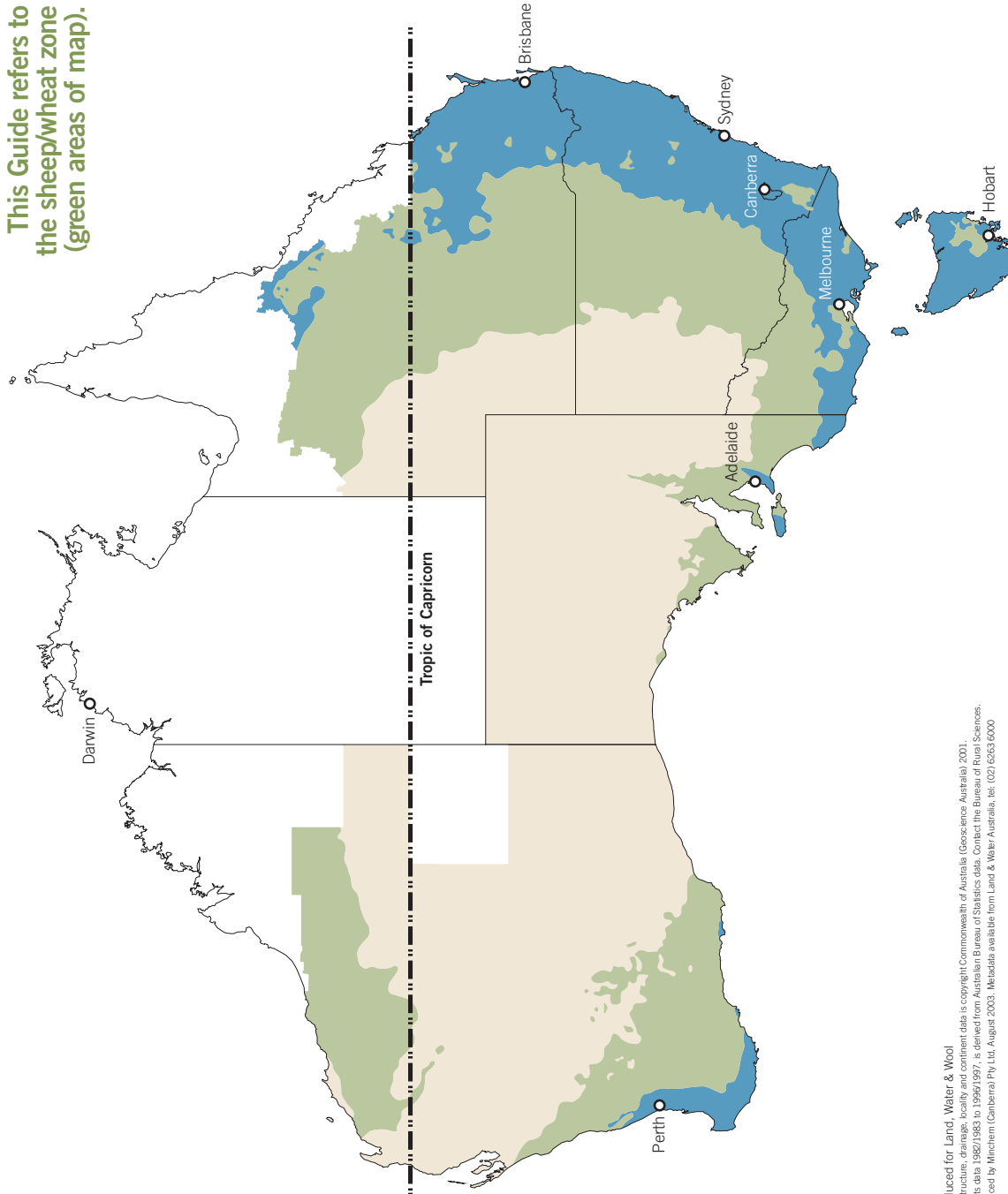
Agronomic zones



Scale 1 : 16,000,000



This Guide refers to the sheep/wheat zone (green areas of map).



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Who is this Guide for?

This Guide aims to help woolgrowers and those that work with them, to improve and protect the health of water courses and riparian land on their farms, as well as to minimise the impacts of wool production on water quality and stream health. The aim is to use improved management to achieve both environmental and productive benefits. It also provides information about how these requirements can be incorporated into farm design and wool production operations. Any part of the farm that is linked to the local stream system by water flow, including those parts linked only during storm events, is covered by this River Guide. This is because what happens on them, and how they are managed, can have a significant influence on the stream's health and its water quality.

The Australian wool industry covers a broad range of rainfall and vegetation types (see map). Three zones are broadly recognised based on rainfall and these are: pastoral, sheep/wheat and high rainfall. Rather than attempt to produce a single River Guide for the entire Australian wool industry, two separate documents have been produced. This Guide has been prepared for woolgrowers in lower rainfall areas, where the average annual rainfall is in the range 300–600 mm, sometimes referred to as the sheep/wheat zone. It covers much of the wheatbelt in Western Australia, the mid-north and drier parts of the south-east of South Australia, the riverine plains and drier parts of Victoria and New South Wales, the midlands region in Tasmania, and the western slopes and plains in New South Wales and southern Queensland.

A separate Guide has been prepared for woolgrowers in higher rainfall areas and tablelands, where the average annual rainfall is above 600 mm. It covers the higher rainfall parts of the south-west of Western Australia, high rainfall areas in the south-east of South Australia, the tablelands and higher rainfall parts of Victoria and Tasmania, and the tablelands in New South Wales and southern Queensland.

It is recognised that this division is arbitrary, but it was considered worthwhile as some of the management issues identified by woolgrowers are different between these two zones. As well, the water courses and riparian areas are different and require management practices that are designed specifically for them. In each version of the Guide, the case studies have been chosen to represent the geographic location covered.

Neither Guide addresses the management of watercourses and riparian areas in the pastoral zone. Although some of the principles in this Guide can be applied there, river systems in the pastoral zone have special characteristics and the scale of stock management and grazing units are very different. There were insufficient resources available to prepare a Guide for this zone at present, but one may be developed in the future if woolgrowers seek it.

This Guide refers to the sheep/wheat zone (300–600 mm).

Wool Industry River Management Guide: Sheep/wheat zones

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Land, Water & Wool is a research partnership between Australian Wool Innovation Limited and Land & Water Australia.

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Foreword

Australia's woolgrowers manage a large proportion of our natural resources and they recognise the imperative to manage these resources carefully for profitable wool production, both now and in the future.

Improved management of natural resources, including streams, creeks and adjacent riparian zones, is an integral part of farm operations and represents "good business" for the wool industry.

Notwithstanding the significant efforts made by many woolgrowers to enhance their resource base, all agricultural industries, including wool, are coming under increasing market, community and regulatory pressure to employ sustainable practices and demonstrate that they are doing so.

With most Australian woolgrowers having properties which adjoin at least one waterway, managing these water systems and keeping them healthy is a crucial part of running a profitable wool producing enterprise.

This River Guide demonstrates how woolgrowers in the sheep/wheat zone can use practical, cost effective methods for improved river management, addressing issues such as gully and streambank erosion, water quality and weed management.

The Guide is another way in which the Land, Water & Wool program, a collaboration between Australian Wool Innovation Limited and Land & Water Australia, is working to make a positive difference to productive natural resource management in the wool industry.

Len Stephens
Chief Executive Officer
Australian Wool Innovation Limited



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Acknowledgements

This Guide has been prepared through close collaboration with the Australian wool industry, particularly producer groups in different parts of the country. Their willingness to be involved and their support through the Land, Water & Wool Program, a joint initiative of Australian Wool Innovation Limited and Land & Water Australia, is gratefully acknowledged. The technical details in this Guide have been prepared by bringing together information from many other documents and research reports. Where possible, these are referred to in the text, often as sources of further information. In addition, the following people have made major contributions by helping to identify the crucial management issues for woolgrowers in managing streams, creeks and associated riparian areas, or by providing specialist technical knowledge.

Tom Dunbabin, Richard Weatherley, Anwen Lovett, Lu Hogan, Renelle Jeffrey, Mike Wagg, Russell Pattinson, Peter Hanrahan, Andrew Lawson, Jann Williams, Kim Mitchell, Kirsten Martin, Kylie Nicholls, Biz Nicolson, Fleur Flanery, Wayne Tennant, Louise Hutton, Amy Jansen, Robin Watts, Leanne Wheaton, Sandy White, Allison Mortlock.

Special thanks to all those woolgrowers featured in our case studies.



Chapter 1

Purpose of the Guide



Chapter 1

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Purpose of the Guide

Sheep need access to high quality water for maximum productivity, and many wool businesses have recognised this as vital for their continued viability. Water quality is affected directly by how well small streams, creeks and gullies are managed, including those located on farms. Hence, woolgrowers have a strong financial, as well as environmental interest in achieving best practice in river and riparian management.

This Guide has been developed as a resource to assist the wool industry and woolgrowers to improve their productive use and environmental management of streams, creeks and associated riparian lands. It reflects a major emphasis of the Land, Water & Wool Program to demonstrate and publicise practical ways in which woolgrowers can increase both profitability and environmental outcomes on-farm. Some of the principles outlined here can also be applied to the management of large farm dams and drains, but the Guide is focused primarily on natural watercourses and adjacent riparian zones.

Land, Water & Wool (LWW) is a joint initiative of Australian Wool Innovation Limited and Land & Water Australia. It is an integrated natural resources management program that focuses on issues associated with sustainable wool production. For more information visit the website — www.landwaterwool.gov.au

The first step in developing this Guide was to work with woolgrowers to identify the management issues they considered most important in relation to water courses and riparian areas. To this were added research findings from a 12-year national research program supported through Land & Water Australia (for details see www.rivers.gov.au) that investigated how riparian areas function, as well as information gained from LWW-funded projects about river and riparian management located in Tasmania, South Australia and New South Wales. Bringing these sets of information together enabled the development of this Guide. This Guide has been prepared primarily for use by people with some technical knowledge who work with woolgrowers, including farm consultants and advisers, staff of government agencies, catchment management authorities, coordinators, woolgrower or Landcare groups and community organisations

For each of the management issues identified by woolgrowers, we have listed the management objective (or purpose) that can be attained within the context of commercial and environmentally sustainable wool production. This is followed by the general principles for achieving that management objective, based on the best science available today. The Guide then lists practical steps that can be taken by woolgrowers to implement those principles. Wherever possible, this is followed by a description of one or more case studies of woolgrowers who have successfully achieved the management objective. At the end of the Guide there is a rapid appraisal of riparian condition tool that can be used to assess how the current state of the stream, creek or riparian area compares with the objectives and practices; this can also be used to track changes in condition over time.

It is intended that this Guide be used to complement existing information on sustainable wool production, as well as to assist the development of other products, workshops and field days. Provided that the original source of the material in this Guide is acknowledged, reproduction of the document or of individual sections is encouraged. It is recognised that today's best practice may not be tomorrow's. It is therefore expected that this Guide may be reviewed and further improved from time to time, based on the experience of woolgrowers and as new scientific knowledge becomes available.



Background to the Australian wool industry

The Australian wool industry remains one of Australia's most important agricultural enterprises. In 2003/04 — the value of wool exports was \$2.3 billion, equivalent to around 6.3% of the gross value of all agricultural commodities. Total wool production remains second only to beef production as the most common enterprise on Australian farms. Much of the agricultural land south of the tropic of Capricorn (see map) is grazed at one time or another by sheep for wool production, and wool production is a major enterprise on native pastures in the rangelands. Native pastures also play an important role in fine wool production in areas such as Tasmania and the northern tablelands of New South Wales. The extensive nature of wool production over much of Australia means that maintaining sound environmental management is an important issue for the industry.

There were estimated to be around 40,000 broadacre farms running sheep in 2000–01. Of these, around 11,000 farms receive the majority of their income from sheep and wool production and are classified as specialist woolgrowers; they account for about 32% of Australia's total wool output. The remaining broadacre farms receive most of their income from enterprises other than sheep and wool, and are generally described as mixed enterprise farms that produce wool as part of their operation.

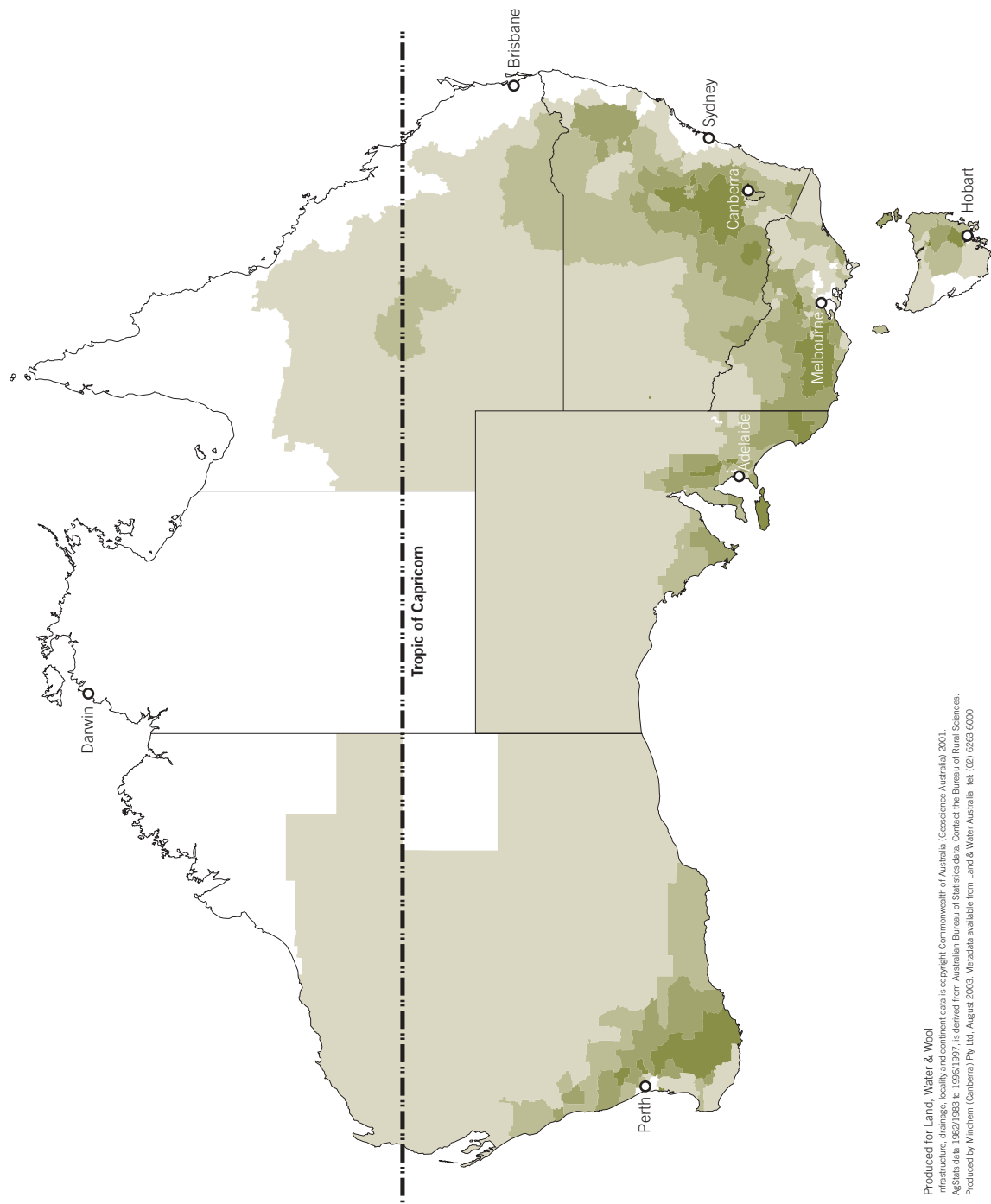
There is a wide range of wool enterprise size and profitability and, thus, a wide range in capacity to undertake substantial works to improve riparian management. There is no firm information on the number of wool-producing farms that have waterways (creeks, streams, or rivers) either running through or forming a boundary of the property. However, when it is recognised that even the management of ephemeral creeks and gullies is important for water quality downstream (including estuaries), it seems likely that the majority of wool producing farms will need to give some consideration to the management of streams, creeks and associated riparian areas. As a result, this Guide is expected to have wide application within the wool industry.

“Ephemeral”

Creeks, gullies and drainage lines that may run with water only occasionally.

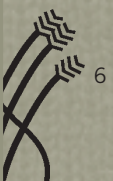


Ephemeral creeks like this one may not flow for several years at a time, but often have permanent pools and an underground flow within their sand or gravel beds. These features, together with periodic flood flows, make them very important parts of the landscape for native plants, animals and people. Photo Phil Price.



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Chapter 2

The importance of streams, creeks and riparian land



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The importance of streams, creeks and riparian land

Water in the landscape

Australia is well-known as the driest inhabited continent, with a generally low and highly-variable rainfall. In this situation, it is not surprising that access to supplies of clean water is especially important for agricultural production and for rural communities, as well as to major urban centres. The limited water resources available in the southern part of Australia have already been well-developed in response to this need, particularly in the Murray-Darling Basin, but also in catchments adjacent to major urban centres. Currently, there are major concerns about the amount of water available for use, the decline in water quality, and the need to store and share water for society's varied needs. Water allocations for irrigation have not always been managed well, and over extraction has led to degradation in some river systems.

Water quantity is immediately influenced by climate, but also at a longer time-scale by land use and management practice. There is little that can be done to manage the effects of climate variability, except through increasing water storage and water use efficiency, however, land use and management is something that can be changed. We know that the clearing of catchments for agricultural development by removing deep-rooted, native perennial vegetation and replacing it with annual shallow rooted species, has resulted in more water either running-off as surface flow or infiltrating into the soil and potentially accumulating as rising groundwater. Dryland salinity and the erosion of stream beds, banks and gullies are some of the most significant negative impacts generated by this change in catchment hydrology.

“Hydrology”

Hydrology here refers to the movement of water within the landscape through both surface and sub-surface pathways, and the balance between inputs (rainfall) and outputs (streams and groundwater flow).

Water quality is a particular concern to all communities, whether rural or urban. The battle for water quality is generally won or lost in the small creeks, gullies and streams within a catchment. This is partly because these small waterways generally make up three-quarters of the total stream network within any given catchment (see diagram page 11). As well, it is far easier to manage these smaller waterways for water quality than it is to try to influence quality in a large river system where the channel is tens of metres wide. This point is not always recognised by landholders, who may disregard the importance of managing the land to optimise water quality, especially where the creek or gully may run only occasionally.

It is important to recognise that the battle for water quality is generally won or lost in the small creeks, gullies and streams within a catchment.



It is far easier to manage smaller waterways for water quality than it is to try to influence quality in a large river system where the channel is tens of metres wide.

Water storage is another issue of particular importance to woolgrowers, and in most States there is now legislation to control the storage and transfer of water. As well as these aspects of quantity, quality and storage of water for productive or consumptive uses, waterways are particularly important in the maintenance of a healthy landscape. In a seasonally dry landscape waterways are important for both plants and animals. Many animals spend part of their lifecycle in, or associated with, water courses and riparian areas, and use them as an essential source of water or habitat. Riparian areas provide a refuge for plants and animals during times of stress, such as drought or fire, and are often characterised by their own particular species that are not found elsewhere in the landscape. Water courses and riparian areas are often referred to as the arteries of the landscape, and provide an important home base and movement corridor for the maintenance and migration of plants and animals throughout the region.

Streams, creeks and riparian areas are therefore important for both production and environmental health. Sheep need access to clean water for maximum wool production, and careful management of riparian areas can provide other valuable benefits through increased feed and utilisation, as well as from shade and shelter from extreme weather; when added, these benefits can increase profit significantly. The range of production benefits is described in more detail in the following sections.

At the same time, river and riparian areas in good condition are vital for healthy ecosystems and functions, as well as to conserve Australia's unique plants and animals. Sometimes these management objectives may appear to be in conflict, but with careful thought, it is possible to improve management and achieve a win-win situation where productivity and environmental outcomes can be maintained and improved. A major aim of this Guide is to describe these opportunities and demonstrate how they can be achieved by woolgrowers. Some of these principles can also be applied to the management of large farm dams and drains.

“Riparian”

Any land which adjoins, directly influences, or is influenced by, a body of water.



Photo: Lu Hogan.

Scaled diagram showing that management of small waterways in catchments is important because they generally make up three quarters of the total stream network.

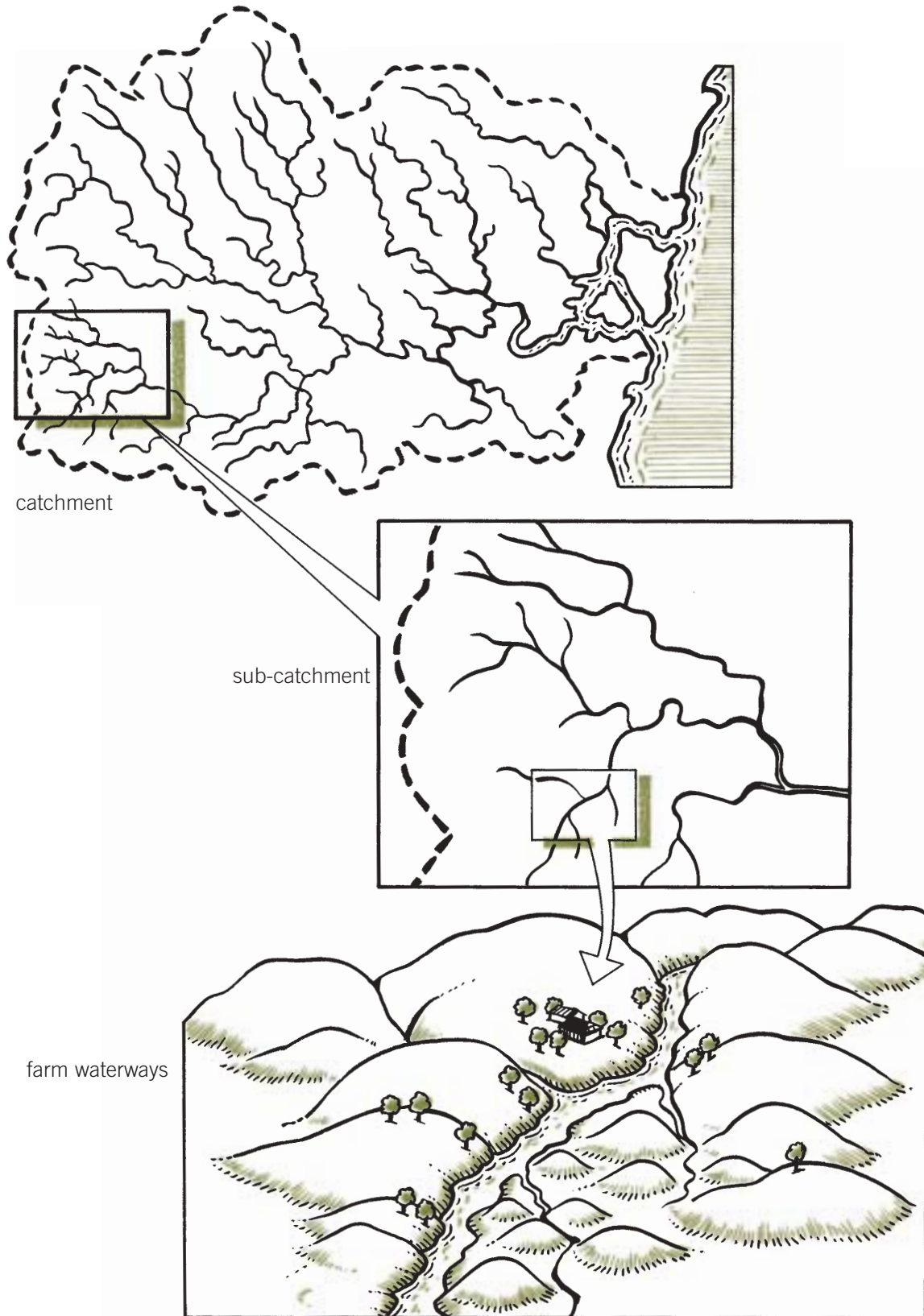


Illustration Paul Lennon.



What is riparian land?

Riparian land can be defined in a number of ways — *how* it is defined in particular situations largely depends on *why* it is being defined. The definition of riparian land provided below refers to the roles or functions that riparian land plays.

Riparian land is any land which adjoins, directly influences, or is influenced by, a body of water.

Using this definition, riparian land includes:

- the land immediately alongside small creeks and streams, including the bank itself;
- gullies and dips, including those within, or adjacent to, pasture paddocks, that sometimes run with surface water;
- land adjacent to drains or channels that empty into streams or wetlands;
- areas surrounding lakes and large dams;
- wetlands, billabongs, and floodplains that are linked with a stream or creek in times of flood; and
- vegetation dependent on groundwater supplied by a stream or creek.



Riparian land along riverbanks.
Photo Guy Roth.



Floodplain.
Photo Michael Askey-Doran.



Pool in riparian area.
Photo Lori Gould.



Waterhole.
Photo Andrew Hudson.



Wetland. Photo NSW Murray
Wetlands Working Group.



Riparian trees shading a stream.
Photo CSIRO Sustainable Ecosystems.

The width of land recognised by a woolgrower as being ‘riparian’ will depend on its purpose and management objective. For example, the riparian width required to trap soil from a cultivated paddock upslope (filter strip) may be a fraction of the width required to provide wildlife habitat, yet both may be riparian management objectives. Government legislation contains legal definitions of water courses and riparian land that woolgrowers need to be aware of, and these are described in Appendix B.

Factors that affect the condition of streams, creeks and riparian land

Riparian land changes under the influence of natural factors such as fires, unusual frosts, cyclones or floods. However, these are relatively infrequent events, allowing time for riparian land and its natural vegetative cover to recover. In contrast, the human impact since European settlement of Australia is very noticeable on riparian land, with large-scale changes in condition and health throughout much of southern Australia. The widespread clearing of riparian vegetation for agricultural or urban development, engineering works and infrastructure for dams, weirs, roads and bridges, as well as grazing by domestic stock, have had the biggest impacts.

In recent years, there have been several surveys undertaken of the condition of streams and rivers in various parts of Australia¹. Although the exact proportions differ from region to region, a general conclusion from these studies is that in southern Australia 30–40% of all streams and rivers and their adjacent riparian lands are in very poor condition, a further 30–40% are in moderate but declining condition, while only about 30% remain in good condition². Wool growing occurs in all of the catchments that make up these statistics, making the production of this Guide very timely, as it provides an opportunity for the wool industry to contribute to catchment plans to improve stream or creek condition, while maintaining or improving commercial wool production.

Major effects of ‘catchment development’ on riparian land and adjacent water courses are as follows:

- *Removing riparian trees and shade* by clearing riparian trees or natural death combined with lack of regeneration due to continuous grazing, increases the amount of light and heat reaching the stream or creek. This favours the growth of nuisance algae and weeds, and can completely change the conditions in the water so that it no longer supports native fish and other animals. Excessive in-stream weed and algal growth can trap sediments, and this can block the channel and prevent it from carrying floodwaters. When the weed and algae eventually dies and begins to decay, it deoxygenates the water and can contribute to fish kills downstream. Removal of shade can mean higher losses of a precious resource due to increased evaporation, and loss of native vegetation can also result in invasion by aggressive introduced species such as willows, privet or olives.
- *Lack of riparian trees for habitat*. Under natural conditions, trees occasionally fall into the channel and provide an important habitat for animals and plants living in the stream. Large tree trunks and branches in the water result in a range of flow speeds, which are important for some stream animals. In streams with sandy beds, this woody material provides the only secure anchor for in-stream plants and protection for animals. Removing these branches and trunks disrupts in-stream life by reducing habitat for insects, crustaceans and fish, as well as destabilising stream beds and banks making them more prone to erosion in high flows. Loss of native riparian vegetation with no regeneration means that there is no longer any source of this important in-stream material.
- *Cropping up to the top of streambanks* increases the delivery of sediments and nutrients to water courses. Perennial groundcovers play an important role in filtering sediment from overland flow and when this cover is removed, large volumes of fine-grained sediment smother in-stream habitat and cloud the water, while the additional nutrients carried on the soil particles stimulate weed and algal growth. The increased sediment and nutrient loads also affect estuarine and marine life beyond the river mouth. Stock tracks along and up and down stream or creek banks are a major source of in-stream sediment and nutrients on grazing properties.

1 Examples are: *State of the Environment Report*, 1996; *The Condition of Rivers in the Queensland Murray Darling Basin*, D.P. Johnson 2001; *Stressed Rivers Assessment Report*, NSW DLWC 1999.

2 These estimates reflect the condition of rivers in wool-growing catchments; an initial analysis of one NSW catchment using data from the Australian Natural Resources Atlas and Data Library (NLWRA, 2002) confirms this general picture.





Fallen wood in the river provides habitat for insects, crustaceans and fish. Photo Ian Rutherford.

- *Uncontrolled stock access* to riparian lands leads to overgrazing and trampling of vegetation, the breakdown of soil structure and contamination of the water with nutrient-rich urine and faeces. Research has shown that even a low level of unmanaged grazing pressure can be enough to prevent regeneration of native riparian species. Stock dung and urine entering streams directly or washed in during heavy rains are a major source of contaminating nutrients and of disease organisms, greatly reducing the quality and value of water for downstream users.
- *Loss of riparian vegetation* and its protective root systems destabilises streambanks, often resulting in large increases in the width, depth and erosion of channels. This channel erosion can then deliver more sediment to the water course. Significant areas of valuable agricultural land can be lost as a result of channel erosion and, along with increased water turbidity, can greatly reduce water quality for downstream users. The reduction in water quality and loss of natural riparian food inputs (leaves, fruit, twigs, insects) also disrupts the food sources and life cycles of aquatic plants and animals.

“Turbidity”

Turbidity is the ‘dirtiness’ or ‘cloudiness’ in the water that results from fine clay particles suspended within the water column. When soil from bare areas of paddocks or from stream or channel banks erodes into the water, the larger sand and silt particles settle out, but the fine clay particles may remain suspended for many weeks. Turbid water is often milky brown in colour and it is not possible to see down to the stream bed; light penetration is restricted to the surface layers.

“Salinisation”

Salinisation refers to the process by which rising groundwaters bring to the surface salt which had been stored lower in the soil profile. As this water is used by plants or evaporates from the soil surface, the salts are left behind. As the salt accumulates, a point is reached where plants can no longer grow, and a bare scald results, often with a white deposit of salt which may be washed into the adjacent water course during rain. This is the basic process underlying the spread of dryland, or secondary, salinity.



Yenyening Lakes in Western Australia, some of which are highly saline. Photo Jenny Davies.

- *Removing vegetation throughout a catchment* can lead to raised water tables and salinisation of land. Salt in both surface and sub-surface flow may then drain into water courses and reduce water quality, as well as damaging in-stream plants and animals. This issue is a high priority for parts of the Murray-Darling Basin, where decreasing water quality will eventually threaten the livelihood of downstream irrigators.
- *Altering the streamflow* by building dams and weirs, as well as pumping out water, can severely affect in-stream life and the habitat values of a water course. Reduced flow levels below dams, rapidly-changing water levels due to releases, and cold water from deep offtake points, all reduce the health of downstream riparian vegetation and in-stream plants and animals.
- *Removing sand and gravel*, channel straightening, and construction of levee banks and drains change the channel characteristics and can result in increased erosion. This can lead to loss of agricultural land as well as damage to infrastructure such as roads, bridges and buildings.
- *Altering fire regimes* especially in combination with poorly timed grazing, and invading introduced weeds degrade riparian land.
- *Urban development* influences water quality and the condition of riparian lands.





Sheep that have unmanaged access to riparian areas such as this one can do extensive damage to native vegetation and can lead to water quality and bank erosion problems. Photo Land, Water & Wool.

The impacts of these disturbances are not only cumulative; they exacerbate each other. For example, clearing riparian vegetation from small creeks and streams multiplies, many times over, the impact of nutrient enrichment from surrounding land. This is because the clearing of tall vegetation also results in higher light levels and higher temperatures, creating the conditions needed to enable nuisance weeds and algae to flourish in the stream and to dominate in-stream life.

Property planning as the key to sound riparian management

By recognising and managing riparian areas as different but integral parts of the whole farm and wool enterprise, it is possible for woolgrowers to gain significant environmental and economic benefits. One of the best ways to achieve this is to encourage and work with the wool producer to develop and implement a property management plan.

By recognising and managing riparian areas as different but integral parts of the whole farm and wool enterprise, it is possible for woolgrowers to gain significant environmental and economic benefits.

Property management planning, or whole property planning as it sometimes called, is a process of planning property design and management by matching economic production to the property's ecological characteristics and resources. The process arose from a realisation that land degradation, and the flow on impact it has on reduced production and degradation of other natural resources including streams and rivers, is a sign of inappropriate land use and/or farming practices. Unless land degradation processes are halted, and where possible reversed, farm production will continue to



This overview of Property Management Planning is from 'Taking Control — Property Management Planning', Van der Rijt, V., Centre for Conservation Farming, Charles Sturt University.

decline, resulting in a non-viable enterprise and farming system. Effective property management planning is the key to woolgrowers getting the best from their river and riparian areas so that they can optimise production while at the same time maintaining or improving their natural resource base.

Developing a property management plan requires the woolgrower to assess the strengths and limitations of the farm's resources, and to clarify his/her objectives regarding the future use of these resources. This combination of business plan, personal objectives, and knowledge of the property's natural resources and their capacity to support pasture and wool production, then forms the basis for preparing a future plan that outlines the direction in which the woolgrower wants to develop the farm. As this will change with time, the plan is not fixed, but changes over time to meet the grower's objectives. The plan also helps the landholder to coordinate advice from a wide range of sources such as district agronomists, soil conservationists, property planners, and financial advisers. This advice can be effectively used within a whole farm perspective.

Farm resources and objectives

The woolgrower would work through each of these areas to consider strengths, weaknesses and how this influences business and personal objectives for the future.

- personal / family goals
- enterprise type chosen
- production and management skills and limitations
- physical features of property
- land capability, areas requiring special management
- productivity levels of different land units
- financial return and cash flow
- labour input required

Preparing the property plan

The first step in the planning process is the mapping of the farm into homogenous land units (capability classes). This is done on the basis of:

1. terrain e.g. ridge, hillslope, floodplain
2. slope class
3. soil type (texture/structure/fertility)
4. timber and vegetation cover, pasture type and productivity
5. limitations e.g. waterlogging, soil acidification
6. areas with erosion hazard
7. aspect

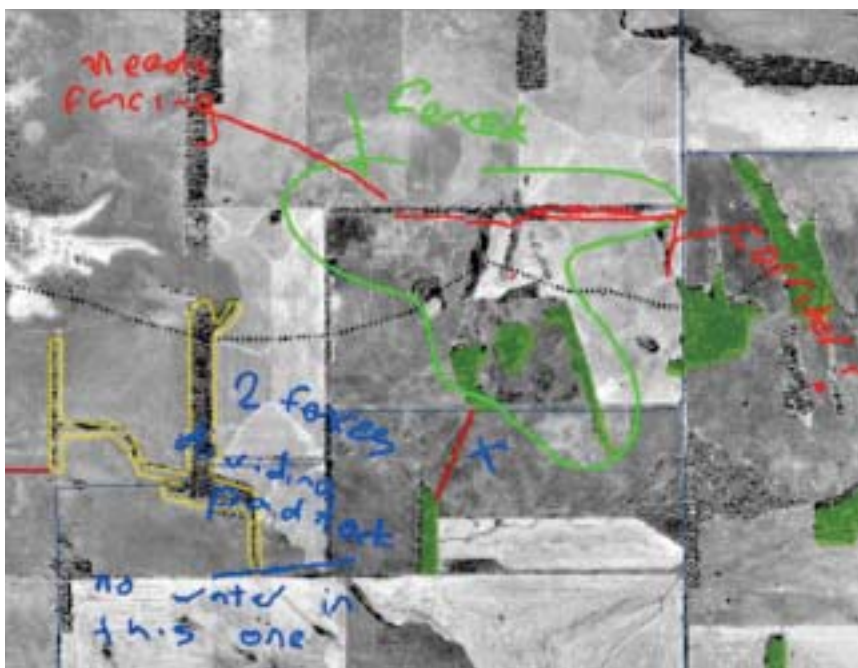


The process of mapping the farm to land units is to allow for each unit to be used to its productive potential, whilst protecting each unit according to its needs and limitations, so that degradation does not occur. This is a critical step for getting the best use and management of riparian areas, because they can be the most productive parts of the farm but they also need special attention and careful management, as described in more detail in the following sections. Where problems such as dryland salinity or high surface run-off are a problem, planning will need to be formulated on a catchment/sub-catchment basis.

The mapping process is simplified by obtaining a black and white aerial photo enlargement of the farm from the local department of natural resources/agricultural agency or catchment management authority. The land units can be marked out on the map using physical features such as trees and dams to help mark in the boundary locations. Other features that can be included on the base map include water courses and drainage lines, dams, existing trees, and any sensitive sites such as erodible soils, waterlogged areas or wildlife havens. “Protected” land that should not be cleared and that may require special use and management should also be marked in. This would include all riparian land adjacent to a stream or drainage line (the exact width will depend on the situation, current condition, and the growers’ management objectives, but generally would include at least 10 metres from the top of the bank), and land with a slope exceeding 20%.

Clear plastic overlays can be used over the aerial photo to depict other features of the property. The first overlay consists of the existing layout such as fencelines and gates, water troughs, existing soil conservation works, stock yards, buildings, roads and tracks, and powerlines. Depending on the farm and situation other overlays may include:

- soil information — soil type, pH, EC (electrical conductivity);
- paddock information — identification, current land use, seasonal productivity;
- native vegetation, windbreaks, agroforestry, proposed areas for planting or natural regeneration;
- services — power lines, telecom cables, water lines, gas pipelines;
- weed infestation.



Property maps enable features such as streams and creeks to be seen within the context of the whole farm. In this case, wildlife corridors are being mapped and a staged plan developed to replant and alter fencing lines.

Photo Andrew Huggett.

The final overlay(s) shows the future plan for the property. The woolgrower needs to be involved in the process of drawing up the future plan as it needs to meet their business and personal goals, as well as optimising the use of natural resources on their property.

Fencing the farm according to land classes enables areas to be used to their full potential, without being restricted by areas of lesser capability that require different management. It is difficult to manage each land unit according to its needs and capabilities when several land types occur in the one paddock. It is important, therefore, to look at the existing layout in comparison to the land class units when drafting future plans. These should show a range of possible layouts with proposed stages for implementation to fit in with the constraints of the farm. At this stage, it is crucial to identify all riparian areas that justify special management to make best use of their potential productivity (often higher than that of surrounding hillslopes, and with green feed later into the summer), or to address other issues such as possible stock losses during a flood, disease or weed control, or to protect water quality. These issues are described in more detail in the following sections of this Guide.

Fencing to land types often results in a greater number of smaller, odd-shaped paddocks and the capital cost can be high. This may not suit all woolgrowers, but it does provide for significant improvements in grazing management to assist in maintaining good pasture composition, feed production and utilisation, as well as disease control. Fencing or using other means of controlling stock access (e.g. siting of water points) is often the first step to better management of streams and riparian areas (see section B) to boost wool production and avoid land and river degradation.

The inclusion of laneways in the plan allows for more efficient movement of stock and vehicles around the farm. A 20–30 metre wide laneway with windbreaks provides excellent shelter following shearing or during lambing. The laneway should be wide enough for machinery operation to maintain pasture production, and reduce the risk of erosion from stock movement. In some situations heavy grazing of the laneway may enable it to function as a firebreak over summer.

Land uses

The type of farming system established is largely dependent upon the climate, particularly rainfall distribution and amount, and soil type. In a mixed farming system, the inclusion of crop and pasture rotations has many beneficial effects including:

- maintenance/improvement to soil structure and fertility, e.g. incorporation of good annual or perennial legumes in pastures;
- flexibility e.g. to alter the crop:livestock ratio to match changes in commodity prices;
- efficient use of farm resources e.g. to spread skills and labour and optimise their use;
- integrated weed management e.g. use of grazing management and crop rotations to control weeds; and
- breaking life cycles of disease organisms e.g. seasonal grazing of crop residues to reduce parasite populations in wetter riparian areas.

On grazing-only, including specialist wool properties, it may be possible to use a mix of pasture types, including native pastures, to achieve some of these benefits. Riparian areas with greater soil depth and retained moisture can make a major contribution to development of a mix of crops and pastures and hence to farming flexibility and profit.



Planning for trees

The integration of trees on the farm should take place after the basic layout has been defined and the need for trees identified. This ensures that the trees are established in the right location and for the right reason. The benefits of trees on farms include:

- reducing water and wind erosion, soil salinisation;
- providing protection and shelter for stock;
- enhancing the quality of surface and underground water supplies;
- providing diverse ecosystems to sustain wildlife and native plants which can provide natural controls of pests;
- restoring the natural beauty of the landscape; and
- providing wood and other tree products.

A minimum of 5–10% replanted tree cover has been the accepted guide for farms with little or no remaining native vegetation. Recent research suggests that for properties where grazing is the dominant enterprise, at least 30% retained tree cover over grazed grassland can be more profitable and is required to maintain vital ecosystem functions (McIntyre, McIvor & Heard, 2002). Trees in riparian areas are especially important as they provide shade to the adjacent stream, inputs to riverine food-webs, shade and shelter for stock, and help to stabilise streambanks and prevent erosion.



Planting trees can often be a social event for local communities to get to know each other and plan projects together. Photos (above) Michael Askey-Doran, (below) Phil Price.

Geographical Information Systems

In the planning process, a number of overlays depicting data collected on the farm can be drawn over the base map. Much of this data can be drawn in freehand at the same scale as the black and white aerial photo enlargement. However this task can be difficult if results from surveys such as an electromagnetic survey are to be incorporated in the plan, or data from contour and/or soil maps which are likely to be at different scales.

A computer-based geographical information system (GIS) is capable of storing all this data using geographical references so that data at different scales can be used in the planning process. The data is digitised and stored on the computer allowing for the display of the data required, and providing for ease of alteration to existing plans. The GIS is very useful in situations requiring a catchment approach, as individual farm data can be aggregated together to display the catchment data and formulate a catchment-based plan.

Planning at the catchment level

The recent development of catchment plans and blueprints in most States and Territories provides the wool industry with an over-arching structure it can use to integrate riparian management and property development. For example, Rivercare planning places the property in the broader whole of river context and can be the gel that brings a number of landowners to the 'planning table' to work together. Appendix C in this guideline provides an overview of a sample of these catchment plans, with examples provided from wool growing regions. This snapshot provides general guidance only, and more information about the documents discussed is available from local government agencies. In addition to catchment plans, there are also Acts and regulations that may influence the management of farms with respect to riparian land, water courses and water use (see Appendix B). By developing a property management plan that incorporates these issues with wool production and applies industry best management practices on-farm, woolgrowers can be confident that they are meeting statutory requirements.



Presentation of a draft design for bird conservation at catchment level in a cropping and sheep community that are working together for environmental and economic outcomes. Photo Andrew Huggett.

In summary

The basis of good management of streams, rivers and riparian areas on wool properties is to plan for their management as part of a whole property plan. This is the key to enabling woolgrowers to determine how they can use these areas to optimise pasture and wool production while also improving their environmental condition. Property management planning develops a future plan of operations based on the woolgrower's objectives and an assessment of the farm's resources. The property management plan enables the use of land units to their potential, whilst protecting them according to their limitations. With the increasing complexity of agricultural production, a property plan can be beneficial in initiating a whole farm perspective to incorporate technological advances while aiming for an ecologically sustainable farming system.

For further information

Government support is provided for property management planning, though it comes under different names depending on the State you are in. For further information in your State refer to the contacts below:

New South Wales	Department of Agriculture, www.agric.nsw.gov.au/reader/farming-systems-planner
Queensland	Department of Primary Industries & Fisheries, www.dpi.qld.gov.au/services
South Australia	Primary Industries & Resources South Australia, Farmbis www.pir.sa.gov.au
Tasmania	Department of Primary Industries, Water & the Environment, Farmbis, www.dpiwe.tas.gov.au
Victoria	Department of Primary Industries, Farmbis, www.dpi.vic.gov.au/farmbis
Western Australia	Department of Agriculture, Property Planning, www.agric.wa.gov.au



A deep incised channel cut by an ephemeral creek. Although flows may be infrequent within creeks of the sheep/wheat zone, channel shape and location can be altered radically by massive erosion of the bed or banks if they are unprotected. Photo Phil Price.

Chapter 3

Managing rivers, streams, creeks and riparian land

In this Chapter we discuss the management issues identified by woolgrowers and those arising from recent scientific research. For each issue, the management objective or purpose is stated, followed by a discussion of the principles of sound management to achieve that objective.

How these principles can be put into practice by woolgrowers is discussed next, and for most issues this is followed by a case study of a woolgrower who has successfully put the principles into practice.

At the end of this Chapter there is a rapid appraisal of riparian condition tool that can be used to assess the current state of a riparian area in comparison to others.

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Section A

Multiple uses and values of riparian areas



Purpose

To manage riparian areas so that a mix of environmental, economic and social benefits are achieved on-farm and in the broader community.



Multiple uses and values of riparian areas

Principles

Riparian lands and water courses have multiple uses and values. Riparian vegetation protects streams by slowing surface runoff, absorbing nutrients and trapping sediment and other contaminants before they reach the water course. Riparian vegetation can also protect adjacent agricultural production. It buffers crops and pastures from the wind and windborne material, and provides habitat for beneficial animals, especially pollinating insects.

Livestock can shelter from harsh weather and graze understorey grasses and shrubs. Riparian vegetation itself can form part of the farm's production system, supplying wood products like timber, poles, posts, broombrush, firewood and charcoal, or non-wood products like seeds, essential oils, foliage, honey, bushfoods and pharmaceuticals. These products may be sold or used directly on the farm. Riparian areas and their streams and creeks are also special places for people, and are often highly valued for recreation, their beauty, and as a place to relax and enjoy nature.

In the future, some of the natural functions of riparian vegetation, like carbon storage, water filtration and salinity control may form part of the farm's production system, and be valued and traded as part of an ecosystem services market.



“What are ecosystem services?”


Ecosystem services are the benefits to humans that come from plants, animals and micro-organisms in nature interacting together as an ecological system, or ecosystem. The functioning of natural ecosystems provides ‘services’ that are essential for human health and survival. Examples of the kinds of services we receive from nature include water filtration, maintenance of soil fertility, pollination, pest control, and cultural and spiritual fulfillment.

The table beginning on the following page describes some of the ‘functions’ or ecosystem services provided by riparian areas, and highlights how this part of a farm, if managed carefully, can achieve multiple objectives.



Multiple uses and values of riparian areas

Uses/values	Description
<p>Provide water for stock and domestic use Section E, page 71</p>	<p>Riparian areas are important sources of drinking water for stock, particularly in times of drought with dams running low. However, uncontrolled stock access in riparian areas is one of the main causes of poor water quality, bank instability and declining in-stream health. By installing a reticulated water system throughout the farm, stock no longer require direct access to riparian areas, yet still benefit from the drinking water the stream or creek provides. Farm productivity is increased when these practices to improve water quality are implemented, with stock in better condition and better production when a clean source of water is provided.</p>
	
<p>These landholders are creating 'biolinks' across their property by planting trees along fencelines and riparian areas. These 'biolinks' not only provide passage for wildlife, but also shade and shelter for stock. Photos courtesy RIRDC.</p>	
<p>Improved water quality Section F, page 85</p>	<p>Good management of riparian land can decrease the amount of soil and nutrients moving from cultivated fields upslope into the stream. By trapping soil and nutrients and other contaminants, water quality is improved and the loss of in-stream habitat through siltation is prevented.</p>
<p>Decreased algal growth Section F, page 85</p>	<p>Riparian vegetation helps to reduce light and temperature levels of stream ecosystems. It has been shown that this controls the growth of nuisance plants and algae, even when nutrient levels in the stream water have increased.</p>
	
<p>Nuisance algae, one result of increased nutrient levels. Photo Nick Schofield.</p>	

Uses/values	Description
<p>Decreased erosion Section G, page 97</p>	<p>Well vegetated riparian areas stabilise riverbanks and protect them in times of flood. In addition, if the surrounding riparian land is not well-vegetated with deep-rooted plants, flood-outs and stripping of topsoil from the floodplain can occur. Both forms of erosion can lead to the loss of valuable agricultural land and infrastructure such as roads, bridges, and buildings, as well as sedimentation of the stream or creek.</p>
<p>Retention of nutrients Section G, page 97</p>	<p>In addition to preventing erosion and improving water quality, riparian vegetation acts as a filter absorbing and using natural or added nutrients that might otherwise be washed into streams, stimulating the growth of nuisance plants and algae within rivers (especially where there is little shade).</p>
<p>Denitrification Section F, page 85</p>	<p>Riparian vegetation can play an important role in reducing the amount of nitrate moving into waterways through sub-surface flow. This can help protect downstream aquatic ecosystems and lessen the risk of problems such as algal blooms occurring. This helps to protect water quality for stock use.</p>
	
<p>Woody debris in river provides valuable in-stream habitat for fish, birds and other animals. Photo CSIRO Sustainable Ecosystems.</p>	
<p>Maintaining fish stocks Section J, page 129</p>	<p>Healthy riparian vegetation helps maintain good habitat for aquatic animals, including insects and the fish that feed on them. Riparian vegetation provides important food sources including leaves, fruit and stems that fall into the stream, as well as dappled shade that provides cover for fish. The roots of vegetation provide essential habitat for fish by protecting overhanging banks, while large branches or trunks that fall into the water also provide shelter from predators and a diversity of flow speeds. Wood in streams also provides a breeding refuge for the insects and plants that fish eat.</p>
<p>Healthy ecosystems Sections J, page 129 and K, page 143</p>	<p>Good management of riparian land can prevent or minimise damage to both land-based and in-stream life following catchment development. Such damage can upset important biological balances and lead to the deterioration or even destruction of interdependent environmental systems, e.g. high nutrient from run off leading to blooms of toxic algae.</p>



Uses/values	Description
<p>Maintaining river courses Section G, page 97 and H, page 107</p>	<p>Healthy riparian vegetation protects riverbanks and channels and reduces the risk of erosion. When riverbanks are cleared, increased flow can cause rivers to change their course and form new meanders or flood channels, as well as accelerated erosion of banks and the bed.</p>
<p>Lowered water tables Section C, page 45 and F, page 85</p>	<p>Deep-rooted riparian vegetation may, in some circumstances, act to lower water tables along riverbanks, reducing the movement of salt and nutrients into streams from sub-surface flows, and helping to further stabilise the bank.</p>



Riparian areas are hot spots for biodiversity, even when they only have water for some for the year. Photo CSIRO Sustainable Ecosystems.

<p>Providing fodder for stock Section B, page 33</p>	<p>In many situations riparian areas support the most productive pastures due to deeper soils and retained moisture. Hence, it is a priority for woolgrowers to manage these areas to optimise production. As well, when managed carefully, riparian areas can provide fodder for stock in times of drought, or when feed is short on other parts of the farm. This grazing, combined with the protection offered by riparian areas from wind and temperature extremes, can be especially valuable, e.g. after shearing.</p>
<p>Shelter effects Section D, page 57</p>	<p>The shelter and microclimate that riparian vegetation creates can help to reduce death in newborn or newly shorn sheep, and lead to improved growth and productivity through reduction of heat or cold stress in animals. Vegetated riparian areas reduce wind speeds and this can assist growth and production of crops and pastures.</p>
<p>Decrease in insect pests Section K, page 143</p>	<p>Healthy vegetated riparian land provides habitat for insect-eating birds and insect parasites that can help to protect pastures and crops from damage. It has been shown that losing even a small number of birds can allow significantly more below-ground pasture grubs to survive and become adults.</p>

Uses/values	Description
<p>Maintaining biodiversity Section J, page 129 and K, page 143</p>	<p>Native vegetation on riparian land plays an important role in the lifecycle of many native animals and plants, including some that cannot live in other areas. It provides a wildlife corridor and helps prevent plant and animal species becoming isolated and dying out, as well as being a refuge in times of drought or fire. Floodplains and billabongs are also areas of very high biodiversity following a fresh or flood, and they support many of the surrounding terrestrial ecosystems (e.g. as a source of insects and other aquatic food).</p>
<p>Opportunities for diversification Section A, page 25</p>	<p>Some landholders have combined riparian management with agroforestry production. Others have used riparian land for producing hay or other stored forage, or for growing firewood or specialist crops. These farmers have increased the sustainability of their property while, at the same time, protecting its most valuable land.</p>
<p>Increase in capital values</p>	<p>Anecdotal evidence from real estate agents suggests that well managed riparian frontage can add up to 10% of the market value of a rural property, a valuable contribution to business finances and woolgrowers' "superannuation".</p>
<p>Recreation</p>	<p>Riparian areas provide people with access to rivers, streams and creeks that are an important recreational resource for fishing, canoeing, swimming or simply relaxing.</p>



Protecting riparian areas provides for recreation by present and future generations. Photo Phil Price.

<p>Cultural and spiritual fulfilment</p>	<p>Rivers and riparian areas are important to people for spiritual, cultural and historical reasons. They provide people with connection to the environment, their past, present and future.</p>
<p>Ecotourism</p>	<p>Ecotourism is becoming a major source of income for rural regions, as shown by the resources being used to establish good bird watching habitat, canoe racing, walking trails and other activities compatible with rivers and their adjoining lands.</p>



When you look at this list, it becomes apparent that managing a riparian area to achieve one objective can, at the same time, be providing a benefit elsewhere. In this Guide, we are encouraging woolgrowers and those that work with them to think about how they can get multiple uses and benefits from managing their riparian areas in ways that achieve economic, environmental and social objectives.

The following sections focus on some of the individual management objectives woolgrowers have identified as important for streams, creeks, and riparian areas. These are not mutually exclusive, and tips are provided on how to get the best overall ‘bang for your buck’ when integrating these parts of the property into an overall farming system. Managing riparian areas differently can maximise productive and environmental benefits for the wool producer. The key to sustainable management of riparian areas is to treat and manage them as a sensitive zone that requires a different management approach from other areas of the property. This River Guide will help people working with the wool industry to do this, with the case studies from other woolgrowers linking recommended management approaches to the practical realities of running a commercial wool property.



Photo courtesy Australian Wool Innovation Limited.

Section B

Stock and pasture management in riparian areas



Purpose

To manage stock and pastures in riparian areas so that productivity and environmental gains can be achieved.



Stock and pasture management in riparian areas

Principles

On many wool properties, the riparian areas adjacent to creeks or streams are highly-productive parts of the landscape. They often have deeper soils and more nutrients as a result of erosion from higher slopes and/or flood events, and are less exposed to sun and drying winds so retain soil moisture and green pasture growth longer into the dry season. For this reason, riparian areas, particularly the small floodplains adjacent to streams and creeks, may be some of the most productive areas of a wool-growing farm.

In other situations, for example, where salinity is increasing along valley bottoms, it may be preferable to fence waterways, exclude stock and concentrate more on improving pastures rather than having stock roaming through semi-degraded riparian vegetation which has poor understorey pasture (usually weeds) and is difficult to access for spreading fertiliser etc. Once stock are removed, the riparian area can be allowed to regenerate naturally or be replanted (perhaps with mounding for initial establishment).



Riparian vegetation regenerating following stock exclusion. Photo Guy Roth.

Uncontrolled access by stock to riparian areas is one of the major causes of degradation to creek or stream environments. Uncontrolled access does not optimise productivity as some areas become overgrazed, leading to loss of valuable pasture species, whilst in other areas potential feed goes unused. Many woolgrowers are now finding that the costs involved in controlling stock access to streams and riparian areas can be recouped over time through improved pasture management that enables increased carrying capacity and wool production.

Managing riparian areas within a whole property plan is necessary if productivity and environmental gains are to be made. All areas in a farm need to be considered in terms of land capability, existing pastures, potential for pasture improvement, and likely rates of pasture production at different times of year. A plan provides the basis for an overall grazing management strategy that determines the likely carrying capacity of different areas and paddocks for different types of animals, as well as outlining when those areas should be grazed and at what intensity. The plan also covers other management issues such as fertiliser applications (both amount and timing), stock health and disease management, flood risk, and the need to spell different pastures at different times of year.



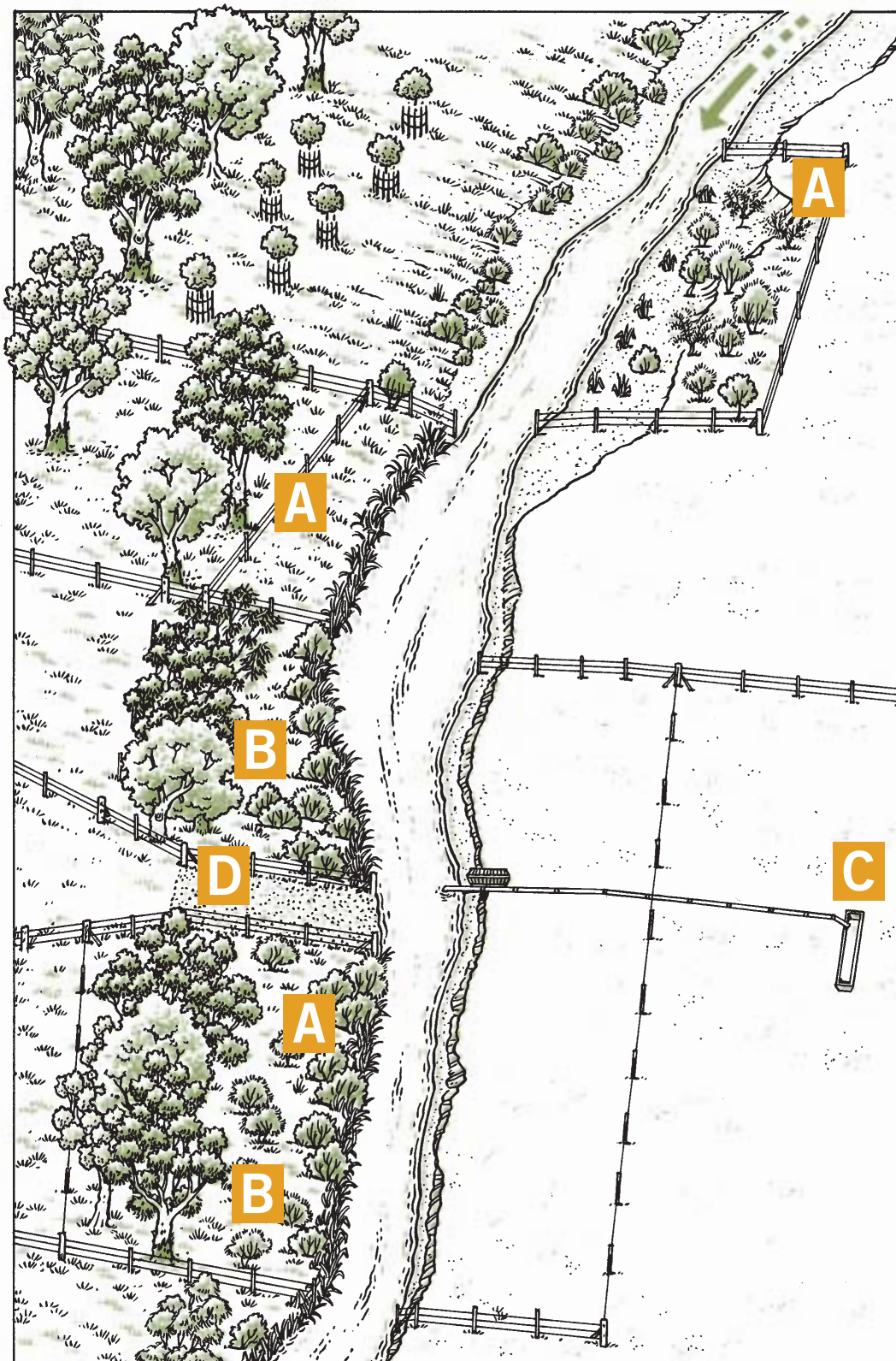
On-farm management practices

Grazing management is the most important single factor influencing the condition and productivity of riparian pastures. Woolgrowers use a range of grazing management styles, including set stocking, rotational grazing by season, and rotational or cell grazing based on feed on offer. As a general rule, set stocking is not recommended for riparian areas unless the overall stocking rate is low and there is no obvious symptom of degradation of the pasture, such as a slow decline in palatable species, a lack of their regeneration or areas of bare soil and/or erosion.

1. Identify and map onto the property plan all riparian areas where different management strategies may be required to optimise pasture growth, deal with seasonal issues near water courses (flood risk, difficulty of access, parasite control in wet areas), optimise the use of shade and shelter, or achieve environmental objectives. Fencing may be required to control stock access so that the riparian area can be grazed strategically, and the options available discussed with the woolgrower.
2. Establish some form of rotational grazing on the property as it is likely to provide a better long-term management regime. This might involve grazing riparian areas later in spring or summer, when other higher parts of the property have begun to dry out and lose green feed. Some woolgrowers have tested the 'living haystack' approach, in which riparian areas are seen as a valuable resource used to cover feed droughts on other parts of the property. Others are testing the value of cell grazing in riparian areas, and believe it may assist in increasing wool production where riparian areas are naturally highly productive due to deep soils and better moisture. Rotational grazing can be used to prevent pastures seeding where vegetable contamination is a problem, with other paddocks "locked up" when seed content is at its highest; work in Western Australia suggests this can reduce significantly the level of vegetable contamination (seed and shive) in wool.



Wool quality declines when seed and shive get caught in the fleece. Photos courtesy Australian Wool Innovation Limited.



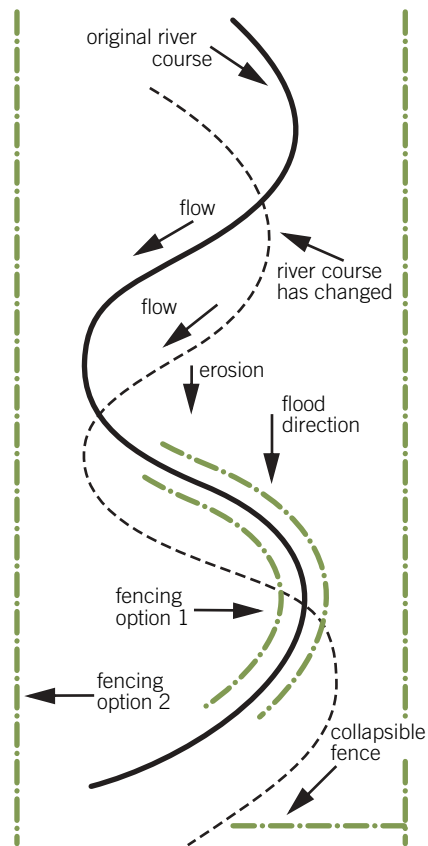
This diagram shows how woolgrowers can gradually restore parts of their riparian land. In some parts of the stream, stock have been excluded so that natural regeneration can occur (A), in other parts revegetation has been more actively pursued to protect against bank erosion (B). Off-stream watering has been used on one side of the stream (C), whilst on the other side a gravelled stock drinking point restricts access to a small, but stable part of the streambank where damage can be controlled (D). Planning a gradual restoration strategy that can be implemented in small units, such as this diagram shows, makes it less daunting for the woolgrower to consider managing their riparian area as a different, yet integral part of their farm.





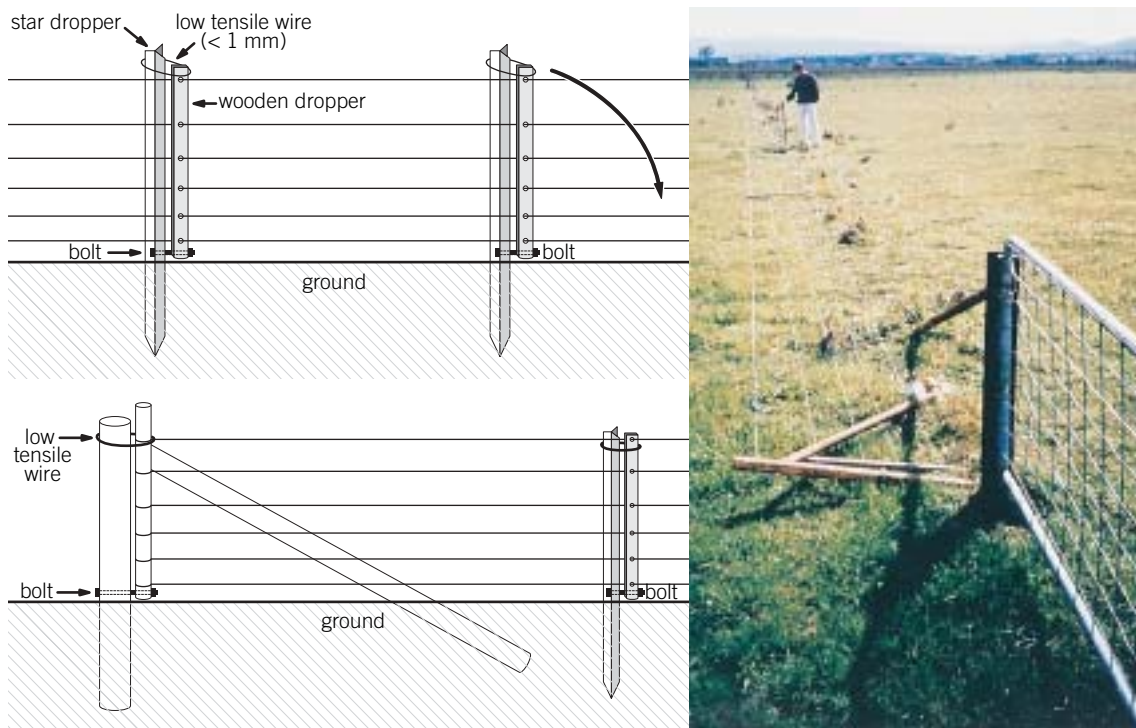
This riparian zone has been fenced out to restrict stock access. Once the area has been rehabilitated, stock may be permitted access for drought refuge or shelter in times of severe weather events. Photo Siwan Lovett.

3. Maintain a vigorous and competitive pasture sward to prevent invasion by unpalatable or woody weeds into riparian areas. This will also reduce soil loss and erosion during intense rainfall or periodic flooding. Spelling riparian paddocks to enable flowering, seed-set and natural regeneration of the most palatable and productive species is practised by many woolgrowers, with others using a combination of autumn spelling and occasional fire to help maintain the preferred composition and production of native riparian pastures. Season and duration of spelling should be based on careful observation of the growth and seeding patterns of preferred pasture species.
4. Do not graze riparian pastures during prolonged warm and wet periods if control of fluke and other internal parasites is a priority for woolgrowers. In the north, this means careful management over the summer period. In the south, riparian areas can be grazed more safely towards the end of summer, when hot and/or drier conditions have resulted in lower disease potential.
5. Monitor and control stock access to riparian areas. By monitoring the impact that stock are having on riparian pastures and streambanks, woolgrowers can move them to another paddock as soon as there are signs of damage. Some woolgrowers have found that using off-stream watering points, mineral or supplement licks, and providing shade and shelter away from the stream or creek, can be quite effective at changing animal behaviour, reducing the amount of time sheep spend in the riparian area. Depending on the woolgrowers' particular situation, these techniques may be reasonably effective at much lesser cost than fencing. Using multiple or movable watering points in a large riparian paddock can allow more complete and even use of feed, with benefits to overall production and less weed invasion into over-grazed areas around troughs.



What to consider when positioning a riparian fence line.

6. In those situations where stock have access to the stream for water, provide gravelled or stone-reinforced access points. These reduce erosion and sediment run-off into the stream, and will be preferred by sheep to areas of mud where bogging and poor water quality present risks. An even better alternative is to provide off-stream watering well away from the bank and riparian area.
7. If installing fences to enable greater control of stock in and around riparian areas, there are three main types to consider.
 - Plain wire suspension fence — this is often preferred for use in areas where periodic flooding is likely. Plain wire is less likely to collect flood debris, be damaged or pushed over by flood waters. Wherever possible, the fence should be placed parallel to the direction of flood flow to minimise the debris capture. A plain wire fence is generally cheaper than fabricated mesh, although it may require droppers, and given the need for tension, there is some limitation on following the curves and meanders of a stream or creek. A plain wire fence can be cut, if necessary, when a flood is imminent and is relatively simple to replace and re-strain after the flood has passed. This practice can help to ensure that strainers and in-ground droppers remain in place.
 - Prefabricated mesh such as Ringlock or Hingejoint. These fences are more effective in controlling stock than a plain wire fence and do not require droppers. They are, however, more expensive and susceptible to collection of debris. They cannot be as readily removed or made ready for a flood, although the recent invention of a lay-down form of fencing may make this less of a problem. The lay-down fence has panels hinged at the bottom and held in place by a tensioned bolt at the top. When flood debris push against a low wire underneath the mesh, the bolt is released and the fence is then able to lay flat on the ground, where it is unlikely to collect debris or to be damaged during the flood event. Once the flood has passed, the panel can be lifted up and re-hung, using the tensioned bolt.



Drop/lay down fence section. Upper diagram showing a section hinged at star droppers, and bottom diagram showing hinge adjacent to the end strainer. Photo Ian Bell.



A home made 'cockies gate' that is easy to put up and down to allow stock access to a 'riparian paddock' that is strategically grazed depending on season and feed on offer. Photo Phil Price.

- Two or three-wire electric fence. This is cheap, quick to erect, and relatively flood-proof, but does require some form of electric power to operate it. With the decreasing price of solar-powered battery systems to energise electric fences, this type of fence is now often preferred by woolgrowers for use in a flood-prone area. Some woolgrowers consider an electric fence is not as effective at controlling sheep as a prefabricated mesh fence, but others disagree. Electric fences are reported to work well where pasture utilisation and height allows the bottom wire to be made "hot", as this prevents animals pushing it up and shorting the current. Woolgrowers using a rotational grazing system, where sheep are moved to fresh feed every few days, report that 3-wire electric fences work well, perhaps because there is less tendency for animals to "push" at the fence to reach new pasture. Some woolgrowers also make it a habit, when sheep prices are good, to routinely cull animals that do not respond well to an electric fence.

For some woolgrowers, combining a mesh fence located just outside the floodplain, with a simple electric fence placed closer to the stream works well, as this combination allows sheep to be kept safely out of the riparian zone when required, for example in time of flood risk or as a seasonal disease control measure, while the riparian pasture can be grazed outside those times but with stock still prevented from entering the stream itself. The electric fence can more easily follow the stream meander bends so that all the riparian pasture can be grazed. The expensive mesh fence is not at risk of flood damage, while the electric fence can be simply and cheaply replaced if damaged by unexpected flood.



Case study

John and Jill Neal, 'Campview'

Location: Moonie via Goondiwindi, Queensland

Average annual rainfall: 557 millimetres

Property size: 3600 hectares

Enterprises: 5000 merino sheep and 200 beef cattle

Stocking rate: 19 stock days per hectare per 100 millimetres rain

Pasture base: predominantly Queensland bluegrass

Vegetation and soil types: Grazing country: brigalow, beulah, ti-tree — 'melon hole' country (black soil with a loamy base). River frontage: box, coolibah, beulah and sandalwood

River management: approximately 6 kilometres of Moonie River

For Queensland graziers John and Jill Neal, the quality and long-term nature of grazing offered by native pastures is a strong incentive to maintain and improve the natural resources underpinning their 3600-hectare grazing operation. John says that “while improved species provide more feed in early years, we find the native grasses do not decline as much in the longer term, are more diverse and sustainable and suit the natural climate of the country. There is also a faster response to storm rainfall. Further, the quality of the native pastures is better during winter than improved species, which tend to produce a big bulk of summer feed and require protein supplements in winter to maintain livestock growth.”



A priority for the Neals has been to protect the Moonie River from livestock grazing while ensuring the property is effectively drought-proofed using alternative water sources for livestock. Photos in this case study Currie Communications.





Motivated by a desire to prevent stock walking into the river or surrounding country, John and Jill have significantly invested in a major fencing program, development of a bore equipped with computer-controlled pumps, polypipe and trough systems to provide a secure water supply for their grazing enterprise.

The Moonie area has been extensively cleared for cropping with wheat, but along the river, in the vicinity of Campview, significant areas of native vegetation remain. For the Neals, retaining around 30% of woodland vegetation on the property is about right. More than one quarter of the property currently contains large areas of woodland, while the Neals are allowing smaller clumps to naturally regenerate for shade and timber belts on land previously cleared for cultivation. Controlled grazing is employed on the property to achieve evenness of grazing, and as a tool to spell country for as long as possible. A parasitic lichen is actively being promoted to affect the growth of limebush — a major pest in the area.

Grazing for Profit workshops have played an important role in John's approaches to pasture and business management. Time-controlled grazing systems are gradually being established, with a grazing chart system now in place that is used when making assessments of the feed availability in each paddock. Detailed records of grazing and spelling are maintained. Expert advice from Greening Australia and a grant through Natural Heritage Trust has also influenced the extensive fencing and stock water reticulation program to exclude stock from a large reserve of timber and waterholes along the river on their property.

A major farm management activity in recent years has been to completely fence-out the 6 kilometres of Moonie River frontage that passes through 'Campview'. Motivated by a desire to prevent stock walking into the river or surrounding country, John and Jill have invested more than \$120,000 in a major fencing program, development of a bore equipped with two computer-controlled pumps, 18 kilometres of polypipe and 15 'cup and saucer' trough systems to provide a secure water supply for their grazing enterprise.





A special place: Striking the balance between production and conservation is at the core of farming for John and Jill Neal on Campview.

John says there is no doubt the health of their property — and their stock — is far better off following the riparian management program. Pastures perform better because paddocks can be adequately spelled and the erosion and pugging problems along the waterway have all but disappeared. Stock now access higher quality water through the reticulated system and the overall health of the stock and land is visibly better. Watering points have been designed to prevent the stock trampling and rushing the troughs — the sort of stress that can cost a grazier money.

The watering program has been carefully planned. Water points have been arranged so that stock needn't walk any further than 1.5 kilometres to water, which is regarded as the limit for efficient feed utilisation of a pasture.

Core production goals for the Neals include:

- the improvement of the sheep flock with good bloodlines;
- pasture improvement through more intensive fencing and time-controlled grazing;
- further subdivision of paddocks and installation of watering points to assist time controlled grazing (currently the farm has 29 paddocks, which are to be subdivided to end up with 69); and
- improvements to increase stock carrying capacity — while matching carrying capacity to pasture — using stock days per hectare per 100 millimetres of rain.

Despite a run of dry seasons, progress in implementing the plan has been good. According to John, pastures are improving, the subdivision is continuing and another 12 watering points were installed in 2003–04. Wool production is moving up from 4.5–5 kilograms per head (average of the whole flock) with good quality 20–21 micron wool. Cultivation areas of the farm have been returned to native pasture, which is gradually improving in quality.



Striking the balance between production and conservation is at the core of farming on Campview. The Neals believe they will be ahead in productivity terms over the longer term by returning to a native pasture base and diverting the considerable funds that would be required for improving pastures to other areas. “The sustainability of native pastures versus improved species is an important consideration,” says John. “The native pastures are a personal choice for our family for long-term sustainability and are being encouraged in preference to introduced species, particularly for feed during the protein-deficient months of winter.”

The Neals also have a commitment to retaining timber on the property and protecting water sources from stock so that good water quality is maintained and reticulated through troughs across the property. “Livestock production would suffer if shade and shelterbelts are removed through development, and our resilience to drought — through the availability of grasses and edible shrubs in timber stands — would be reduced. The timber is particularly important for shade in summer and providing shelter in winter. If the stocking rate is increased and these reserves are not available, then the effect of drought will be more severe.”

For John and Jill, the water supply program is now fully operational, delivering water to all watering points at a rate of one litre per second. The design of the system could effectively double this rate of water supply if seasons and pasture condition allow stocking rates to increase and the demand for water is greater. Equally as important for the Neals, however, is that the Moonie River is protected from livestock grazing and the property is effectively drought-proofed.



This case study was prepared by Land, Water & Wool Native Vegetation & Biodiversity Sub-program and Currie Communications. For more information visit the website www.landwaterwool.gov.au

Section C

Managing riparian vegetation



Purpose

To maintain and improve the health and diversity of riparian vegetation on wool properties.



Managing riparian vegetation

Principles

The vegetation of riparian land is often more diverse and more productive than in other parts of the landscape. This is because soils are richer in nutrients than further upslope, and there is a greater availability of water, shade and shelter. Riparian soils receive nutrients from both land and water. Minerals, nutrients and sediments from upland areas are transported to lower-lying riparian lands by surface run-off after rain, while nutrients and silt may be deposited along streams during floods. Periodic flooding is particularly important in contributing to the enrichment of floodplain riparian soils along large, lowland rivers. Riparian vegetation at a particular site reflects past flood or other climatic events, as well as different landforms, soils, and land uses that exist along the stream. As a result, riparian vegetation is often complex, with increased species diversity. Some riparian plant species occur only along streams as they require the better soils and increased moisture for survival and reproduction.

Naturally healthy or rehabilitated riparian vegetation can be used for a number of purposes:

- providing shade and shelter for stock;
- lowering groundwater levels adjacent to streams;
- stabilising banks;
- trapping sediment and nutrients;
- shading streams for reduced light and temperature;
- providing wildlife habitat;
- increasing property values;
- providing fodder in times of drought;
- growing high value timbers for harvesting (providing harvesting operations do not damage the surrounding riparian land and follow planning and regulatory requirements);
- harvesting of native fruits and seeds; and
- improving in-stream life which helps to maintain fish stocks (including those in estuaries and in-shore areas).



Tree with hollows like this one provide important habitat for wildlife. Photo Guy Roth.

For these reasons, the management of riparian vegetation on wool properties can be designed to optimise both productivity and environmental outcomes.





This riparian area has been protected from grazing and is fulfilling a range of different functions. Photo Lori Gould.

On-farm management practices

In many wool-growing districts, the natural riparian vegetation has been extensively altered, largely through grazing by domestic stock and clearing. Once native vegetation is lost it is difficult to reinstate it. In some places, scattered large trees remain, but there is often little natural understorey and native grasses have been replaced by annual and exotic species, including weeds. Many of the native trees are old and where riparian areas are over grazed, there are no new trees to replace them. Research has shown that these changes, combined with catchment development for intensive cropping, can result in large amounts of soil being washed into stream channels. This often blocks the channel, reduces water quality and harms in-stream life. At the same time, increased light levels and water temperatures favour the growth of nuisance weeds and algae, particularly when nutrients from surrounding areas have been carried into the stream. The result is that many streams are in poor ecological condition.

1. Survey all the streams and creeks running through or adjacent to the property so that their status and condition can be recorded. Section L of this Guide provides a method for rapid assessment of riparian condition. This on-site survey will identify opportunities for improved management of existing riparian vegetation or rehabilitation through replanting of riparian lands with local plant species. This activity may be undertaken with neighbours as part of a whole-community approach to stream and riparian management, but individual landholders can also plan and implement restoration projects on their own property.
2. Work out which part of the stream is going to be the focus of rehabilitation. The time and resources required to rehabilitate riparian vegetation means that if replanting it is best to replant one section of a stream each year over several years, beginning in the uppermost reaches and gradually working downstream.

3. Identify existing native vegetation that requires protection and areas where there is potential for natural regeneration as it is much easier to protect existing native vegetation than to replant it. Where native species remain on the farm and are in sufficient health to flower and produce viable seed, natural regeneration is the best and cheapest way to revegetate. Check to see whether seed is present either on plants or in the soil, and then aim to remove grazing for at least 24 months to give new plants time to establish and grow to a stage where they can survive the return of stock.



The grasses, reeds, logs and branches at the toe of this bank are protecting it against further erosion. The site would respond well to rehabilitation as the toe is currently protected and there are some trees remaining on the riverbank to help bind the soil and provide a seed source for regeneration. Photo Guy Roth.



This eucalypt is one of the last remaining mature trees holding the streambank together, when it dies it is likely that this part of the streambank will collapse and the bank will erode and be lost. Photo Guy Roth.





River view. Photo Lu Hogan.

4. Consult local experts, for example Greening Australia, a river planner or government agency, to develop a plan for riparian rehabilitation. Visit local sites where there has been minimal disturbance, as this will show you what natural riparian vegetation could look like; note which species occur in which parts of the channel, banks and adjacent riparian areas. Some site preparation may be required, for example hand removal or spot-spraying of weeds, or a low intensity burn to remove dead plant material; these actions should occur before seed fall and the greatest likelihood of rains for germination.
5. Replant the northern bank first in east–west flowing streams, as this provides a maximum amount of shade for in-stream life. In consultation with local experts, select a mix of plant species focusing on the early stage or pioneer species that are favoured for their fast growth rate and ability to cope with full sun and frosts. Once established, birds, other animals, windblown seed and occasional floods are likely to bring in a diversity of additional species over time.



Regeneration of river red gum is now possible without continuous grazing. Photo Lu Hogan.





Even though this may look 'messy', the scattered wood and leaf litter in this riparian area is providing valuable habitat for insects, bugs, birds and larger animals. Photo: Phil Price.

6. Implement a weed control strategy to protect the area being rehabilitated. Weed control prior to and following planting is often the key to successful revegetation. However, many areas have been invaded by exotic weed species following extreme disturbance of the natural vegetation, and significant time is required to remove and control these pest species, to prepare the site, to replant and to continue follow-up maintenance.
7. Avoid the tendency to 'tidy up' and burn fallen timber in riparian areas as this wood is important habitat for plants and animals. It can make control of weeds and feral animals more difficult, but it should be left wherever possible.

For more information on managing riparian widths: Price, P., Lovett, S. & Lovett, J. 2004, 'Managing riparian widths', *Fact Sheet 13*, Land & Water Australia, Canberra, www.rivers.gov.au



Trees in and next to a riparian area provide shelter from wind and also shade. Photo Land, Water & Wool.



Replanting tips — using longstem tubestock to restore riparian lands

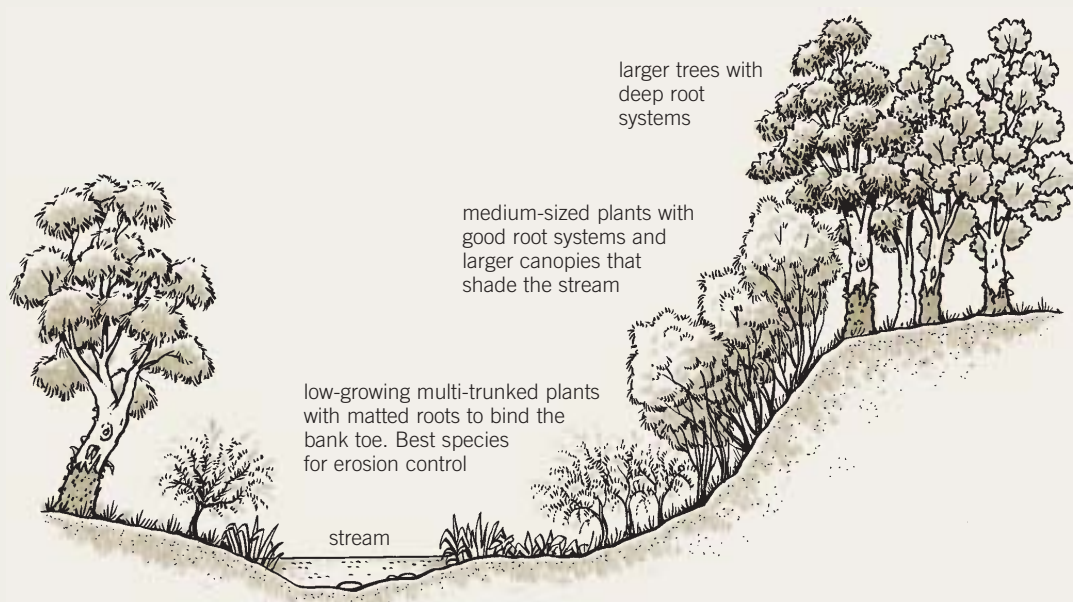
(Modified from NSW Department of Land & Water Conservation fact sheet)

Using longstem tubestock as an alternative to willows

Bill Hicks, a Hunter Valley Landcare member has developed an alternative for planting and growing native trees — longstem native tubestock, or 'longstems'. Longstems differ from regular native tubestock in the way they are grown and planted. Longstems are grown for up to 18 months using a specific nutrient and storage regime. The result is a climate-hardened plant with thick, woody, elongated stems (up to 2 metres long) with closely spaced growth nodes from which roots sprout once the longstem is planted. The longstem is planted in the streambank with its root ball buried 0.5–1.5 metres deep in the soil, leaving only the top 5–10 centimetres of the plant above the surface. Special water jets have been developed to plant longstems.

The results of trials show that longstems have the following advantages over regular native tubestock:

- increased growth rates and better survival rates — planting at depth enables longstems to access sub-surface soil moisture and potentially lessens competition with weeds;
- root establishment at depth — longstems can be planted in environments where previously only willows could be expected to have survived; and longstems achieve rapid erosion control; and
- minimal follow-up care, with the need for watering and weeding largely eliminated.



Where to use longstems

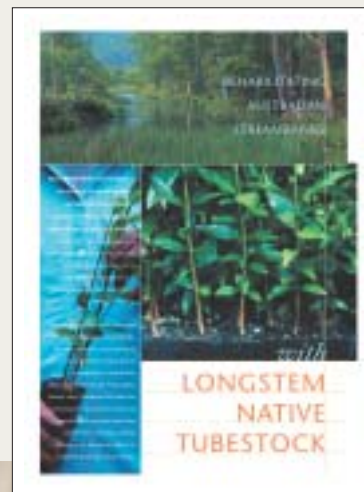
Most plant species that occur naturally along streams are considered to be suitable for longstem development due to their tolerance to sediment build-up around the stem, although it is always a good idea to trial any untested species before mass plantings take place. Longstems can potentially be planted in the riparian areas of most Australian streams. Use well-vegetated riparian areas as a guide for planting layouts. The form of the grown plants should guide selection of a planting position in the streambanks as illustrated in the diagram shown opposite.

More information

Supplies of longstems are currently limited. However, commercial production is being encouraged through regional workshops and education. A detailed brochure outlining how to grow and plant longstems is available from the New South Wales Department of Infrastructure Planning and Natural Resources. In all states, your local Catchment or Rivercare coordinators will be able to provide you with details of local longstem suppliers and the best species for your area.

Source: Department of Land & Water Conservation.
Rehabilitating Australian Streambanks with Longstem Native Tubestock. http://www.dlwc.nsw.gov.au/care/water/streambank_rehab/index.html. Includes link to Rehabilitating Australian Streambanks with Longstem Native Tubestock.

There is also a video available that can be purchased from either DIPNR Information Centre, tel: (02) 9762 8044 or from the person who developed the technique — Bill Hicks, Norkhil Technologies Pty Ltd, tel: (02) 4998 8387, E-mail: norkhil@hunterlink.net.au





Case study

Terry and Andrea Stacey, 'Rocklands'

Location: near Quairading, Western Australia

Average annual rainfall: 300 millimetres

Property size: 4000 hectares

Enterprises: prime lambs, wool and cropping (wheat, barley and lupins)

Pasture base: subterranean clover mixture plus ryegrass and capeweed

Soil types: loamy duplex, some grey clays

River management: fencing off the Conallan Creek and revegetation to prevent erosion and create a wildlife corridor

Rocklands, near Quairading in the Western Australian wheatbelt, is owned by Terry and Andrea Stacey. Staceys have lived in the area since it was opened up nearly a century ago. Terry and his brother Russell run a total of about 4000 hectares together. Prime lambs are the main output from about 3000 merino ewes crossed to poll dorset rams. About 2500 lambs are sold off each year when they reach 40 kilograms liveweight — usually in September or October. Wool and about 2300 hectares of wheat, barley and lupins are additional enterprises.

Salinity is a fact of life in the central wheatbelt, which has a flat landscape and very few permanent waterways. The Conallan Creek which traverses the Stacey property flows briefly for a few days after winter rains, but is mostly dry. The area was cleared for farming nearly a century ago and since then the water table has risen, killing many trees along the creekline. The creekline, like most low-lying areas is obviously saline and dominated by samphires (very salt-tolerant plants).

The Conallan Creek Catchment Group comprises nine local farmers including the Staceys and was formed in 2000. The group had revegetated several saline areas, and this experience probably worked to the members' advantage in obtaining a Natural Heritage Trust grant in 2001 to help fund further work. Overall, eight projects were approved among group members. The Staceys' aim was to fence off the saltland near the creek to exclude stock, encourage regeneration of vegetation, and create a wildlife corridor along the creek.

Expert advice was sought from a wide variety of sources, but some options were not taken up when it was realised that their situation was not suitable, such as that from the WA Lucerne Growers Inc. and the Eastern Wheatbelt Regional Oil Mallee Officer. The Water and Rivers Commission, local Landcare coordinator and the Cunderdin Tree Nursery all proved useful. The mining company Alcoa has also been very active in revegetation work with four demonstration catchments in this region, providing good examples of what could be done in similar areas.

The first step was to fence off the low-lying creekline areas from the good cropping and grazing land, allowing it to be managed separately. This was completed over several months in 2001, involving removal of old fences as well as building 4.1 kilometres of new fence. About 20 hectares was excluded from the rest of the farm's operations, which had the advantage of extending the useful grazing areas available in what had been very large paddocks. Rabbits were cleaned out with 1080 poison to make sure they provided no threat to young plants.





Before: The Staceys' aim was to fence off the saltland near the creek to exclude stock, encourage regeneration of vegetation, and create a wildlife corridor along the creek.

Photos Currie Communications.



And 'after': After 4 years, growth of planted species above the creek has been disappointingly slow although survival rates of the trees and shrubs have been high. However fencing and hence stock exclusion has been a major catalyst for regeneration of bluebush, samphire and other native species within the creekline area — easily outdoing the planted species.

The Water and Rivers Commission (now part of the Department of Environment) established a 2 hectare demonstration site on a flat area in 2001 using a wide variety of shrubs and trees. With the help of local volunteers and Green Corps participants they planted about 30 different species over two years, aiming to put in as wide a range as possible to see what worked. Individual species were chosen for tolerance to salinity, drought, floods and likely attraction to native fauna.

At the same time, Terry Stacey began planting 5 hectares of land beginning with 9000 trees and shrubs and eventually extending to 16,000. Because of the cost of specialised tree-planting machinery that would only be used for a few days a year, many shires, including Quairading, hire out machines to local farmers. The planter needs to be booked well in advance, and it is just bad luck if the chosen dates happen to coincide with bad weather once the crops are out of the way! With such large numbers of trees involved, planting by hand would not be practical. Survival rates with the machine are also better than by hand.

Growth of most of these young trees and shrubs has been very slow, although survival rates are high. However, closer to the creekline, natural regeneration of jam (*Acacia acuminata*) and other wattles has been excellent. Many are several times larger than the actively planted trees and shrubs in the rip-lines a few metres away. Wavy-leaf saltbush (*Atriplex undulata*), old man saltbush (*Atriplex nummularia*), small-leaf bluebush (*Maireana brevifolia*) and samphires in the creekline, have been among the more successful species. Although this is normally York gum (*Eucalyptus loxophleba*) country, new plantings that went in during a dry 2002 had a hard start and are still only about 30 to 40 centimetres high after several years.



The management plan for the area includes riffing of sections of creekbed — lining it with rocks to guide water to the centre, rather than allowing it to spread more widely. An area near the bridge on the Quairading-Tammin road was completed with Green Corps assistance to help prevent erosion. But this is a very labour-intensive operation and it could be some time before other areas are completed — unless a squad of volunteers materialises. Two boreholes were drilled to monitor changes in water table level. To date, overall changes have been minimal, although levels have risen and fallen within each season.

Being able to access Natural Heritage Trust funding, particularly for the 4 kilometres of fencing, has made a big difference to the rate at which this work has been done, but the Staceys' keenness to restore their section of creek would have kept it on the agenda anyway. Terry Stacey is disappointed that growth of many planted species has been slow to date, especially compared with the natural regeneration that has occurred following fencing and exclusion of stock, but believes they have done all they could. He hopes it is just a result of several drier than normal years and a return to better seasons could result in faster progress. A couple of field days have been held on the property, and this has been useful for other farmers to see which species are working.

Since the creekline area has been fenced off, kangaroos have returned — although fences provide no barrier to their movement. Terry is very happy to see this, but believes that birds are unlikely to be attracted for some time until vegetation growth is much more advanced. He has seen examples on other local properties such as his brother's, where substantial revegetation with eucalypts, wattles and other native species has taken around 10 years.

This case study was prepared by Currie Communications.



Saltbush has performed well on the riparian zone.
Photo Currie Communications.

Section D

Increasing wool production with shade and shelter



Purpose

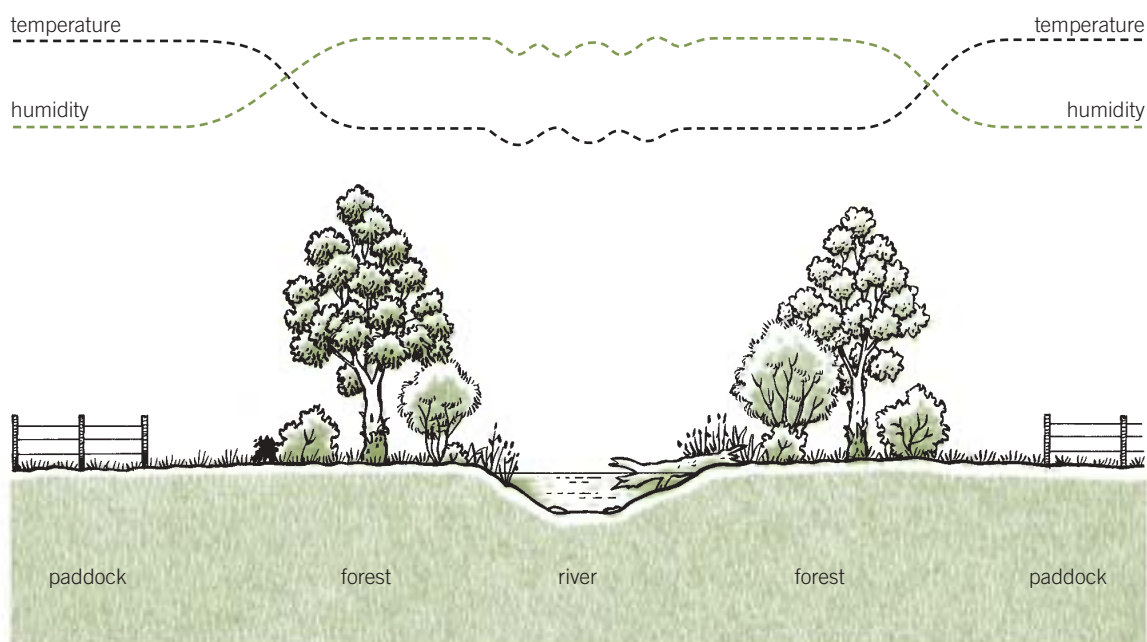
To manage riparian areas so that agricultural productivity can be improved on-farm.



Increasing wool production with shade and shelter

Principles

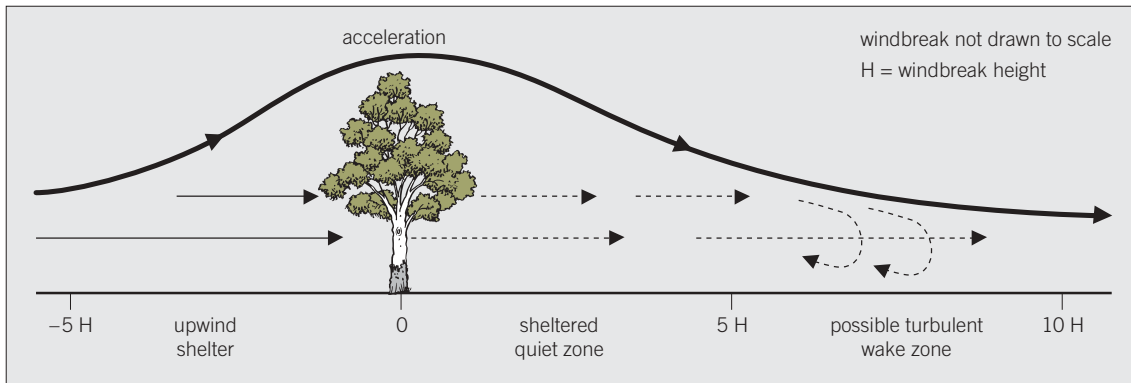
Livestock like to graze the understorey grasses and shrubs on riparian land, favouring the microclimate, feed, shelter and moisture found there. Shelter can improve livestock productivity and survival by increasing pasture supply and reducing cold and heat stress on animals. It can also assist pasture growth directly (better growing conditions) and indirectly (prevention of erosion, providing habitat for pollinators). The long-term aim of grazing on riparian land should be to improve animal health and wool production, while minimising damage to the vegetation and maintaining adequate ground cover. This can be achieved by managing the timing, intensity and duration of grazing, together with providing access to clean water.



Riparian vegetation has a moderating effect on air temperature and humidity, creating a special microclimate.
Illustration Paul Lennon.

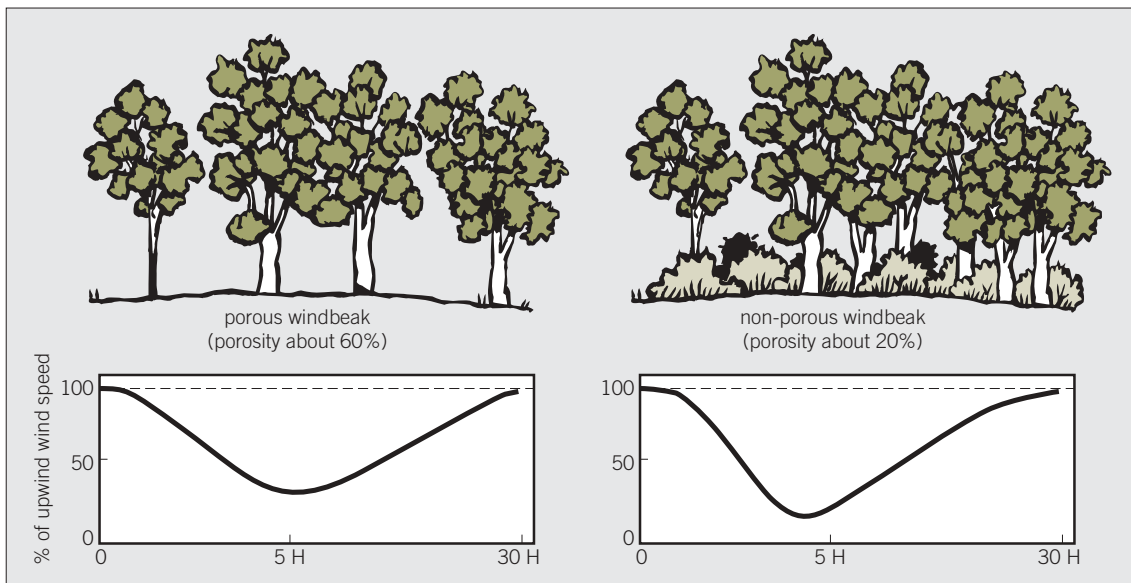
Shelter provided by riparian vegetation substantially reduces windspeed on the farm. The degree and distribution of shelter depends mainly on the height, structure and position of the windbreak. This means that the width of paddock that is protected is largely determined by the height of the windbreak, while the degree of protection (percentage reduction in wind speed) at certain parts of this shelter zone is influenced by the porosity (spaces) of the belt. The area close to a dense belt has a very high degree of wind reduction, while a more permeable belt has the best protection several windbreak heights away, although this may still be less than the maximum obtained within one height of a dense belt.





Above: The effect of a tree windbreak on airflow.

Below: The effects of a high porosity and low porosity windbreak on wind speed.



Source: *Design Principles for Farm Forestry*, 1997, Rural Industries Research & Development Corporation, Joint Venture Agroforestry Program.

The ideal windbreak has moderate porosity along both its length and height, reducing wind speed and improving microclimate. Porosity is determined by tree species, the number of rows and tree spacing. Gaps (including gates) need to be avoided as they can severely reduce the sheltering capacity of the windbreak. Foliage should extend all the way to the ground to prevent wind funneling at low levels. As an example, a 10 metre high windbreak can provide some protection over an area extending up to 300 metres downwind. Healthy native vegetation on riparian land forms an excellent windbreak as it has a mix of shrubs, grasses and trees at different layers and levels that slows down wind speed and creates a sheltered microclimate for stock to use in adjoining paddocks.

In general, to be effective windbreaks should be at least 20 H (where H is the average height of the tallest tree layer) in length. The following information draws on the findings from the National Windbreaks Program managed by the Rural Industries R&D Corporation.

Windbreak effects can be divided into three main zones:

Competition zone (-2 to +2H)

- competition for water, light and nutrients between trees and crops or pastures reduced yields at all field sites;
- gaps can lead to wind erosion and sandblasting damage;
- shading can offset increases in air temperature that result from wind shelter;
- competition will not be a major issue for riparian windbreaks that have the stream on one side, and perhaps an access track on the other.

Quiet zone (2 to 8 H)

- calmer, warmer and/or more humid by day;
- in dry conditions reduction in atmospheric water demand may lead to improved water use efficiency — translating to either more biomass for the same water use or less water use for the same biomass;
- enhanced plant development and biomass production are possible;
- an important zone for stock protection.

Wake zone (more than 8 H)

- effects of wind shelter on temperature and humidity are small;
- shelter from wind reduces the risk of direct damage to plants from leaf tearing and stripping, plant lodging and sandblasting.

The effects of porosity on wind speed are significant. In one example, the most porous windbreak, with a porosity of 70%, provided less than 40% reduction in wind speed at maximum reduction point, while one with porosity of only 30% gave a 75% reduction. Whatever the porosity, the maximum reduction in wind speed is achieved at a distance of about 5 H. There is no difference in the width of the paddock area sheltered by windbreaks of different porosities. In another example, the sheltered area extended up to about 23 H, maximum protection. Wind speed reduced to about 52% of the upwind figure, was provided at 4 H, while by 15 H the wind speed had risen to 80% of that in the open.

Wool production and quality

Shelter can increase wool production mainly by altering the microclimate in the sheltered area, and from reducing the direct effects of wind on plants and stock. Research undertaken in Armidale, NSW found that wool production in well stocked plots partially sheltered by a 1-metre-high iron fence was 43% greater than in open plots (Lynch & Donnelly, 1980) over a five-year period (most of the effect occurred in two years of well-below average rainfall). This was due to a combination of direct sheltering of the sheep and increased pasture growth. Lynch et al. (1980), quoted in Reid and Thompson (1999), showed that paired 1-metre barriers of Sarlon shadecloth (porosity 50%) reduced water loss. They argued that the “saving” of 12.3 millimetres of soil water in one month led to an increase of 15–21% in metabolisable energy intake in sheep grazing at 20 and 30 sheep/hectare on a phalaris/white clover pasture. Shelter from cold winds also reduces the amount of energy required by animals to maintain body temperature, providing more energy for weight gain and wool production.



In a more-recent trial (Reid & Thompson, 1999), plots that were protected by a windbreak ran more sheep (5.5 versus 3.9 dse/hectare), cut more wool (3.4 versus 3.0 kg greasy/hectare), maintained higher sheep body weight (13%) and in one case cut finer wool (17.8 vs 18.3 micron) than adjacent plots without a windbreak. The mean wool income of the protected and unprotected plots was, respectively, \$70.13 versus \$65.76 when sheep density was kept constant, and \$147.90 versus \$95.25 when sheep density was varied and matched to available feed. A whole-farm financial analysis, for a 1000 hectare New England grazing property with and without north-south oriented windbreaks (12 hectares) along sub-divisional fences, showed that a modest investment in establishing windbreaks (less than \$2000 per hectare of windbreak) provided an attractive rate of return for all but the lowest tested (10.5%) increase in stocking rate. Similar results could be expected from establishment of riparian windbreaks in most areas where wind effects on stock and/or pastures are significant.

Research has shown that with shorn sheep, shelter that reduces wind speed by 50% can reduce animal energy losses by 20%. Even with 3 centimetres of wool, persistent strong wind can reduce gains in liveweight or wool production. Shelter that can cut such wind speeds by 50% can increase liveweight gain by 30% (Bird, 2003). As well, ewes with access to shelter from extreme weather will produce lambs with higher birth weights and have more nutritious milk; both these factors will reduce lamb mortality (Quayle, 2001).

In addition, high wool cuts are dependent on the density of secondary follicles that form on the lamb foetus during the last six weeks of pregnancy. The number of follicles formed is dependent on the ewe's nutrition. Stressed ewes will produce lambs with fewer follicles and this trait will persist for the rest of the lamb's life. Shelter that reduces stress prior to lambing can therefore provide benefits over many years of a sheep's life (Quayle, 2001).



Shelter for newly shorn sheep is very important, particularly when extreme weather events can threaten their survival. Photo courtesy Australian Wool Innovation Limited.

In warmer regions or during periods of very hot weather, shade from riparian vegetation can also be very beneficial for sheep. Research has shown that high ambient temperatures have a detrimental effect on fertility. Heat stress 12 days before oestrus reduced fertilisation and lambing rates, and it can lengthen the oestrous cycle by one or two days, dampen oestrus behaviour towards rams and reduce the length of oestrus. During the first nine days following fertilisation heat stress can also cause embryo mortality. Heat stress has also been found to depress wool growth. Therefore, access to shade during joining can be an important contributor to high lambing percentage and to subsequent wool production (Dutt, 1963, 1964; McLennan, 2005; Hopkins, Nolan & Pepper, 1980).



Shelter reduces deaths of newborn lambs. The average of all trials in south-east Australia shows that effective shelter reduces these losses by 50%. Wind is the major problem, but losses are greatest when accompanied by low temperature and rain. Without shelter, all lambs born on such severe days may die. A chill index has been developed (see RIRDC, 1997) to allow calculation of the effects of different wind speeds on new born lambs at different temperatures. This shows that even at an ambient temperature of 9°C, a wind speed of 30 km/hour is sufficient to bring heat loss to a critical level. Reducing the wind speed by half to 15 km/hour decreases heat loss to a safe level. At a temperature of 3°C, wind speed should be less than 10 km/hour to prevent dangerous heat loss.

Shelter from wind also reduces losses of exposed shorn sheep. Severe weather in 1982, 1983 and 1987 in south-west Victoria resulted in a recorded 250,000 sheep dying from exposure. In contrast, losses were minor where sheep had access to shelter. The presence of native vegetation, woodlots, and intact riparian areas on farms provides insurance against such losses (Bird, 2003).

The data quoted here concern reproduction and growth rates and stock losses. Other than the results quoted above from Reid and Thompson, there is no data on the impact of shade and shelter on wool quality, for example reduction in fibre diameter, or tender or break points that result from severe animal stress, as well as reduced contamination from airborne dust or vegetable matter. However, these could provide additional benefits from retained or planted native vegetation in riparian areas alongside water courses.

Sheltering livestock from the weather (sun, heat, wind, cold, rain and frost) improves their condition, especially for lambs and newly shorn sheep, and can lift wool production. This is best achieved through carefully-planned, strategic use of riparian pasture paddocks adjacent to fenced-off native vegetation along the streambank. This configuration protects the native vegetation from over-grazing and damage, while enabling full use of the next door pasture at critical times of the year.



This landholder is allowing their riparian area to regenerate so that it can provide shade and shelter for stock and crops. Photos Julie O'Halloran.

Additional agricultural productivity gains

As well as the direct effects on sheep survival, reproduction, and growth, from shade and shelter, provided by riparian vegetation can benefit pasture production in several ways. Reduction in wind speed and provision of shade can reduce pasture water use (transpiration) and loss of moisture by evaporation from the soil surface, so that more feed can be produced for the same amount of rainfall. The average increase in pasture production measured by a range of experiments was 9%, with a range of nil to 60% (latter figure from New Zealand). Overall, the direct benefits to pasture production are small, but they can be significant during winter when feed is at a premium and they may be larger in the drier years. Shelter can also reduce wind erosion of surface soil and its attached nutrients, and reduced wind speed leads to less abrasion and tearing of pasture plant leaves. Overall, through a modest contribution to pasture production (and perhaps quality), especially in winter, when combined with the reduced stress on animals, windbreaks can make a significant contribution to carrying capacity and animal productivity (Bird, 2003).

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Healthy vegetated riparian land not only benefits crops, pastures and livestock by acting as a windbreak, but also by providing habitat for pollinators. For some plants like grasses and cereal crops, the movement of pollen by wind is sufficient to pollinate flowers, but much of our food comes from those that require animals to visit their flowers to help move pollen, and so produce seeds. Birds, bats and even small possums can pollinate some flowers, but the most important pollinators are insects, with the most significant being bees. Lucerne, an important pasture species, is a pollinator-dependent species. These pollinators are declining due to loss of habitat and pesticide use. Farmers in many parts of the world now have to purchase the services of bee keepers to pollinate their crops.



Using windbreaks on properties makes commercial sense as they provide valuable shelter for crops as well as stock. Photos (this page and opposite) courtesy RIRDC.

Riparian vegetation also provides habitat for insect-eating birds and insect parasites that can help protect pastures and crops from damage. Virtually all bird species feed on insects and, in so doing, can suppress plant-eating insects. Christmas beetle adults are eaten by cuckoo-shrikes, kingfishers and the larger honeyeaters as well as many other species, while whistlers snatch leaf beetles and caterpillars from eucalypt foliage. Magpies can consume many scarab larvae per hectare each year. Ibis also eat large number of insects, particularly grasshoppers and larvae. Losing even a small number of birds can allow significantly more below ground grubs to survive and become adults. Small mammals, like sugar gliders and bats, and predatory insects and spiders can take a significant proportion of insects that are not eaten by birds. Insect predators of pasture pests, including many wasp species, may also be important in controlling pest numbers and preventing a build-up of pest populations, and are favoured by access to native vegetation to complete their life-cycle. Predation of crop and pasture insects is greatest next to intact riparian areas, native vegetation and forested land, providing further evidence of the benefits to agricultural productivity in maintaining and protecting these parts of the farm.

On-farm management practices

The agricultural productivity gains that can be made by providing shelter belts means that it makes sense to protect and maintain any native vegetation or riparian area on wool properties. As well, remember that in many situations the riparian pastures are especially productive (deeper soil, retained moisture, higher fertility), so woolgrowers should give priority to optimising the feed produced and used on these areas. The key to this is to identify streams and riparian areas, and to plan for their specialised use and management, as part of a whole property plan (see page 16).

As well, remember that in many situations the riparian pastures are especially productive (deeper soil, retained moisture, higher fertility), so woolgrowers should give priority to optimising the feed produced and used on these areas.

1. In riparian areas, try to maintain or establish a strip at least 10 metres wide with a mix of native trees, shrubs and grasses to provide maximum shelter from wind for stock and crops in adjoining paddocks. Fence the area to prevent livestock eating foliage and increasing porosity, especially if the riparian area is a narrow strip where every tree counts.
2. If starting from scratch, plant at least one row of trees or shrubs that give good coverage down to the ground in multi-row plantings, so that other rows can include tall trees that lose their foliage near ground level, or can be pruned to improve the value of their timber. Use mixed, local species in multiple rows to maximise beneficial animals, especially native pollinators like bees and birds. Achieve the maximum possible height as soon as possible by choosing fast growing tree-species — if the trees are short-lived, ensure that you supplement the area with slower growing trees to replace those that die.





The riparian areas adjacent to the expanding gully are being prepared by this woolgrower for direct seeding. Fencing out the sheep and revegetating will help to dry the soil, spread overland flow, and assist the gully sides to stabilise, while mustering time and loss of sheep in the deep gully should also be reduced. Photo Fleur Flanery.

3. Replace young trees that die as soon as possible and control weeds during the establishment phase. The aim is to reduce gaps so that the riparian area forms an effective windbreak for livestock in adjoining paddocks. To estimate the porosity of the riparian windbreak, using your naked eye simply stand directly in front of, but some distance away from the windbreak, and estimate the proportion of 'open' versus 'closed' areas. It is even more accurate if you use a photograph. Once you have identified the 'open' areas, try to plant trees and shrubs to fill the gaps.
4. The longer the windbreak, the more effective it is in providing shelter. The wind can change direction by up to 30° and result in only small reductions in the distance sheltered if the windbreak is long enough (i.e. more than 20 times its average height). Even when the wind is blowing along the line of trees, a small area is sheltered because of the 'drag' effect of the trees on the wind. If the riparian area is short in length, try to continue the windbreak at adjoining ends into the paddock so that maximum shelter effects can be gained. Consult your local vegetation or Greening Australia expert for advice on the right mix of native species for the riparian area to gain maximum shelter effects for livestock.
5. Seek local knowledge about the best local species and planting methods to establish or enhance a windbreak. Weed control is a key issue, and can start the year before the planned planting. Ripping can be used to open up the subsoil to speed establishment, and to temporarily reduce competition from nearby established trees. Direct seeding, where it is feasible, is much cheaper than planting tubestock, and avoids the possible need for supplementary watering during the first year. Local agencies and Greening Australia staff have a wealth of experience in revegetation methods.





Case study

Mark and Anna Gubbins, 'Coolana'

Location: Chatsworth, Western Victoria

Average annual rainfall: 530 millimetres

Property size: 2630 hectares (650 hectares cropping)

Enterprises: 10,000 composite breed sheep for prime lamb and wool production; 1000 pure bred Angus cattle for stud and commercial beef production; annual cropping program comprising wheat, barley, oats and canola

Soil types: ironstone gravels and basalt

River management: 13 kilometres of Hopkins River frontage

Six years after completing a major fencing program to close off most of the Hopkins river frontage on his family property, Mark Gubbins is astounded at the re-growth of natural vegetation along the river's banks. "It's amazing to see how well the river banks have regrown," Mark says. "Nature has the biggest band aid of its own if you give it a chance. Things have grown in places where we thought they never would, for example, river red gums. I just can't believe how quickly the river has said 'thanks'."

The river is not only a watering point for sheep and cattle at the Gubbins' property, Coolana, located at Chatsworth in Victoria's Western District. It is aesthetically adding value to the property, has increased the amount of native wildlife species such as birds and platypus, is a shelter for stock and provides many social benefits, according to Mark. "Apart from increasing the general health of the river system, our family enjoys being able to go for walks along the river and observing echidnas and the like," Mark says. "Plus it's a great spot for fishing and for showing friends and guests some of the indigenous habitat."

Twenty years ago this was not the case, stock at Coolana had unhindered access to the river, creating erosion and other problems such as making it difficult to muster. Mark realised that his efforts on other parts of the property needed to now focus on the river. "The river is a valuable asset and while many trees and shelter belts have been planted throughout our property for many years, we had not really focussed on the river. We realised we had to change our ways." So more than 20 years ago, Mark took the bit between his teeth and decided to fence off the river, leaving just a few strategic watering points where the stock would have minimal impact on the river bank.

"In a relatively short period of time a vigorous re-growth was evident. So we instigated a long-term plan of fencing and direct seeding of trees," he says. "Then we had a chance to hasten the work through the Corridors Australia project in 1996 and that more or less accelerated our 20-year plan into just two. Today we have a terrific river system that supports the stock, wildlife, fish and that fits into whole property management."

Mark manages the 2630-hectare Coolana with his wife Anna and Mark's parents who are now semi-retired. There are three permanent staff and a casual staff member. Mark and Anna have two children, Ben and Max. Coolana is a mixed enterprise comprising beef, prime lambs and cropping. Stock numbers include 1000 beef cattle (all pure bred Angus) and 10,000 sheep (composite breeds from a Corriedale background for prime lamb and wool production).





Hopkins River before regeneration (left) and after fencing out and allowing native plants to regenerate (right).

The cropping program covers 650 hectares with a variety of cereals (wheat, barley and oats) and canola. The winter wheat and barley crops are usually grazed. The average rainfall on the property is 530 millimetres. The topography includes 13 kilometres of frontage to the Hopkins River. The country on the northern side of the river is mostly ironstone and gravel and to the south of the river, the ground is mostly basalt.

Coolana is also home to about 40 hectares of natural wetlands and more than 40 kilometres of trees in shelter belts. Mark and his family are actively involved in many on-farm revegetation programs such as Landcare and the local catchment management initiative, Water Shed 2000.

Mark's approach to property management places an emphasis on the long-term survival of the land. "We no longer see these fenced off areas as wasted country. They are a real asset. Some people question the value of the trees and the revegetation but I can't remember the last time we had any problems with stock during cold snaps and high winds. "The benefits of shelter are obvious. It cuts wind velocity and provides a haven for lambing and for shorn sheep. In fact all our shorn sheep now are moved off shears into sheltered paddocks as part of standard practice."

"As for the cost of fencing, when you spread it out over two generations, it is almost negligible, especially when you consider it will allow us to keep farming here in the future. In my opinion, the benefits of the fencing and tree planting far outweigh the costs. Aside from the fencing, we spend about \$500 a year on seed for trees and shrubs. That's a tiny price to pay for something like an established river red gum. And we have created an environmental barrier for the river, for example, we are no longer spraying along the river's edge. This means we are minimising the chemical input into the river and that has made us think a lot more about doing a better job of farming in general when it comes to applying chemicals."

While Mark and his family have followed their own plan for the past 30 years or so, they have had some advice and inspiration along the way. Mark is in regular contact with other like-minded producers in the district, such as Richard Weatherly (who also has Hopkins River frontage). Neville Oddie, a farmer at Ballarat was also influential when he worked with the Catchment Management Authority and provided advice on water way health and waterway management. "We had no real scientific approach to our tree-planting and fencing. We kept to a sensible plan that we knew we could achieve. The results to date are very heartening. We have a lot of fun and I love that aspect of property management."

In detail, the fencing program along the Coolana Hopkins River frontage has seen stock access cut from 100% to about 10%. The river fencing is a 6-wire, standard design fence, although three of the six wires are electric. There are two bridges and two other river crossings on the property.



Above: Fencing used along riparian areas. **Right:** Mark Gubbins.

Looking back at the work so far, Mark says he probably could have got away with not direct seeding trees along the riverbank. “With the amazing natural re-growth of red gums, we probably did not need to direct seed. It seems that as far as the river goes, just letting the ground have a chance is the best way. I would also recommend to be as cost effective as possible with fencing and to not use insul timber posts as we found they do not last very long. Mark says another important lesson he learnt the hard way was to not squib when it comes to chemical control in establishing the trees. “If you want to direct seed trees, establishment and preparation has to be done right. You will get a much better result, so don’t be afraid to get advice from experienced operators.”



This case study, and photos, was prepared by Currie Communications.



Section E

Using riparian areas
to water stock:
do's and don'ts



Purpose

To ensure that stock have access to an adequate supply of drinking water all year round.



Using riparian areas to water stock: do's and don'ts

Principles

Sheep need access to adequate supplies of good-quality water for optimal weight gain and wool production. The amount of water required varies according to the type of animal (e.g. lactating ewe versus wether), the type and quality of pasture (green versus dry), and the ambient weather conditions. Water consumption decreases when on green feed, during the cooler months and following rain. In hot weather, animals use more water for evaporative cooling. Shearing can increase the heat stress on sheep because the insulation formerly provided by the fleece is lost.

Water consumption can increase by 78% over normal under extreme, hot conditions. The provision of shade decreases this requirement (see also section D). In normal conditions and with good water quality, consumption in summer is about 40% higher than in winter, but can be 50–80% higher if the supplied water is above 2000 ppm total dissolved salts. The table below indicates the likely range of water required by different animals under normal conditions, with the lower amounts being for winter and the higher for summer.

	Average daily requirement litres per head	Approximate annual volume required in kilolitres per head
Weaners, average all feeds	2.0–4.0	0.7–1.5
Fattening lambs, dry feed	2.5	0.90
Fattening lambs, irrigated pasture	1.2	0.45
Lactating ewes, dry feed	4.0–10.0	1.5–3.7
Mature sheep, dry pasture	2.0–9.0	0.7–3.3
Mature sheep, irrigated pasture	3.0–4.0	1.1–1.5
Mature sheep, saltbush	4.0–12.0	1.5–4.4

Sources: NSW Department of Primary Industry 2004, Queensland Department of Natural Resources, Victorian Department of Primary Industry, and Wilson (1975).

In the better-watered parts of Australia, generally the higher rainfall and tableland zones, many woolgrowers allow stock open access to creeks or streams as their main source of drinking water. In those cases where the stream flows all year round, this is a cheap watering option, with the added advantage that stock can graze along the river. However, although the use of streams to water stock is cheap economically, there are disadvantages. In some areas winter flows are high, with riparian areas difficult to access and stock at risk from being lost in floods. The stream may dry up altogether in the summer months, or the water may be too salty for stock to drink, necessitating alternative water supplies.





Unrestricted stock access has contributed to declining water quality, erosion and loss of riparian vegetation at both these sites. Both have now been fenced, but the area shown on the right is likely to regenerate naturally much more quickly as the remaining trees will provide cover a valuable source of seed and cover for new seedlings. The site on the left may need more-intensive management, perhaps including protection of the toe of the bank at the water's edge to prevent further erosion. Both areas can continue to provide valuable water for stock, using one of the methods described in this section. Photos Siwan Lovett.

Another disadvantage of having uncontrolled stock access to riparian areas is that water quality may be compromised by both natural and induced changes. Erosion from upstream can result in muddy or turbid water, while excessive nutrients may lead to blooms of algae (including toxic blue-green species). Stock do not like to drink poor quality water, and this reduces their consumption which can lead to a loss of productivity in the warmer months. Transmission of animal diseases that compromise health and productivity is another risk where streams are intensively used by stock. Intensive grazing of riparian areas can also lead to flushing of dung into the stream following heavy rainfall, further reducing water quality downstream. Stock often camp around water, especially during hot weather, and this makes mustering and checking sheep for problems such as fly strike difficult as they can be down in the river and hard to see or in inaccessible parts of the riverbank.

Another problem is the potential for overgrazing in riparian areas, particularly where a small section of stream is the main source of stock water. Removal of palatable species and their replacement by weeds, loss of feed and quality grazing, as well as damage from stock tracks by compaction and pugging of moist soil, all contribute to a decline in water quality and riparian health. Over time, if stock are allowed continued access to riparian areas water quality declines, as does in-stream health and adjoining riparian vegetation. These areas may also carry a high disease burden if used continuously by stock. Further risks include stock becoming bogged in streams and creeks, as well as a reduction in wool quality if it is dirty and muddy.





The water in this riparian area has become toxic and no longer safe for human or animal access. Situations like this are increasing in waterways across Australia, with unrestricted stock access a major contributing factor to the high nutrient levels that create the conditions under which blue-green algae can flourish. Photo Phil Price.

The key to better management and more profit for woolgrowers is fencing or other means of controlling stock access, together with alternate systems that deliver good, clean water to stock on demand.

Opportunities and benefits from off-stream watering

In response to the problems of uncontrolled stock access to streams and creeks, an increasing number of woolgrowers are using alternative methods of watering their stock. Whilst this involves initial capital expenditure and ongoing maintenance costs, woolgrowers also report the following benefits:

- installing a watering system is often the trigger to change paddock layout and fencing so that grazing units better reflect land capability for grazing (e.g. hillslopes versus flats), and seasonal pasture availability, leading to improved utilisation and increased carrying capacity;
- once a watering system is installed woolgrowers have a greater ability to match their grazing management system (set stocked, rotational or cell) with animal needs (e.g. pregnant ewes versus wethers) according to season and amount of feed on offer;
- there is better overall utilisation of feed on offer through improved grazing and pasture management, especially where there is a mix of native and improved pastures;
- the increased flexibility in grazing management supports the use of integrated pest and disease control methods;
- the use of watering points enables better control over stock and grazing patterns (even in the absence of fencing);
- sheep prefer water that is clean and fresh and some woolgrowers report noticeable improvements in animal health, growth rates and wool production as a result of a continuous source of clean and uncontaminated water; stock are not lost in floods or accidents within the stream channel;
- there is reduced mustering time as stock are not hidden within the channel or surrounding vegetation;





The bed of this incised creek has become partly stabilised, at least until the next flood, but the steep banks remain bare and open to further erosion. This section does not provide reliable stock water, and its grazing value is minimal. Fencing to prevent access by sheep will help the channel to revegetate and further stabilise, and also prevent loss of animals by accident or during flood, as well as making mustering easier. Photo Phil Price.

- the condition of riparian areas improves significantly, with natural regeneration able to occur once stock are removed from the stream;
- important ecosystem functions (see section J) are maintained; and
- there is better integration of riparian areas into whole-of-property grazing management plan that aims to optimise pasture growth and wool production.

The pay-back period to recoup the costs and ongoing maintenance of alternative watering systems will vary according to the system used and the particular property and flock size. Improvement in pasture quality, plant growth rate and feed utilisation, all the result of greater flexibility in rotating mobs through grazing management, are considered by woolgrowers to be the main sources of increased economic return. Increased carrying capacity, animal growth rate and wool production have also been reported.

Water quality and the condition of riparian areas are key components of most catchment and water management plans (see Appendix C), with targets being set in most regions for in-stream nutrient and salt levels and the proportion of riparian areas with native vegetation. The use of off-stream watering systems for stock is an important tool that catchment management agencies will be encouraging, and woolgrowers may be able to receive support and possibly financial assistance from these agencies if they establish an off-stream watering system.

On-farm management practices

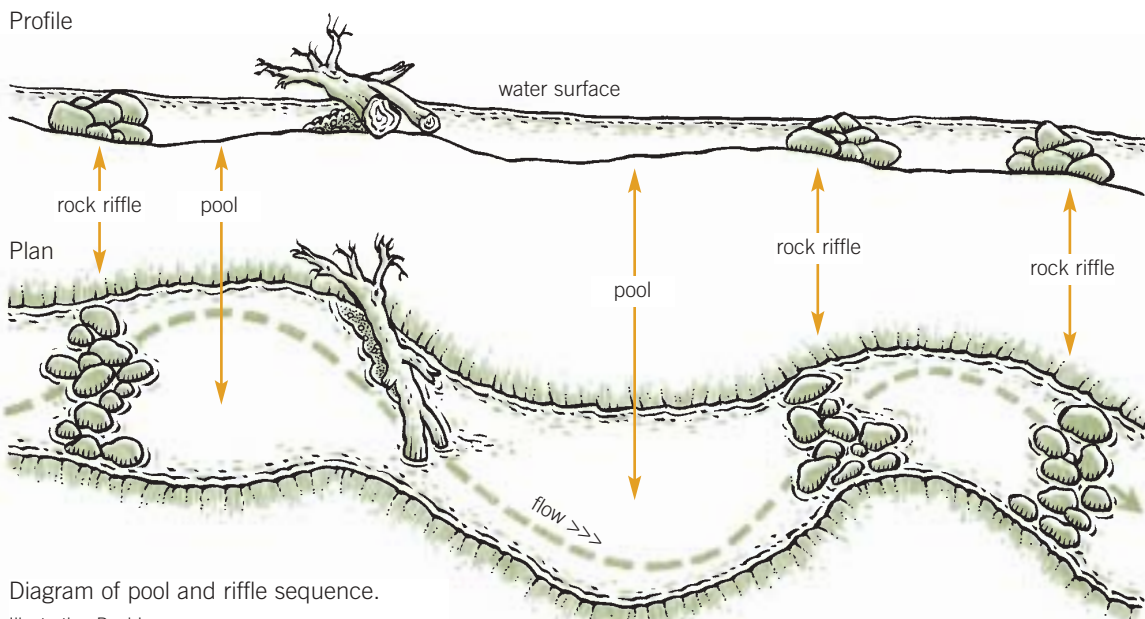
Restricting stock access to streams

Where water supply is adequate and maintained year-round, it is likely that many woolgrowers will continue to use creeks and streams as the only, or at least a major, source of stock water. There are still several good management practices worth considering so that environmental and productivity gains can be made.

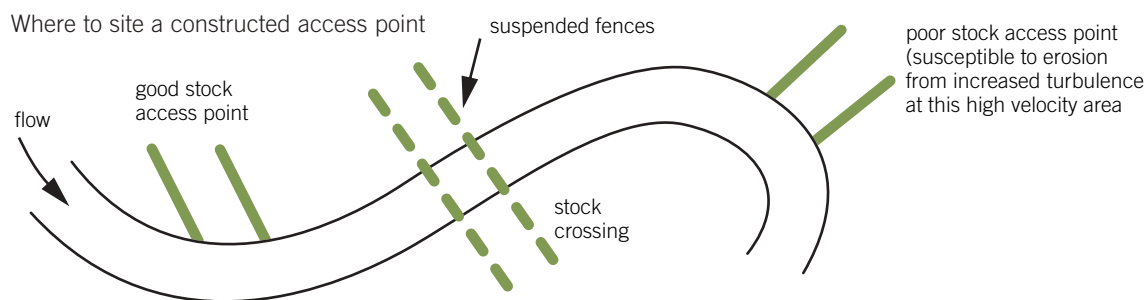
1. Examine the stream to be used and decide whether stock need access to the whole length, or whether it would be better to control the number and size of access points. Stock access at the outer bends of streams should be avoided where possible, as this is a region of high flow *velocity*. Inside *meander bends* and reaches adjacent to *rock riffles* are areas of generally low velocity, making them safer for stock access. With a limited access point, it is possible to make the movement of stock into the stream safer by providing a gravelled or log-reinforced access point, with fencing on each side to prevent animals wandering along the streambank (see diagram overleaf). Depending on the materials available on-farm, the cost of a constructed access point would be a few hundred dollars at most.

“Velocity”

Velocity refers to the speed of the flow in the stream.



2. Another option is to block off the stream during those parts of the year when stock do not need access to the water, for example, when they are getting sufficient moisture from pasture or have access to clean water in dams. This may help to prevent stock losses during flood events, and the riparian areas can be grazed in the warmer months as hill slope pastures begin to dry out. Restricted access to the stream and riparian areas during the warm and wet months can be incorporated into a control program for fluke and other animal parasites.



3. Monitor the effect that stock are having on the stream and the surrounding areas so that the woolgrower can adjust access to riparian areas accordingly. A simple way to do this is to establish fixed photo points using steel droppers or plates. Their approximate location can also be tagged using a hand-held Global Positioning System (GPS) location finder. A series of photos taken from the fixed point up and downstream during each main season of the year will, over time, provide a good record of changes in pasture and other riparian vegetation, as well as changes to the amount of bare soil or eroding banks, or changes in the size and position of the stream channel. This record is particularly useful to assess trends over time, following a change in management — for example, restriction of stock access to the stream for some period of the year.

Alternative stock watering options

1. Capture run-off higher in the landscape through construction of a dam, and then gravity-feed or, if necessary pump, this to other parts of the property so that all paddocks can be watered. The dam must be able to store enough water to provide for both evaporative losses and stock needs throughout the year. Ideally, its capacity should be sufficient for 2–3 years of stock needs to take account of rainfall variability. Some properties may require several smaller dams to meet their needs, although one large, deep dam will lose less water by evaporation than several small, shallow ones. There are regulations in all States that govern dam construction and the amount or proportion of run-off that can be captured and stored for future use (see Appendix B). Cost varies according to the site and soil suitability, but \$2–\$6 per cubic metre (1 KL) of storage space is common. Some natural resource management funding schemes will contribute to the cost of dam construction.
2. In cases where the landscape does not lend itself to construction of one or more dams at a high level, and/or there may be insufficient run-off to provide the amount or seasonal availability of water required, pump water from the stream (or from a groundwater resource) to a high storage point from where it can be gravity fed, or use a pressurised system with one or more storage tanks. Pumping is obviously a more expensive process than gravity feeding, but it too can be cost-effective in many situations when linked with improvements to pasture and grazing management. Capital and operating costs vary widely within a range of \$1000–\$5000 for an installed electric pump or windmill, and daily power cost of \$2–\$20.
3. If using a pump, there are many different options available.
 - An electric or petrol-/diesel-powered pump is an obvious choice, but may require personal attention to start, stop and ensure adequate water supplies are maintained. An electrically-powered pump can be set up with automatic sensing of pressure or water levels telemetered to the motor so the particular water level or pressure is maintained constantly. Both systems are quite expensive to purchase, but can be expected to operate over many years so the capital cost can be amortised.



These images courtesy Pumpmaster
(www.pumpmaster.com.au)

- An alternative to a mains electric-powered pump is a solar-powered system. These are being used successfully by many woolgrowers, and although the capital costs can sometimes be higher than a mains system, the operating costs should be significantly less. Solar-powered pumps are generally less powerful and hence move smaller volumes over lower height differences. They may require battery support to ensure there is power necessary on sunless days. They can also be operated over long periods during winter when stock do not need access to large volumes of water, so it is possible to pump over long periods into a storage system which is then gradually depleted during the warmer months.



The “ecotrough” developed by woolgrowers David and Ruth Read showing (inset) reeds planted in a restricting container, and (above) reeds growing to provide shade and keeping the water temperature down, keeping the water highly palatable for sheep. Photos David and Ruth Read.

- Another approach to pumping water from the stream to a storage area is the ram pump. This pump uses the streamflow to operate a ram that pumps a smaller volume of water up to a storage tank or dam. These are relatively cheap to purchase and install, however, they do require adequate flow and a fall of at least 1 metre for their operation. Cost of the pump is around \$1000–\$2000 depending on capacity. As with the solar pumps, they can be used during the high-flow winter and spring to fill storages that will then supply stock over the warmer months.
 - A further method to pump water uses “air displacement”, in which compressed air is piped to the source and used to displace and then transfer water from a sealed container (the pump housing). This method can be used to transfer water from a bore, stream, dam or sump to troughs. The system requires an air compressor (can be remote from the water source) and an electronic pump controller attached to the pump itself (this can be solar powered). Air-driven pumps are especially suited for situations requiring continuous operation at low volumes per hour, and where the water supply is intermittent (e.g. low-producing bores), where they can be very cost-effective.
4. Off-stream systems provide woolgrowers with greater flexibility to move water around the property and better control over animal behaviour and grazing patterns. To gain the full benefits of an alternative watering system, it is necessary to plan paddock layout and grazing management at a whole-property scale. This should take into account land capability and the innate productivity of different parts of the property (for example, hills with shallow soils versus flats in lower-lying areas with greater soil depth that often retain moisture and green growth for longer). Changing fencing according to land class and capability can provide increased pasture productivity and quality, as well as substantially improve utilisation of feed on offer; both are important drivers of profitability.

In addition to the need to achieve commercial benefits and to make alternative watering systems cost-effective over time, there are also likely to be significant benefits to environmental management from controlling or removing stock access to streams and their adjacent riparian areas. Some of these are described in more detail later in this Guide.

Rob and Annabel Dulhunty have redeveloped their farm and revised the paddock layout of their property. The new farm layout shows paddock areas (hectares), tree plantings and windbreaks (cross-hatching), and the riparian area fenced out (meandering line through middle of the property).

Aerial photography courtesy NSW Land and Property Information, Bathurst. Datum GDA Geocentric Datum of Australia. Grid: MGA94 (GDA94) Map Grid of Australia. The paddock overlays were developed in Practical Systems' *FarmMap* software.



Information courtesy Rob and Annabel Dulhunty, Nant Lodge, Glen Innes.



Case study

Lindsay Young, 'Lewisham'

Location: Ross, Northern Midlands, Tasmania

Average annual rainfall: 450 millimetres

Property size: 1000 hectares of undulating improved country, incorporating Mt Augustus, stony ridges and alluvial floodplains along the Macquarie River

Enterprises: 7500 poll merino sheep

Soil types: mix of soils from sandy loams to black soils on the river flats

River management: 5 kilometres frontage Macquarie River fenced and excluded from stock

The Young family believe the river is the life blood of the community and therefore should be the starting point for efforts to improve the local environment for all. The success or not of farming practices throughout the catchment are evident in the water quality and general state of the river. Our motivation to be involved in landcare increased with a stubble fire caused by a harvester one summer day. Following this was a dust storm when we watched with dismay our soil blowing away. We realised that our soil had lost structure and organic matter, even after 10 years of zero till and chemical fallow.

That was when we decided to alter our farming practices and work with nature, instead of using machinery, chemicals and diesel. We started to phase out cereal cropping and in its place put in perennial pastures to improve soil conditions. This change took place over three years, and during this time we sold machinery and increased sheep numbers. In addition to improving our land management practices, Ovine Johnnes Disease (MN2) and Tasmanian Quality Wool accreditation have been undertaken. For OJD certification, we need to prevent all contact with stock from neighbouring properties. We fenced our 5 kilometres of the Macquarie River in 1999 and this is permanently excluded from stock. The vegetation that has established there is a mixture of native and exotic grasses and this acts as a buffer to reduce sediments and nutrients entering the river system, as well as providing good nesting material and hiding places for small birds. We realised that you don't always need native plants to attract the local bird and butterfly populations, they are quite happy to make use of any long grass that is there. We have started planting the banks with native trees and shrubs, and have planted out patches of native plants on other parts of the farm as well. Our conservation efforts are now just a part of our productive enterprise.



Lindsay is replanting along the Macquarie River to help stabilise the streambank, and provide shade and shelter from the strong winds for his sheep. Photos throughout case study Rae Glazik and Michael Askey-Doran.





Left: A cheap fence that can be quickly re-hung has been used in this flood-prone area. **Right:** Soil next to the stream is a black heavy clay that holds moisture well. By planting deep, the tubestock will soon be able to access the local watertable.

We see three positive key components to good management; what is below the ground, what is above the ground and what grazes the pasture. So for example, we do not just run sheep with fine wool. We look at high fleece weights of fine wool, good carcass characteristics and fertility, and immunity to internal parasites and blowflies. We breed plain-bodied sheep that do not require mulesing, and we match carrying capacity with stocking rates which is as variable as rainfall, so stocking rates are adjusted each season to match prevailing weather conditions. The farm is rotationally grazed, with the 1000 hectares divided into 90 paddocks. The 7500 sheep are divided into three mobs. Ninety paddocks gives us a lot of flexibility to move the mobs around so we can control grazing pressure and increase rest periods where and when necessary.

Our aim now is to have superior pasture composition and utilisation. We want to increase the health of the soil, as soil is the engine for the plants. If we increase organic carbons in the soil we will be encouraging the soil fauna and flora, such as nematodes, bacteria, fungi and protozoa. This will boost the nutrient recycling, and the capacity of the soil to hold water will escalate. Given that our rainfall of 450 mm per annum fluctuates and the rolling 12-month average is 300 mm at present, water holding ability is vital to get through these dry periods, so we need to increase the organic matter in the soil as one tonne of organic matter holds five tonnes of water. We also think this will decrease erosion and this in turn will reduce the sediment flowing downhill and ultimately into the river system.

In the past we have had to use chemicals to control soil pests, such as the red-legged earth mite. With a better balance of soil and plant fauna, insects such as lady bird nymphs will be doing this for us. We believe this is the key to long term successful management as we will be working with nature to improve production, our overheads will decrease and the farm will be in better shape. And importantly, people on the farm and the environment around us will not be exposed to toxic and expensive chemicals.





The riparian area has now been replanted with a mix of local native species.



The riparian section is undergoing a transformation with trees and shrubs planted in 2004. Three different plant types are being trialled, tubestock, advanced plants and longstems. The sites are being monitored for success rates and a comparison of the costs for each technique will be made. We have planted clumps of native plants to encourage birds and insects as we believe this will create a better balance in the ecosystem. Seed collected by my late father has been grown and planted in these sites.

Fencing on the floodplain has its problems, and each summer we remove the flood debris. Leaving it until summer means the job is easier as the debris is dry and brittle and comes away easily. Weed management is on-going. Initially we worked with our neighbours and removed the willows along our section of the river and we continue to tackle the ongoing problem of staying on top of willow re-growth. In 2005 another section of the river will be planted out with a range of trees and shrubs, along with three more patches away from the river.





And what of the future and how to reach those aims? The future health of the Macquarie River rests with those who live and manage businesses within its catchment. Forestry, agriculture and recently the increased use of irrigation bring substantial challenges and only a holistic approach from all in the community will bring a positive outcome.

This case study was prepared by Lindsay Young and Rae Glazik. The work in the riparian area of Lewisham is funded through the Land, Water & Wool-Rivers Sub-program.



Section F

Maintaining good water quality



Purpose

To maintain or improve the quality of stream water available for use by stock and by downstream neighbours and communities.



Maintaining good water quality

Principles

The quality of water in creeks, streams, rivers and estuaries reflects the type of land use and management throughout the catchment. When water quality is reduced through pollution by soil, sediment, nutrients, pesticides, salt, or other contaminants including animal wastes, all water users suffer. In the wheat/sheep zone, the main contaminants affecting water quality are likely to be:

- sediment from eroding streambanks, stock tracks, or from adjacent paddocks under cultivation. In situations where there is low groundcover due to overgrazing or dry conditions, sediment loads increase as there is no vegetation to stop soil eroding under heavy rain or wind and then moving into streams;
- nutrients from natural sources or fertiliser, either attached to soil particles or in soluble forms;
- pesticides from intensive land uses or from treated animals;
- animal wastes, particularly dung washed from the riparian zone and possibly nitrate from urine patches where there are perched water tables;
- dead stock in unfenced waterways; and
- salt from areas where rising groundwater is bringing salt to the surface.

Agriculture is not the only source of contaminants of water within creeks or streams. Urban development and other intensive land uses are often major sources of contaminants, and some background level of soil erosion and nutrient movement is common in most catchments.

“A perched water table”

A perched water table forms in the upper soil layers when the rate of infiltration through the topsoil exceeds the rate at which water can move down through the subsoil. They can be found in duplex soils at the texture contrast horizon, usually for a few weeks over the wet winter period.

Sediment

The clearing of catchments for agricultural land, soil disturbance during forestry operations, urban development and bare areas such as gravel roads and stock tracks, have led to substantial increases in the amounts of sediment (gravel, sand, silt and clay) entering our streams and creeks. This sediment and its associated nutrients and chemicals can contaminate human and stock water supplies, smother breeding sites for fish and other in-stream animals and, by filling up pools in the creek bed, deprive these animals of the deeper waters that are vital refuge in dry seasons and prolonged droughts. Whatever the specific impact, the end result is likely to be significantly decreased water quality.



Data from the National Land and Water Resources Audit 2002 show that river sediment loads are 10–15 times higher now than before European settlement in some river basins, and that on average 90% of the sediment reaching estuaries comes from only 20% of the catchments. Large sand deposits moving slowly down river systems are common in the Murray Darling Basin, south-east Queensland and the Glenelg catchment in western Victoria.

Nutrients

Under natural conditions, most Australian streams and creeks have low levels of nutrients, and native aquatic plants and animals cannot survive when these are increased due to contamination. The combination of over-clearing of native riparian vegetation resulting in high light levels, low flow and nutrient enrichment, boosts in-stream growth and aquatic growth. Creeks and streams in this condition often have massive, choking growth of emergent water plants like rushes and sedges (macrophytes). Algae can also become a problem and may be attached to rocks and grow as long streamers or floating mats in the water. Algal growth may include massive blooms of toxic blue-green algae. When this excessive in-stream vegetation dies during periods of low flow or under cold winter temperatures, the mass of organic material begins to decompose, removing oxygen from the water and often leading to kills of fish and other in-stream life. This means it is important to keep nutrients out of the creek, and back within the paddock where we want them for increased pasture growth.



Nutrient enriched water with no shade creates ideal conditions for algal growth. Photo Kylie Nicholls.

Pesticides

Pesticide contaminants can enter streams and creeks either directly through spraydrift or run-off, or indirectly when treated plants begin to decompose, or pesticides are excreted in animal wastes. This form of pollution is generally not a major issue in wool-growing regions, because grazing is extensive and spread over considerable distances, but it can be an issue for mixed farms that include intensive production. Many of these pesticides, and possibly antibiotics and hormonal chemicals, will be in soluble form and it is difficult to keep them out of creeks once mobilised.

Animal wastes

Animal wastes must be kept away from creeks as they are powerful sources of nutrients (especially nitrogen and phosphorus). Dung also potentially carries disease organisms that may infect other stock downstream. Urine patches are a significant source of nitrate pollution, as this form of nitrogen is mobile and can move through the soil profile and into adjacent water courses. The wash-off of dung

from sloping riparian land into a creek during heavy rainfall is another potential source of contamination. The risk associated with pollution by animal wastes can be reduced by careful management and timing of grazing in riparian areas to maintain good cover and ensure stock are out of the area before intense rainfall. The use of grass filter strips and strips of natural vegetation along a creek will also help to prevent these pollutants from moving into stream water. Soil organisms within these filters may also help to fix and retain nutrients released from animal wastes.

Salt

In some parts of the sheep/wheat zone, salt is becoming a significant pollutant of streams and creeks. Australian soils, due to their age and the arid nature of the continent, often contain quite high quantities of salt. This salt is derived either from salt spray generated from the oceans and moved inland by atmospheric circulation and/or salt derived from decomposition of parent rock. Prior to European settlement, the native vegetation was effective at using nearly all available soil moisture over summer and this meant that salts were generally stored in the deeper layers of the soil profile. With the clearing of catchments for agriculture and the replacement of deep-rooted, perennial vegetation with more shallow-rooted annual crops and pastures, less rainfall is being used by plants and more is available to leach through the soil profile and to raise groundwater levels.

As groundwaters rise, they mobilise the deeper salt stores, and bring that salt to the surface; this is the main underlying cause of dryland (secondary) salinity. Salt can move laterally from the soil profile into adjacent streams through perched water tables, particularly where different soil horizons join. Salt rising to the surface through capillary action and then left as a surface crust due to evaporation can be washed off in the next rainfall and into the adjacent water course. As this salt is in a soluble form, it is also difficult to trap once mobilised and prevent its movement into creeks. Monitoring data shows that many water courses in the wheat/sheep belt are becoming more saline with time. In some places, for example the West Australian wheatbelt, many of these water courses were naturally brackish, but this is not generally the case in the East. Moreover, the salt draining from dryland catchments in parts of Queensland, New South Wales and Victoria is predicted to in the future threaten the viability of large, downstream irrigation areas.



This saline lake is in the sheep wheat belt of Western Australia. Recent research has shown that although these lakes are very salty, they still support high biodiversity, particularly in times of high rainfall events when the lake becomes connected to the floodplain. Photo Jenny Davis.



On-farm management practices

There are a number of approaches that can be taken by woolgrowers to help prevent or reduce these potential contaminants from reaching creeks or streams. Preventing contaminants from entering waterways is the most sensible approach as, once in the water, pollutants are difficult, expensive, and sometimes impossible, to remove.

1. Maintain adequate vegetative cover on all sloping land to prevent or slow contaminants from entering streams and creeks. As a general rule, where ground cover is less than 30%, extensive soil erosion through sheet movement or formation of small rills can be expected, especially under intense rainfall. Wind erosion can also remove valuable topsoil where vegetative cover is low. Careful management of grazing to ensure a minimum of 30% cover, (preferably 70%) is always maintained is a key step in preventing these types of erosion from occurring.



Above: Leaf litter groundcover increasing from left to right.



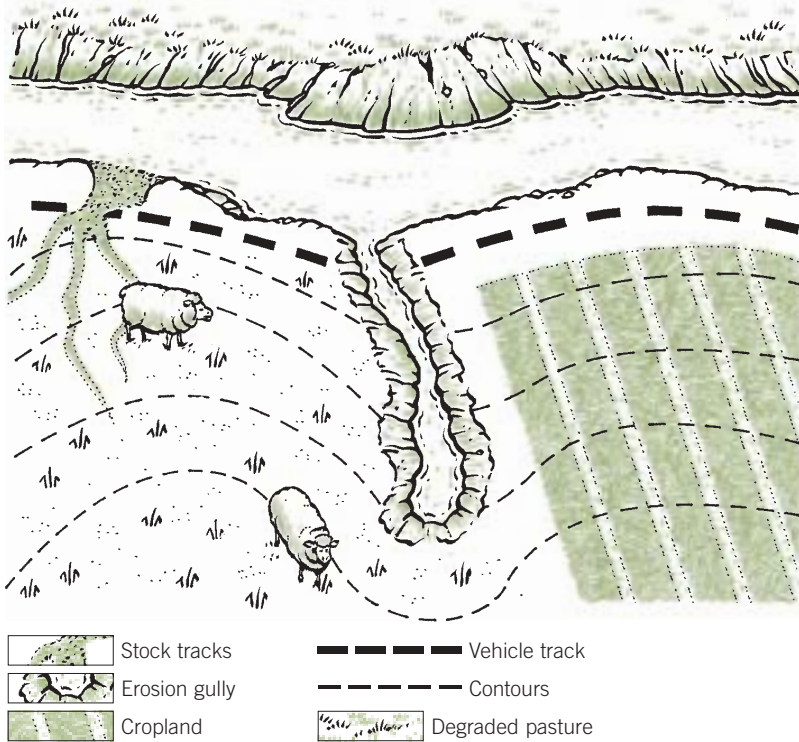
Left: Exotic annual understorey (left) versus native perennial tussock understorey (right).

Photos Amy Jansen.



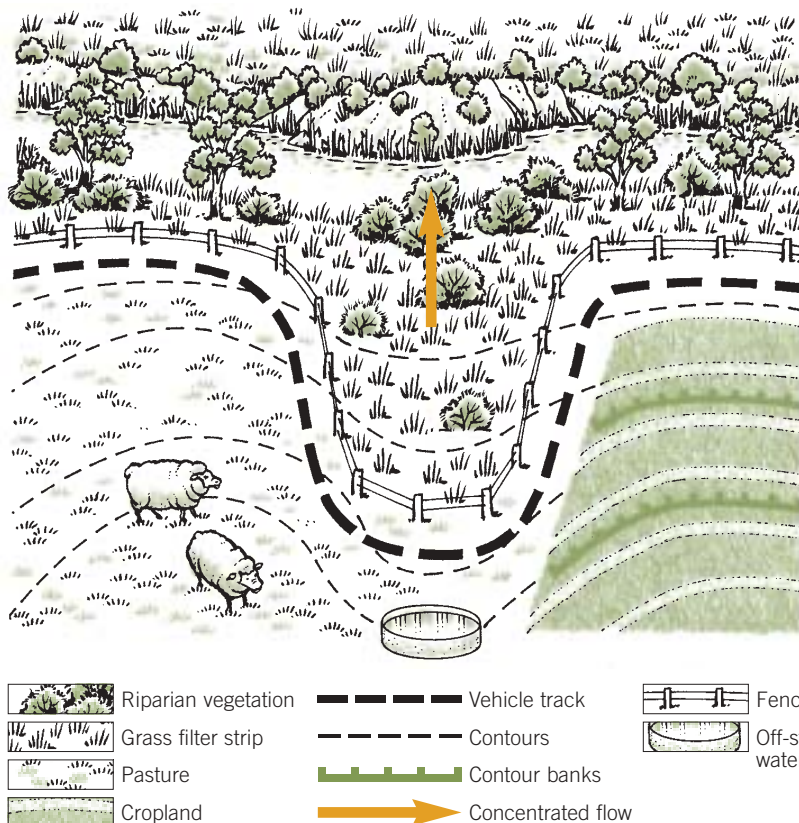
Well vegetated riparian area acting as a filter for contaminants to protect water quality. Photo CSIRO Sustainable Ecosystems.

- Wherever possible, laneways and tracks for stock movement should go along the contours rather than across them; this is especially important on or adjacent to the water course banks. Where tracks must go up and down the slope, use periodic shallow drains and/or levees placed across the track so that drainage water can be taken off into grassed areas. These simple measures can have a large effect on the amount of erosion and sediment generation that takes place on animal tracks during heavy rainfall.



A degraded stream and riparian land. Significant sediment and nutrient is derived from degraded pasture, poor crop layout, unlimited stock access and gully erosion.

Illustrations Paul Lennon.



A riparian filter strip protects water quality by trapping sediment, absorbing nutrients and providing shade over the stream to reduce water temperatures. Crop layout and a vigorous pasture with good cover reduce the potential for soil erosion.

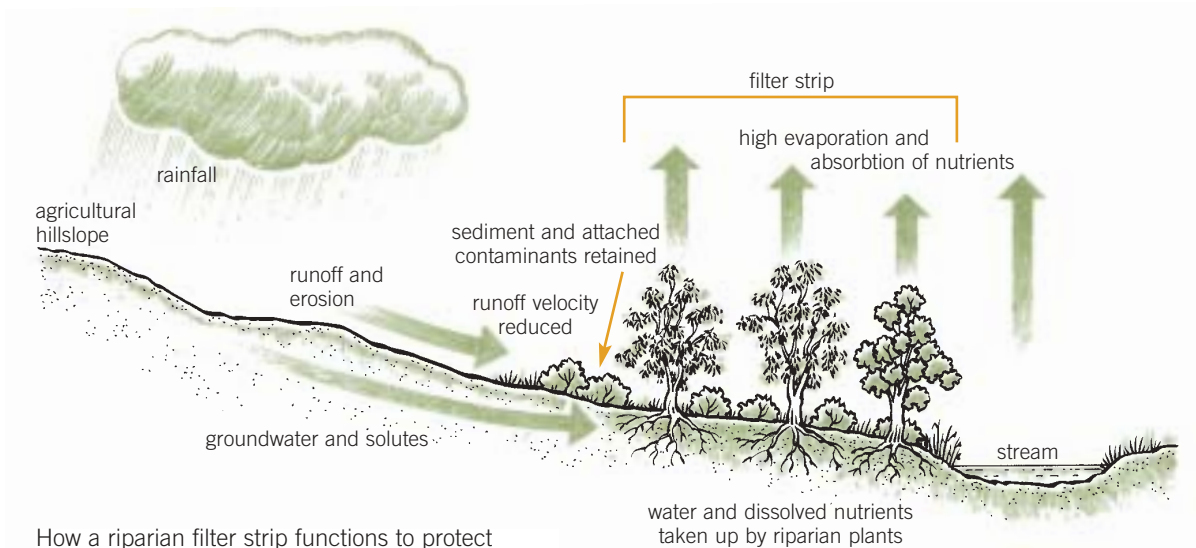


How a filter strip works. Illustration Carolyn Brooks. Photo Ian Prosser.

3. Use vegetated filter strips, both within the paddock and near the stream, to trap and retain sediment moving in overland flow. The aim is to slow the flow down sufficiently that the sediment and attached nutrients drop out and are trapped within and among the vegetation, preferably where they can contribute to increased pasture growth. A well-grassed filter strip only 6 metres wide can be very effective in trapping small amounts of sediment where overland flow is shallow. In dips and gullies where flow is concentrated, the filter strip needs to be proportionately wider.
4. Most of the nutrients entering streams, whether naturally occurring or from fertiliser application, are attached to soil particles. The steps taken to reduce soil erosion or to filter and trap sediment described above are also successful in keeping these nutrients in the pasture and not in the stream.

For more information on the use of filter strips, see: Prosser, I. & Karssies, L. 2001, 'Designing filter strips to trap sediment and attached nutrient', *Riparian Land Management Technical Guideline No. 1*, Land & Water Australia, Canberra, www.rivers.gov.au





How a riparian filter strip functions to protect the stream from contaminants. Illustration Paul Lennon.



Good vegetative cover on hillslopes reduces soil erosion, filters surface flows and protects water quality in the streams and creeks running through the valley floor. Photo Kylie Nicholls.

5. To prevent or reduce animal wastes (and parasites and disease organisms) entering creeks, it is essential to manage stock access to the water course and its immediate riparian area. A physical barrier (fence) is effective, but often impractical due to capital expense and maintenance, especially with the large riparian paddocks and lower margins per hectare normal in the sheep-wheat zone. Best management practice could include managing the timing and duration of stock access to riparian areas to ensure these are not overgrazed, removing sheep well before a season of potential intense rainfall events such as summer storms, and providing a restricted number of constructed watering points on the creek. If a reticulated system is in place for providing stock water, management of watering points can be a cost-effective way of altering animal access and grazing patterns.





Case study

Biz and Lindsay Nicolson, 'Bonneys Plains'

Location: Conara, Northern Midlands, Tasmania

Average annual rainfall: 500 millimetres

Property size: 5000 hectares, 20% property arable with balance native grasslands and rough hill country

Enterprises: 8500 fine wool merino, native plant nursery

Pasture base: 80% native pasture, 20% ryegrass, cocksfoot, clover

Soil types: dolerite-based clay loams

River management: 7 kilometres South Esk River, 8 kilometres Buffalo Brook

Lindsay and Biz Nicolson know and understand the physical and environmental limitations of their Conara property, Bonneys Plains. It is that knowledge which forms the basis of their farming practices and a preparedness to live and run their farm within those constraints. The Nicolsons are not taking on the losing battle of trying to change nature to suit themselves but, instead, are working with nature by incorporating enterprises which are compatible with the environment.

The couple has run 2310 hectares of the original Bonneys Plains property since 1988 when Lindsay's father Jock retired and the family property was split in two. Lindsay's brother Robert operated the other half of the property until February 2005 when it was purchased by Biz and Lindsay. The property now has the next generation of Nicolsons investing in it, with Biz and Lindsay's children Hanna, Sam and Isobelle taking an active role in the farming operation and bringing a new energy and perspective to the farming enterprise.

"When my father Jock ran Bonneys Plains he believed Buffalo Brook which dissected the property was the lifeblood of the grazing operation," said Lindsay. "All the paddocks along the creek had stock access and during dry summer spells every paddock was opened to the stream as it always had water." Much to Jock's concern, Lindsay and Biz double fenced their section of Buffalo Brook to prevent stock access forever. Biz and Lindsay believed the water could still be used but managed differently.

Loss of soil from serious stream bank erosion along the entire length of Buffalo Brook was considered the highest priority as the alluvial and dolerite soils were unstable. "The sheep walked along the banks creating tracks. After a good rain the banks would fall in as far as the sheep track and the whole process would start again," Lindsay explained. Buffalo Brook had cut an entirely new course through the valley floor following the 1929 floods, approximately 200 metres east of its original course. The banks were severely eroded, there was little or no riparian vegetation, water quality was very poor and there was no sign of aquatic life.

"We asked Greg Pinkard from the Department of Primary Industries to come and look and he was pretty horrified. He said we could spend a lot of money putting in capital works and then if we got a flood it would all be washed away, so we just double fenced and excluded all the livestock and the amount of repair has been amazing," Lindsay said. "Many different tree and shrub species have regenerated along the stream banks, the wildlife has returned — including fish, birds and platypus and the water quality has improved out of sight. We had no idea of the impact the stock made until we fenced them out," Lindsay said. "The reduction of manure and nutrients leaching into the stream



Buffalo Brook, above 1986, below 2004. Photos Lindsay Nicholson.

has meant the water stays cleaner with little algae. We also lost quite a few sheep, mainly those with fly-strike and staggers. The sheep went down for a drink but were too weak to get up the bank, now that isn't a problem."

In the past 50 years the stream meanders had eroded 50 metres of streambank, so with this as the benchmark, the fences were positioned approximately 50 metres from the existing streambank. "We planted a few trees in the first year but soon realised that was a waste of time and effort as natural regeneration soon outstripped our meagre efforts", said Lindsay "With native bush a few kilometres upstream there was a plentiful supply of seed from native species. The species range from early colonisers such as silver wattle, *Acacia dealbata*, through to later colonisers such as *Micranthemum hexandrum* and grasses and sedges have established along the water edge. We believe these grasses and sedges are vital for trapping sediments and creating conditions to allow for regeneration to take place."



After fencing, the Nicolsons found willows and briar rose became a management issue as stock had kept these weeds in check. Teams of young people through the Australian Volunteers for Conservation and Green Corps have been employed every few years to handle weed outbreaks. The Nicolsons also realised it was not enough to just fence the main stream as the small tributaries contributed to erosion and nutrients, so these have also been double fenced to exclude stock. “To provide alternative stock water we constructed a 3 megalitre dam in the higher country. This dam gravity feeds a series of troughs that supply water to stock in a rotational grazing system,” said Lindsay. “This project was implemented with assistance from Ian Bell, Department of Primary Industries and Land & Water Australia. Water from Buffalo Brook is also pumped to supply troughs in paddocks close to the pump and four waterholes were put in to supply more distant paddocks. This water would’ve ended up in Buffalo Brook, it’s the same water just used differently.”

“We have looked at putting in a large storage dam for irrigation of crops but many of the tributaries are naturally saline. We have had three experts look at this over 15 years and all have said we were playing with fire,” said Biz. “Although there is no evidence of scalding or salt indicator plants, there is a moderate level of salt in the soil profile which will become a problem if we start an irrigated cropping program.”

To overcome these constraints, the Nicolsons established a different crop with the establishment of their on-farm native plant nursery. The nursery started as a hobby and has ended up as a major farm enterprise. “When we started a native garden 32 years ago we had difficulty sourcing native plants that would survive in our climate and then we realised that the plants that were actually surviving were plants that grew on Bonneys Plains,” said Biz. “Through growing plants we have become very aware of what plants are growing here, where they are growing and why they grow where they do. We started growing a few plants for ourselves and giving away or selling whatever we didn’t plant.”

Over the years the Nicolsons have expanded their nursery, growing tubestock, long stems and advanced plants for farm and environmental projects. To implement on-ground works they have a tractor drawn tree planter, a direct seeder and a native grass seed harvester. “We are now concentrating on producing plants for the nursery and garden trade, local councils, tourism and housing developments,” said Biz. “We sell statewide which means we are growing a greater number of species and learning about their growing requirements and how they perform under different situations.”

With the next generation of Nicolsons now part of the farm operation, changes are certain to take place. “We are extremely fortunate to have our children making a career in farm management, there is a renewed sense of optimism and energy and we are looking forward to seeing their vision for Bonneys Plains implemented,” said Biz.

This case study was prepared by Biz Nicolson.



Section G

Preventing soil and bank erosion



Purpose

To prevent erosion of soil from stream or creek beds, banks and adjoining riparian land.



Preventing soil and bank erosion

Principles

Erosion is a natural process in most landscapes. However, erosion rates are dramatically increased by human activity such as agricultural production, urban development and the building of infrastructure like roads. Erosion of soil by water during intense rainfall or flood events can move large quantities of sand, silt and clay into adjacent creeks, making the water muddy (turbid) and reducing water quality for stock and for downstream users. The depth of pools can be significantly reduced as sediment builds up, to the extent that they may disappear altogether, and this removes essential habitat for aquatic life. Soil particles can carry nutrients and other pollutants into the stream, further compromising water quality; these pollutants can also move as fine (colloidal) particles or in fully-dissolved form.

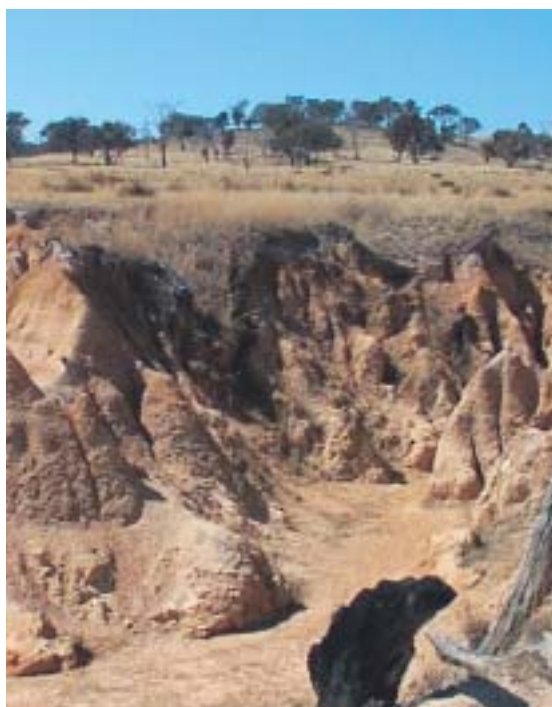
Once sediment and pollutants get into a creek or stream, they may be flushed through the system into the estuary and eventually out to sea where they can smother sea-grass beds and promote the excessive growth of algae within in-shore fisheries or around reefs. If the material stays within the stream, channel capacity can be reduced and further erosion of the creekbank and adjoining land can occur.

The key principle in preventing or reducing erosion on riparian land is to maintain good vegetative cover of the soil surface. This reduces contact between falling raindrops or floodwaters and the soil surface, decreasing the amount of soil eroded into the stream or creek. Vegetation can also slow overland flow and trap sediment particles.



Roadworks upstream have made this small stream highly turbid, reducing water quality considerably.

Photo Phil Price.



An expanding gully with no riparian vegetation to protect it from erosion. Photo Gary Caitcheon.





In parts of the landscape where flow concentrates and the soil or channel banks are not protected by vegetation, large gullies and channels can form over time. These make paddock operations very time consuming and pose a risk to stock as well as woolgrowers and for the continued loss of grazing land. Fencing to prevent stock access and promoting revegetation are the low cost options. Photos Phil Price.

In the case of bank erosion, there are three broad processes at work — sub-aerial erosion, scour and slumping. They may occur singly or in combination, in different parts of the stream or creek. It is important to identify which one is causing the bank to erode so that the appropriate management strategy can be implemented.

Sub-aerial erosion

This involves processes that loosen the soil of the streambank, making it vulnerable to being carried away by the water flowing past. Loosening processes include frost heave, where moisture in the soil freezes and expands at night, flaking off the soil surface; trampling by stock; and the impact of wind and rain. The key to preventing this type of erosion is to ensure there is good vegetative cover over the whole of the bank. The cracking clay soils found in some wool-producing regions are particularly prone to this type of erosion.

Scour

Scour occurs when a force applied to the bank by flowing water exceeds the resistance to erosion of the bank surface. On outer bends of a creek meander, water flow is fast and there is strong contact between the flow and the bank itself. Scouring tends to take place in the area known as the toe of the bank, that is, at the water's edge. Repeated scour at this point can undercut the bank, which then topples into the water when its weight can no longer be supported. For this form of erosion too, the key to management is to ensure the bank is vegetated and protected against the scour mechanism.



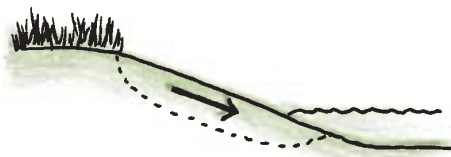
Slumping

Slumping can occur anywhere along a stream, and often follows undercutting by scour. It can occur when the bank soil itself has been saturated, for example by heavy rainfall or from a flood peak, and when the level of flow in the stream drops quickly, leaving the heavy, saturated soil of the bank unsupported. Slumping can often be seen in the middle part of a river network where the bank height exceeds the rooting depth of riparian vegetation, and anywhere where native vegetation has been cleared or lost from the banks. Some soils have natural planes of weakness shown by cracks or gravel bands resulting from past deposition. These are natural places where banks can slump into the stream or creek. Vegetation can be used to prevent slumping by drying out the soil as well as providing networks of roots that reinforce and strengthen the bank soil.

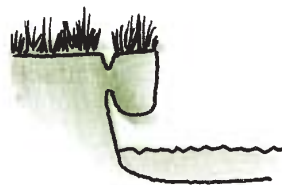
Different forms of erosion by slumping

Before

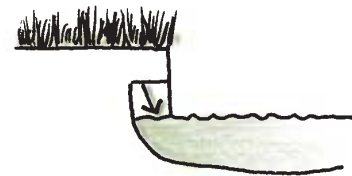
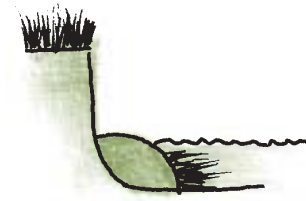
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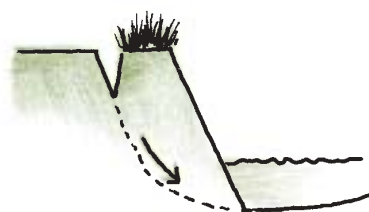
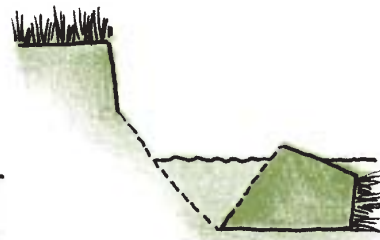
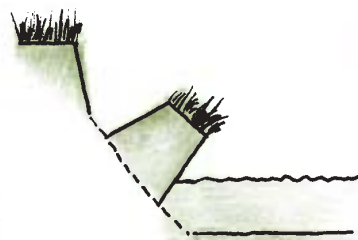
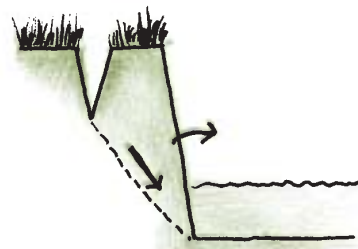
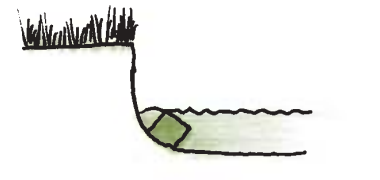
a. Shallow planar-slide failure



b. Scour failure (above and below)



c. Slumping failure (slide → topple)



d. Slumping failure (slope failure → toe failure → base failure)



Broken lines indicate failure planes

Illustration The Idea to Here.



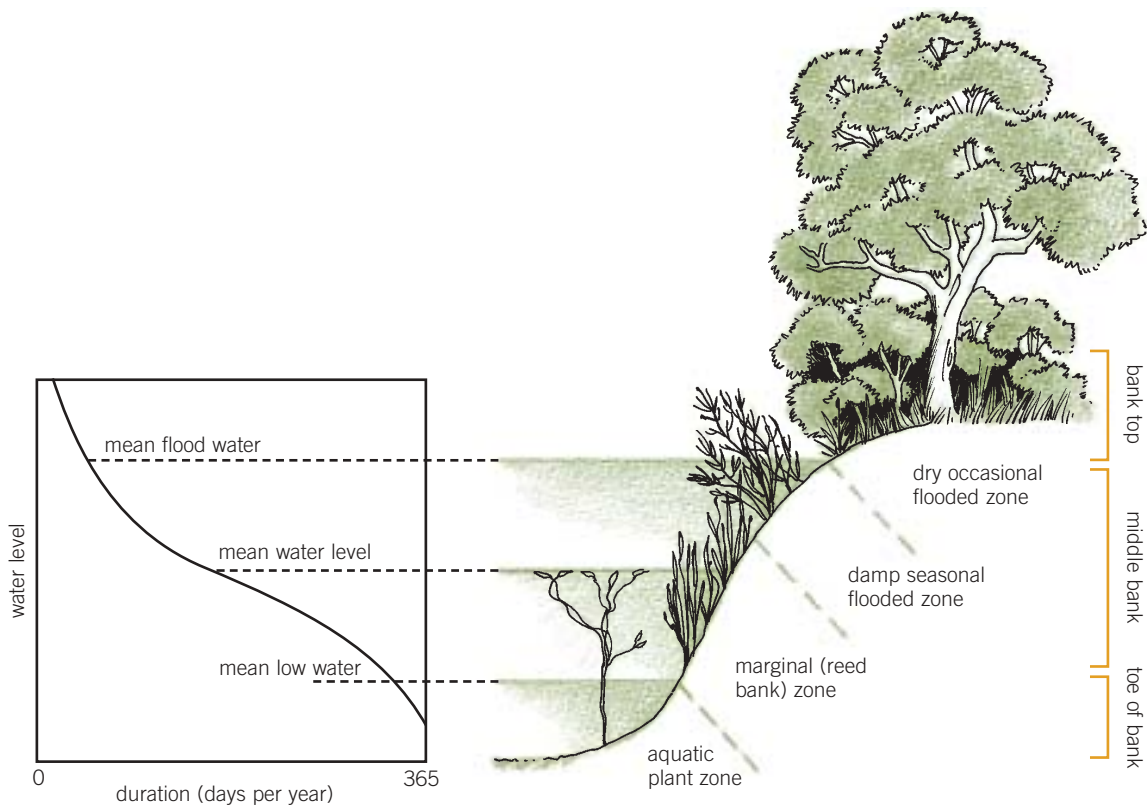
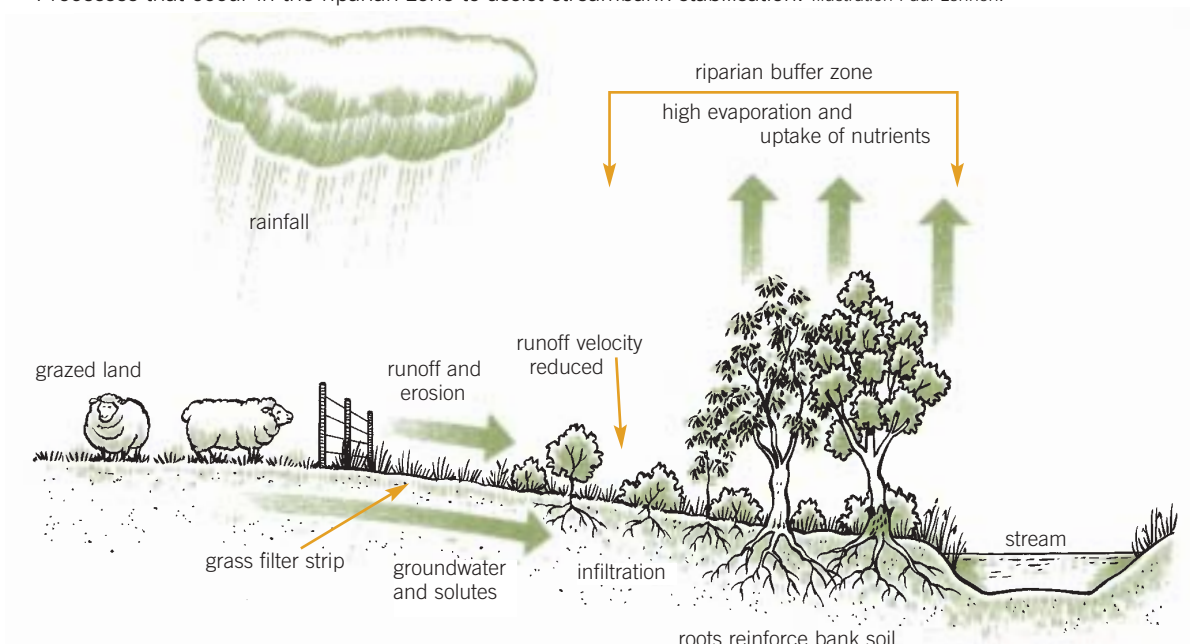


Figure of channel, type of vegetation, and associated mean water levels. Source: Adapted from Seibert (1968).

On-farm management practices

Maintaining good vegetative cover is the key to preventing soil erosion. Riparian vegetation buttresses river banks, with roots acting like reinforcing rods holding the soil together. Plants also help to dry the creekbank after extensive rainfall or flood events, further reducing the risk of erosion. Research data shows tree roots can extend for 10–15 metres from the trunk and to a depth of at least 1.5 metres, (and sometimes more depending on the depth to stream water level), so that even quite widely-spaced trees can be effective at reducing erosion from bank slumping.

Processes that occur in the riparian zone to assist streambank stabilisation. Illustration Paul Lennon.





Erosive forces at work along this small stream are resulting in valuable loss of land for the farmer, as well as declining water quality and in-stream health. Photo Siwan Lovett.

1. Maintain vegetative cover of at least 30% to prevent soil loss through erosion. Stock access to, and grazing management of, riparian paddocks should aim to maintain at least this minimum level throughout the year, with a higher level of cover (70%) required during seasons when intense rainfall or floods are anticipated. This will minimise sediment inputs from grazed riparian paddocks upslope of the channel.
2. Maintain a well-grassed filter strip adjacent to the creek. Research has shown that a 6 metre wide strip can be effective at trapping and retaining sediment from an adjoining paddock when the depth of surface run-off flow is small. In dips and gullies next to the creek, where surface flow collects naturally, and its depth and flow velocity are higher, the filter strip will need to be proportionately wider (see section F for more details).
3. When dealing with sub-aerial and scour erosion, aim to have complete cover of the bank down to the water's edge. Natural vegetation should be retained wherever possible along the bank and for at least 5 metres from the high flood bench or flood level. If there is no vegetation present, encourage natural revegetation of this area. By removing stock from the channel and adjacent riparian strip either permanently, or for at least long enough to allow seeding and regeneration to take place, vegetation cover can be quickly established. In some situations re-colonisation from upstream riparian vegetation may be possible, although care is needed to prevent the establishment of weeds from this source. In situations where there are no sources of seed present for regeneration, revegetate using direct seeding or tubestock. Low-growing native species, including sedges and grasses, as well as species that can bend with water flow, will be most successful at protecting the toe and lower bank areas along a stream or creek.
4. Regeneration or replanting of larger native species of trees and shrubs should be considered on the upper level of the bank, especially where slumping is a problem. Use a mixture of native riparian species to protect the bank and channel. A strip along the top of the bank (minimum 5 metres or one tree width, 25 metres preferred to enable natural regeneration) will also provide important shade for the stream, helping to reduce water temperature and light levels and prevent the growth of in-stream nuisance plants, including algae.

Your local Greening Australia office will be able to help you to choose the species you need for your area.



Case study

Kate and Tony Charlton, 'Cedar Park'

Location: Ballimore, 35 kilometres west of Dubbo, New South Wales

Average annual rainfall: 600 millimetres

Property size: 1358 hectares

Enterprises: 3000 (2500 at present, drought conditions) merino sheep joined to Border Leicester rams, shorn once a year, and averaging 5 kilograms wool cut per head per annum, and 100 breeding cows

Pasture base: improved pasture with tall fescue, lucerne and clover, moving to management of native pastures

Soil types: light loamy river flats predominantly, with some rocky knob areas on gently undulating country

River management: 11 kilometres frontage to the Talbragar River, which is central to the Talbragar Catchment Area

In 1999, former Landcare Co-ordinator Kate Charlton and husband Tony decided to focus their energy and money into solving a major river erosion problem, caused in part by the invasion of European Carp. The carp were busily burrowing into the banks of the Talbragar River on their property 'Cedar Park' on the NSW western plains at Ballimore, north-west of Dubbo. 'Cedar Park' is 1358 hectares and has been in the same family since the 1840s when just 12 hectares were initially farmed. The Charltons, who represent the fifth generation, are justifiably proud of the family tradition of caring for the land and were prepared to put their own money on the line to help save the river from further degradation.

The Charltons clearly recognised that to undertake the return of a significant section of the river banks to good health, would need a co-operative, farming community-based conservation approach. At risk were significant numbers of huge Red River Gums, many of them hundreds of years old, which were seriously threatened by a combination of root damage caused by the European Carp, uncontrolled water going over the river banks, and virtually zero regrowth caused by stock having access to the river for water and grazing.

With lessons learned during Kate's time with Landcare, the Charltons invited all the farmers with frontages to the River, along with anyone who had an interest in the health of the river, to attend a public meeting to address a strategy to revegetate the area, save the river gums, and better utilise the riparian areas along the Talbragar. With support, enthusiasm and strategic input from representatives from the then Department of Land and Water Conservation (DLWC), the group secured funding through the Rivercare Program and National Heritage Trust to kick-start the so-called 'Save the Talbragar River' project. Three neighbouring landholders joined with the Charltons to add momentum and scale to this very important project, titled the Combined Talbragar River System Strategy. The group sought advice from a number of regional specialists in the preparation of the project, including the designing of a trough-based watering system for all four properties, once stock access to the river was controlled by fencing off the riparian area.





Naturally regenerating river red gums along the Talbragar River, Cedar Park, Ballimore, NSW. Photo John Powell.

More than \$270,000 in funding was received, matched on a dollar-for-dollar basis, to fence 25 kilometres of the river and 6 kilometres of creeks, and to carry out all the associated works, including preparation and funding for the tree and shrub planting, the development of the trough-based watering systems for the four properties and many other related tasks. The project aimed to improve the water quality of the river system, with less salt, nutrient and uncontrolled sediment flowing into the river and to restore the river bank stability with revegetation using local native species of grass, trees and shrubs, leading to greater biodiversity.

Before the project began, the banks of the Talbragar River and its adjacent waterways were either narrow strips of old trees or completely bare of trees. In some places, there was no vegetation at all. It was quite clear to everyone, that if stock access and uncontrolled over-bank water flow had continued, the rapidly eroding banks would have lost many old trees; there would be further loss of nesting sites, and the total absence of tree and shrub regeneration.

After the huge task of fencing the 32 kilometres had been completed, the project team then addressed the installation of trough-watering systems on the four properties. The system at Cedar Park uses one pump to pull the water out of the river and a second pump to push the water to the highest point of the farm where a 200,000 litre (44,000 gallon) tank was installed with 25 millimetre piping using gravity to feed the troughs along the river. The Charlton's augmented the water scheme by putting troughs in the remaining paddocks at a cost of \$50,000.

During their 12-month river conservation journey, among the many lessons learned by the group was that stock will always do better on troughs than dams or rivers, which paved the way for the Charltons to change their river management strategy. Stock access to the river was changed with controlled access now the regime. To deter stock from repeatedly going back towards the river for water, putting pasture in the area under further pressure, troughs were placed away from the riparian zone. It was also important to ensure the riparian area did not become a fire hazard.



Tony Charlton (centre) explains how Rhodes grass has stabilised the banks of the Talbragar River on Tony's property Cedar Park, Ballimore, NSW. Photo John Powell.

In addition to the river bank problem, Cedar Park also had a sodic area of about 1 hectare along the banks of the river where nothing would grow, and this trouble spot was restored by bulldozing the area completely, and renovating it with fresh soil and native pasture. Plantings of 4400 trees and shrubs along the river saw the introduction of a wide range of species including Wattle, Casuarina (Bull Oak and River Oak), Eucalyptus, (Yellow Box, River Red Gum, Grey and White Box), and Melaleuca.

Kate and Tony say the Rivercare Project along the Talbragar River has been a stunning success, proof of which can be seen now with the regeneration of about 1000 new trees. They see their farming community-based project as one of the most exciting works in progress they have been involved with, with the amazing transformation of this extensive riparian area a graphic demonstration of what can be done with the full support of the local community and, especially, the skills and experience available from organisations such as Landcare, DWLC, and those interested in preserving our heritage. The Talbragar River restoration has seen visits by many groups including Landcare members from near and far, government departments, conservation groups and a private conservation consulting group from Canberra. Furthermore, by utilising resources made available through several Landcare projects, a total of 23,000 trees were planted by the Charltons between 1996 and 2000.

Kate Charlton says public meetings are the key to finding those with a similar commitment to upgrading water quality, biodiversity of riparian areas and reducing erosion and, importantly, it took a huge commitment in time and money by the four landowners for the project to achieve its objectives, but the results are there for present and future generations.

This case study was prepared by Currie Communications.



Section H

Getting ready for floods



Purpose

To ensure that valuable assets, including stock, buildings and fencing are not lost in periodic flood events.



Getting ready for floods

Principles

Flooding is a natural event in most catchments in Australia, particularly given our variable climate and potential for storms. In the southern part of the country, flooding normally results from an extended wet period during winter that results in saturated soils, being followed by further intense rain from either depressions or storms. When the soil is unable to absorb further rain, or the rainfall intensity exceeds the infiltration rate, overland flow commences and, if it occurs over an extended area, large flow volumes can occur in creeks. In the north, where summer rainfall predominates, floods are more likely to be the result of cyclones and rain-bearing depressions where intensity overwhelms infiltration rates, again leading to large volumes of water in creeks and streams.

Flood flows are important, as they determine the shape, location and size of a stream or creek channel. Under normal flow conditions a creek or stream tends to occupy only a small part of a much larger channel. The channel will often have one or more obvious *benches* that show the full channel capacity required to convey flood peaks. This is a valuable observation to make, as it provides the basis for siting important infrastructure beyond the highest benches (or flow marks) so that it is protected from flood peaks. Flood flows are also important ecologically as they can be the trigger for particular growth or reproductive phases of aquatic plants and animals.

“Benches”

Benches show as a small level area or floodplain, or as an obvious change in bank slope, within the larger channel. They show the channel size (capacity) required to carry a particular and recurring flood peak, for example the one in two year flood flow.

In the past, attempts were made to straighten some creeks in the belief that this would reduce the frequency and duration of flooding by enabling water to move more quickly down the channel. Whilst this is sometimes effective locally, it usually creates much bigger problems downstream, where flood effects are often much more damaging due to increased volume and velocity of the water in the system. It is now generally accepted that it is better to temporarily store and slow down flood flow in the headwaters of many small creeks than to risk a much larger combined peak flow lower in the river system. This can be done by replanting native riparian vegetation, retaining large woody pieces within the channel, and allowing streams and creeks to maintain their natural meander pattern.

When the flow velocity is increased as a result of channel straightening, the erosive power of the water is stronger and this enables it to undercut banks and erode creekbeds. There are many examples of streams and creeks where straightening and removal of in-channel logs and branches, have resulted in deepening and/or widening of the channel through erosion. This can lead to large volumes of sediment being ‘dumped’ into downstream reaches of the creek, while the erosion upstream has also reduced in-stream habitat and the environmental quality of the creek itself.



Above: When this area floods, the water converges from the paddocks down this gully and causes severe erosion. The stream at the bottom of the gully fills with the sediment washed down in the flood making the water turbid and poor quality. Photo Fleur Flanery.

Below: This weir is used to 'hold' water further upstream for irrigation and stock watering. In a major flood it is small enough that it would be overtopped, however, it is its long-term impact in reducing the flow downstream that may have the most deleterious impact on lower reaches and their in-stream and riparian life. Photo Siwan Lovett.



In some areas where wool is produced, landholders have used the opposite approach to moving water away quickly by using in-channel structures to divert flood waters onto surrounding land. This technique increases soil moisture and promotes pasture growth. While it can be successful, this technique can also be very damaging to the environment, as it takes water out of the stream that recharges aquifers and provides the flood flows upon which some species rely to trigger breeding events. In recognition of these problems, most States and Territories now require any works in, or adjacent to a defined watercourse, to be licensed (see Appendix B for further detail).



Flooding affects all those who live along a stream or creek. When getting ready for floods it is important to work with others so that actions taken on one property don't cause problems for others. In many wool-producing regions, floods are thought to have become more frequent since European settlement, and are considered to be larger and more damaging than previously experienced. This may reflect the unintended consequences of the clearing of deep-rooted, native vegetation for agricultural development. Without vegetation to trap and slow water, a greater proportion of rainfall now runs off the land surface quickly, making floods bigger and more intense. Streams and creeks in cleared catchments tend to be deeper and wider as a result, and many woolgrowers believe that flooding causes weeds and other nuisance plants to be spread throughout the catchment. These issues make it sensible that woolgrowers work together to manage floods so that optimum outcomes can be achieved.

On-farm management practices

1. Ensure that farm assets, including stock, buildings, tracks and fencing, are managed to reduce the risk of loss or damage during flood events. Look at the stream or creek channel using past photographs or by talking to people who have lived in the area for a long time, to identify the areas affected by different flood peaks. Many creek or stream channels have one or more benches as part of the bank, indicating how wide the channel becomes to convey particular flood peaks. Place tracks, buildings and fences well away from these points to avoid them being washed away in peak flood events (say 1 in 5 year event).
2. When building streamside fencing to optimise production in riparian areas, use fences designed to cope with floods and which will suffer minimum damage, or can be easily re-erected following passage of the flood (see section B for further information on riparian fencing).



This landholder has decided to work with nature by fencing out the part of the farm that is low lying and 'swampy', and allowing it to regenerate. The area receives the bulk of the floodwater from the property and by allowing it converge, slow down and flow through the wetland much of the sediment 'drops out' and is filtered before it enters the river. Photo Kirrily Rourke.



This riparian area has been fenced out to restrict stock access and allow the native grasses to regenerate, with the result being a bank well protected from flood flows. Prior to fencing this bank was bare and unprotected, with erosion and loss of valuable land the motivating factor for changed management practice. Photo Anne Sullivan.

3. For maximum protection against floods, shield eroding areas of creek channels by maintaining vegetative cover and restricting stock access. Vegetation, especially when it includes native riparian species, will help to hold up and slow flood waters, thereby decreasing the risk of greater peak flows and damage downstream. There are significant advantages in groups of woolgrowers working together to plan and manage a creek or river reach, as the benefits of this work can be undone if parts are left untreated and at risk of flood damage. Other sections of this guide provide more-detailed information on preventing bank erosion or maintaining riparian pasture and vegetation (see sections B, C and G).
4. Where possible, leave branches and even whole trees within the stream channel as this will help to reduce the effects of flooding. In the past, it was believed that this large, woody material, sometimes known as snags, exacerbated flooding and pushed flood flows out onto the surrounding land. However, research has shown that this material would need to occupy at least 10% of the cross-section of the full channel before it has any appreciable effect on channel capacity to convey flood flow. Large woody material actually helps to protect the creekbed from erosion and deepening during flood flows, as well as being an essential component of habitat for plants and animals.

For more information on managing wood in streams, see Cottingham, P., Bunn, S., Price, P. & Lovett, S. (eds), 2003, 'Managing wood in streams', *River Management Technical Update No. 3*, Land & Water Australia, Canberra, www.rivers.gov.au



The wood that has accumulated in this ephemeral creek is providing valuable habitat for wildlife and, when flowing, in-stream organisms. Photo CSIRO Sustainable Ecosystems.





Case study

Gibson and Hogan families, 'Keringal'

Location: 8 kilometres east of Hay, New South Wales
Average annual rainfall: 300 millimetres
Property size: 5500 hectares (1000 hectares irrigation and 4500 hectares native pastures)
Enterprises: merino sheep and irrigated cropping
Pasture base: irrigated winter annuals and native pastures
Soil types: heavy self mulching clays
River management: 4 kilometres of Murrumbidgee River

Keringal has a 4 kilometre frontage to the Murrumbidgee River, divided into two main paddocks. The riparian zone is a forest of River Red Gum (*Eucalyptus camaldulensis*) in the lower benches of the floodplain. Further away from the river the less frequently flooded areas consist of Black Box (*E. largiflorens*), Nitre Goosefoot (*Chenopodium nitrariaceum*) and Lignum (*Muehlenbeckia cunninghamii*). The redgum has been commercially logged for railway sleepers twice since 1950. The riparian zone is adapted to flooding and relies on a flood event to promote regeneration of trees and shrubs and to “deep water” the mature trees. The last substantial flood was in 1974.

Traditionally, the river paddocks were continuously grazed by the family horses and the merino ram flock. As a consequence of the continuous grazing and lack of flood events there was minimal or no regeneration of trees and shrubs in the riparian zone. In 1995, the family made a decision to reduce the grazing pressure in the river paddocks in an attempt to increase vegetation cover and encourage regeneration. A new irrigation paddock with good shade was developed for the rams away from the riparian zone. Management of the rams was much easier in this smaller paddock where they could be easily inspected and clean mustered. The horses were also removed from grazing the river paddocks.



River view. Photos throughout this case study Lu Hogan.



Above: The main channel of the river during a flood.
Right: Timber washed up in the flood.

Initially, the river paddocks were grazed strategically during the winter when the grass cover was greatest. In about 1999, the family decided to completely exclude grazing from the river paddocks. In 2001, the major agricultural areas of the farm were sold and the river paddocks have had no grazing from domestic stock since that time.

Even without a flood event, the exclusion of grazing has resulted in recruitment of River Red Gum, Black Box and a range of perennial shrubs. Perennial grass cover has increased particularly down the steep river banks. The river paddocks provide habitat for kangaroos, echidnas, goannas, possums and a myriad of birdlife that roost and nest in the trees and feed on the surrounding grasslands or fish in the river by day.

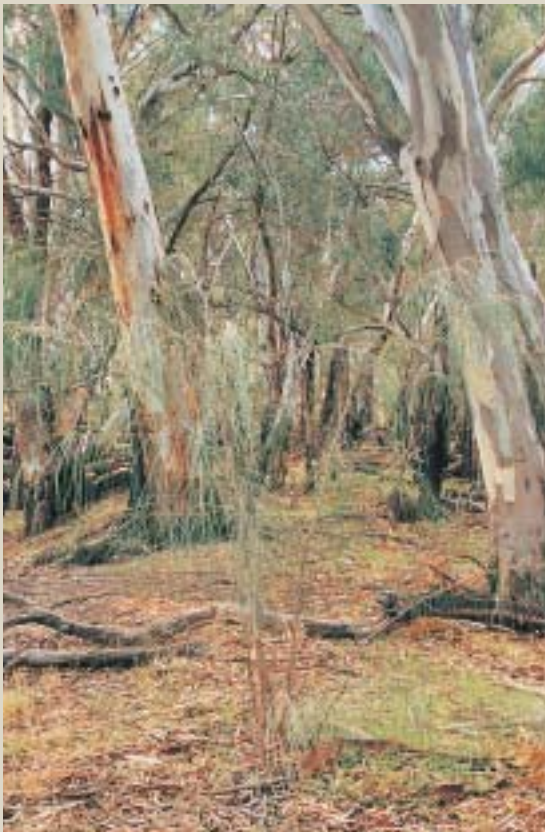
Floods in the Murrumbidgee River are slow moving and there is always plenty of time to prepare for them. It takes three weeks for a flood peak at Wagga Wagga to reach Hay, so there is no excuse for not being ready. All the property's infrastructure is located on high ground that has never flooded, so it is a matter of moving any stock or equipment from low lying areas. Fences can be damaged by debris floating in the flood water, so substantial repairs can be required after the flood subsides. A severe flood will spread many kilometres from the river channel and may cut access roads and isolate livestock and homes.





Lippia.

Some of the major weeds of the riparian zone such as Lippia and Noogoora Burr are spread during flood events. Noogoora Burr can be controlled with spot spraying or cutting, but there is no effective control for Lippia which is now the major weed of inland waterways. Lippia forms a mat over the soil surface and competes with native and introduced grasses resulting in loss of biodiversity and grazing capacity. There is no effective chemical or biological control and cultivation is not possible due the amount of fallen timber and difficulty with access.



Left: Regeneration of River Cooba (*Acacia Salicina*) since stock has been excluded. **Above:** Vegetation cover along river bank has increased since destocking.



The family enjoying the river during summer.

Rabbits are the major pest of the river paddocks which take advantage of the fallen timber for shelter and burrows. Due to the difficult terrain, effective control is dependant on the spread of myxomatosis and calici virus.

The quality of water in the river is dependant on the management of farming land in the higher rainfall zone upstream and the river management policies of the irrigation authorities. Water quality has declined over the last 20 years as a consequence of silt and nutrients entering the water. Many of the sandy beaches along the river are now partly covered in mud that has been carried from upstream. Algal blooms can occur in summer when river levels are low and the water temperature increases. Despite these negative impacts the river is still a place of great beauty and provides an important focus for family events and activities including fishing, swimming, camping and boating and there are still good stocks of native fish, shrimps and crayfish in the river.

This case study was prepared by Lu Hogan.

Section I

Managing weeds, pest animals and fire



Purpose

To prevent the establishment of weeds and pest animals in riparian areas, as well as reducing the risk of fire.



Managing weeds, pest animals and fire

Principles

For many woolgrowers, an important deterrent to changing stock management in riparian areas is the fear that they will become havens for weeds and pest animals, as well as posing a fire risk. These are issues that must be taken into account in planning the management of riparian areas, as the aim is to lift production and environmental condition, not to see these parts of the farm become a harbour for pests and a problem that requires a lot of time and effort to fix. Fortunately many woolgrowers have found ways to improve their management of riparian areas without significant invasion or establishment by weeds, and without them becoming harbours or movement zones for pest animals (both native and feral). There are also a number of things that can be done to reduce the risk of fire in riparian areas.

The most important principle of weed management is that most weed species find it difficult to invade and establish into intact riparian vegetation. In general, if vigorous pasture and healthy native vegetation is maintained or established in riparian areas, weeds will find it harder to compete and establish. Managing grazing so that plant cover of established pasture and native vegetation is maintained is the key management practice for woolgrowers to follow to prevent weeds becoming a problem on their farm.

On riparian land that has become degraded by past land use and management, and on areas that are affected by flood, frost, or wildfire, it is vital to promote natural regeneration or to deliberately revegetate as soon as possible after the disturbance, otherwise weed invasion is almost certain and it will be much harder to bring the area back to a natural condition.



The riparian area has been fenced off from stock but is wide enough to allow access by farm vehicles for weed management. Photos Mike Wagg.





This photo shows bamboo grass and artichokes, both difficult weeds to contain in riparian areas once they take hold. Photo Phil Price.

However, even with this careful approach to management, some weed species especially suited to riparian areas may become established. Weeds can be brought in through wind dispersal of seeds, seeds passing through the droppings of birds and other animals, or seeds and pieces of vegetation transported by the stream. Where these invaders are successful, carefully-managed and selective grazing in the riparian area can be used to control some of them, for example sheep may selectively graze palatable annuals in spring. If stock are allowed access to fenced-off areas to eat weeds before they flower and set seed, it is important that any damage to surrounding native vegetation or the riparian pasture is minimised. Generally, access by sheep to riparian areas should be for short periods only, and timed to achieve good weed control, preferably when the soil is not wet.

If tactical grazing is not possible or sufficient to control weeds, selective control through spraying or hand-weeding can also be considered. Selective spraying using a backpack or with a wiper wand can be very effective if the area to be treated is not large. Particular care must be taken when spraying over or near a creek or stream. For example, *Roundup Biactive* and *Weedmaster* contain a special formulation that is less harmful to aquatic life than the standard glyphosate formulation. Pulling individual weeds out by hand or grubbing out with a hoe can be highly effective when numbers are low.



The most effective way to manage weeds is to prevent their establishment in the first place, and this means keeping a well vegetated ground cover so that weeds cannot find areas to grow. The photo above shows a riparian area in good condition protecting a grazing paddock that has recently been cut for hay. Photo Siwan Lovett.



In many wool-producing regions, riparian areas have already been invaded by woody weeds. These plants, which might include willows, pepper trees, olives, desert ash, tamarisk and other species, may provide some benefits (for example, they may shade the stream or help strengthen banks against erosion), but overall their influence is negative, and in the long run they should be replaced with local native species. Willows, for example, will gradually grow into the stream, blocking the channel, and causing additional flooding. They can be highly aggressive, and now that both sexes in some species are present in Australia there have been some huge seeding events, with millions of seedlings becoming established downstream, completely choking the channel. Willows also use a lot of water, and are harmful to native in-stream animals as they drop all their leaves at once into the stream where they decompose and create anoxic (no oxygen) conditions.

The problem with willows in riparian areas

In many southern areas, willows have been used extensively to help stabilise streambanks. Willows establish easily, grow rapidly, produce fine matted roots ideal for stabilising soil, and require little attention after planting. However, over time the consistent use of willows (and the planting of male and female plants of most species that successfully spread by seed), has caused changes to the ecology and flows of rivers and streams. Some southern rivers are now completely choked by invasive willows. Willows have displaced native riparian species and colonised streambanks, sand and gravel bars in streams, diverting flow and causing erosion on vulnerable banks. The soft textured leaves that are all dropped at the same time do not provide a year-round food source for native in-stream animals. This, together with the extreme shade provided by willows has reduced biodiversity wherever willows dominate riparian areas. Willows are also prodigious users of water, and en masse can reduce natural water flow. Since 1998 willows have been declared a noxious weed in New South Wales. Some of these features also apply to other invasive species found in the higher-rainfall zone including poplars, she-oaks, olives, and desert ash.

Willows are now listed as a weed of national significance. Photo Lizzie Pope. Text source: Department of Land & Water Conservation.



On-farm management practices

Weeds

Riparian environments are subject to natural disturbances, such as flooding, fire or severe frost, as well as the impacts of stock grazing, drift of pesticides and access by machinery. These disturbances provide opportunities for weed species to invade riparian vegetation. Most weed species are much more likely to invade riparian vegetation that has been disturbed and is unhealthy. The recommended management approaches below, aim to reduce weed invasion into riparian vegetation.

1. Maintain a mix of different native vegetation types and layers in riparian areas, so that there are trees, shrub understorey and ground layers of grasses. This will prevent many weeds from finding places to invade.
2. Maintain native riparian vegetation so that it is wide enough to resist drying winds, nutrient movement, and the transport of weed seeds in bird droppings, as these factors assist weeds to invade streams. The ideal width is at least 25–50 metres of riparian vegetation. The smaller width will assist animal species to move across the landscape, but greater widths are required for species to remain resident in the area.
3. Avoid excessive human disturbance in riparian vegetation, for example from repeated vehicle and equipment access, timber gathering or other clearing. Remember however that occasional access may be required to allow spraying, or ripping of rabbit warrens and laying baits for example.
4. Exclude stock from riparian lands or use fencing to control the timing and season of grazing activity — this includes exclusion of feral or native animals where possible if they exist in large numbers. Stock can spread weeds through their wastes and on their wool, while dung and urine also provide the elevated nutrient levels that many weed species need to establish. It is also a good idea to keep stock in a holding yard for 12–24 hours so that they can void any faeces that might carry seeds into riparian areas.
5. In situations where weeds have already invaded riparian vegetation, control them by regular spot-spraying, stem injection treatment of trees, or by hand removal where this is feasible. In many districts, there are community organisations able and willing to assist in such work (for example, Green Corps). There are some noxious weeds that have a legislative requirement for control. Periodic monitoring and weed control will need to be continued each year (for example, during the non-cropping seasons) until the problem can be overcome.
6. When controlling weeds using herbicides, only those registered for use in riparian lands and near water courses should be used. Seek advice from local government agencies about what you can use. Care must be taken not to disturb the surrounding natural vegetation unnecessarily, as this will only encourage further weed invasion.
7. Work with neighbours to prevent re-infestation of the areas being rehabilitated. Most weed invasions of relatively intact riparian vegetation have come from adjacent and upstream lands, where there may be agricultural or urban weeds. This will often require work in upstream regions first and then gradually moving downstream. If this approach is not followed, unattended lands upstream may continue to provide a source of infestation.

Green Corps



Green Corps gives young people the opportunity to participate in projects designed to preserve and restore Australia's natural environment and heritage. Green Corps participants also gain improved career and employment prospects through accredited training, structured work activities and work experience. They receive assistance in preparation for employment, personal development opportunities and also provide an opportunity to contribute to the well being of the community. Contacting the local Green Corps group in your region may result in work such as weed management on wool properties becoming part of a Green Corps project.



Photo courtesy Greening Australia ACT & SE NSW.

Pest animals

There is a risk that unmanaged or revegetated riparian areas may provide harbour for pest animals, which can include both native and feral species. Wallabies, kangaroos and possums, can cause significant damage to native vegetation and compete with stock for riparian pasture. Feral species, including pigs, foxes, rabbits, deer, wild dogs and cats, are also deleterious to native plants and wildlife, can be predators of lambs and may pose a disease risk. In closely-settled areas, where riparian areas are likely to include grazed pasture and small areas of native vegetation, the eradication of these pests is normally not a problem. However, when larger areas are available, particularly in association with bush runs, this is an issue that woolgrowers will need to consider.

Methods of preventing or controlling pest animals are specific for each type of animal and for certain situations. These details are beyond the scope of this Guide, but readers seeking further information are referred to the series of publications available from the Department of Agriculture, Forestry and Fisheries, including “PESTPLAN: a guide to setting priorities and developing a management plan for pest animals”, and the series of guides for control of vertebrate pests including rabbits, feral goats, feral horses, rodents, feral pigs, and wild dogs and dingoes (<http://affashop.gov.au/product.asp?prodid=12598>).



Fire

Fire is a natural phenomenon over much of the Australian continent, but under bad weather conditions it can threaten stock and property, as well as lives. Reducing fire risk is best achieved by managing the amount of fuel available and/or ensuring, in fire-prone areas, that adequate firebreaks have been prepared prior to the fire season. Fenced-off riparian areas will not necessarily present a much greater fire hazard, particularly where native trees shade out understorey species and where riparian pastures are grazed occasionally to assist weed control or to cover seasonal feed droughts. A track between the fenced area and the adjacent grazing paddock may provide a firebreak to reduce the likelihood of fire moving into or from a riparian area. Grazing of adjacent riparian paddocks prior to the start of the fire season can provide an additional measure of safety.

Some woolgrowers grazing native pastures use periodic fire to help maintain composition and pasture quality, and carefully-managed control burns can be used in the same way in riparian areas. However, it must be remembered that opening up the canopy and the soil surface invites weed invasion, so there is a trade-off to be considered between reducing fire risk and possible weed invasion.



This riparian area has had weeds removed and a low intensity burn used to try and promote regeneration. Photo Siwan Lovett.





Case study

John and Sue Holt, 'Burn Brae'

Location: Eden Valley, Lower North, South Australia

Average annual rainfall: 525 millimetres

Property size: 405 hectares

Enterprises: 600 merino ewes averaging 22.5 micron and 5.5 kilograms of wool cut per head per annum, and 85 breeding cows

Pasture base: predominantly phalaris, cocksfoot, fescue and clover pastures

Soil types: sandy loam, slightly acidic

River management: 3 kilometres of creek frontage which is a tributary of the North Para River in the Mt Lofty Ranges catchment area

Fencing off creeks and creating wider belts of riparian vegetation has paid dividends for South Australian graziers John and Sue Holt. According to the Holt family, a change in the management of their riparian areas has reduced erosion and silting, while water quality, ground cover and weed management has significantly improved.

John and Sue Holt along with their sons David and Andrew own a 405 hectare property at Eden Valley, running a self replacing Merino flock, first cross lambs and Poll Hereford cattle. They also run a hay-cutting enterprise for additional stock feed supplies. The average annual rainfall is about 525 millimetres.



Regeneration along the creek that runs through the Burn Brae. Photos throughout this case study Kylie Nicholls.

During 1992, John and Sue planted a shelter belt on their farm which was so successful that it encouraged them to investigate the rehabilitation of their dams and creek. The main watercourse on their farm is a tributary of the North Para River. The creek is ephemeral, running about twice every five years.

The first step was to fence off a major dam along the creek which had been causing problems with erosion due to continual damage when stock went to the dam to drink. The dam was then becoming contaminated with silt due to the eroding soil which significantly reduced the water quality for livestock. The Holts had already cleaned out the dam twice, which they considered a waste of money and time so they decided to investigate alternative options.

The dam and part of the watercourse feeding into the dam was fenced off during 1995 and revegetated with a mix of local plant, shrub and tree species. Sue said since fencing-off the area, the bare ground has disappeared and they are seeing native grass and plant species growing where they have never been before. This includes increased populations of wallaby grass (*Austrodanthonia* spp) and spear grass (*Austrostipa* spp) as well as other plants such as the Native Scurf Pea (*Psoralea australasica*), Running Postman (*Kennedia prostrata*), Australian trefoil (*Lotus australis*) and several species of daisies (*Vittadinia* sp). Many of the banksias and wattles that were originally planted have also started to re-generate.



Natural regeneration from the remaining mature trees has been prolific once stock access was controlled.

This initial on-ground work prompted John and Sue to continue, and they have now completed more than 3 kilometres of fencing along their creek system. From 1995 onwards work started along the remaining farm creek lines. The first stage was knocking in the posts and the area was then sprayed and direct seeded early during spring. John and Sue have made a conscious effort to plant a wide range of local tree, shrub and ground cover species to create a layered and densely vegetated riparian area.

Over the years, the seed for revegetation has been supplied through various seed collectors including State Flora and Trees for Life and where possible the Holt's have collected local seed themselves. The fencing was completed after the direct seeding using a 5-wire electric fence with two live wires. Due to the twists and turns of the creek, each strainer was knocked in on an angle to help reduce fence movement.

Several lift-up gates were installed along the creek to ensure easy access when necessary, particularly in the early stages if any livestock got in.



A chain-type floodgate forming part of the fenced section of the creek.

John built two different types of floodgates using lengths of chain or small sheets of mesh which water can still flow through. But he believes the chain floodgates have worked more successfully, particularly during a heavy flood when there is a lot of debris flowing down the creek. When the floodgates were installed, two posts were knocked in beside each other so if a large flood did occur the small post holding the flood gate would be expendable while John hopes the main fence strainer would remain.

As part of the creek rehabilitation, the Holts have had to move the stock watering points. The water from the main fenced off dam is piped up to a tank near the homestead and reticulated back to troughs in nine paddocks. This will eventually be extended to 11 paddocks. The aim is to have more watering points in each paddock to reduce erosion from stock tracks leading to only one water point. Several other smaller dams have also now been fenced off and revegetated, which will supply water to other farm paddocks. Solar pumps have been installed to pump the water from the dam to the tanks and standard poly pipe buried under the ground is used to transfer the water to the troughs.

Before the Holt family started fencing off their creek, Salvation Jane (*Echium plantagineum*) was a significant weed problem through the riparian areas and in adjacent paddocks. John estimates that the population of Salvation Jane could have reached 100% in some areas, if left untreated. But since fencing off the creek, the Salvation Jane infestation within the fence line has nearly disappeared. John and Sue believe this is mainly due to the increased competition from other native vegetation in the riparian areas.

Rotational grazing has also been introduced in riparian paddocks, which has also contributed to the reduction in weeds. But they do admit that phalaris (*Phalaris aquatica*) has become a problem in the fenced off areas due to its invasive nature. Initially, they trialled a cool burn in winter to reduce the bulk of grass but this had little impact on the overall population of phalaris. Since then, they have been employing a strategic graze during spring using high numbers of either cattle or sheep for a short period of time. This has proved more successful in knocking down the phalaris, enabling other grass species to regenerate.

Benefits outweigh costs

Initially John and Sue received some funding through the then Department of Environment and Natural Resources and the Mt Lofty Ranges Catchment Group but most of the work has been completed using their own capital. They estimate the fencing costs were about \$1000 per kilometre while the revegetation costs incurred were mainly their time and labour. Moving the watering points has also been expensive but this has been completed in stages to stagger the costs. They admit there is a significant capital and labour cost in fencing off creeklines and moving stock water points but they believe the long-term benefits of a healthier and more diverse ecosystem far outweigh the initial capital costs.

According to the Holt family, fencing off the creek areas has provided a huge range of benefits including reduced erosion, increased water quality, improved creek bank stability, weed management and increased biodiversity. Revegetation of these areas has also provided effective shelter for livestock, particularly lambing ewes, as fencing following the creek line has produced what Sue likes to call 'rooms' which provide protection from the elements no matter which way the wind is blowing.

They believe the riparian land acts as an environmental corridor for wildlife and are encouraged by the number of bird species returning to their farm to live in these areas.

John and Sue are active members of their local Spring Valley Landcare Group and Barossa Catchment Group and are also involved in an Australian Land Management System pilot project on Environmental Management Systems being run through the Eastern Hills and Murray Plains Catchment Group. They are so satisfied with their riparian results that they plan to continue a conservation program on other areas of their farm.



This case study was prepared by Kylie Nicholls.

Section J

Maintaining in-stream health



Purpose

To manage riparian lands so that in-stream life is healthy and diverse.



Maintaining in-stream health

Principles

Riparian areas support high levels of natural biodiversity. The combination of water, vegetation and connection to other parts of the landscape make riparian areas biological ‘hotspots’ for plants, animals, birds and fish. This section of the Guide describes how riparian areas influence and support in-stream life, and shows the close relationship between how riparian land is managed and the impacts it has on in-stream life. This means that the two must be considered together when making management decisions.

“Biodiversity”

Biodiversity describes the variety of life on earth. Variety (or diversity) is not only the spice of life, it is essential to life. The diversity of biological life (biodiversity) exists at three scales. These range from genes to species to ecosystems. Loss at any point in the scale affects the other scales of biodiversity. A common measurement of biodiversity is the total number of species found in an area.

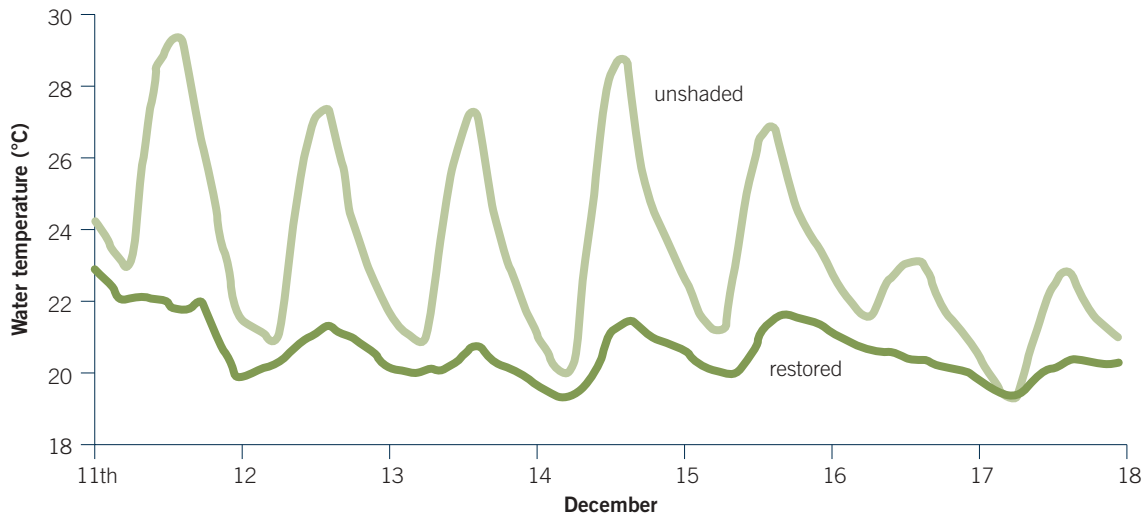


Riparian areas are biological ‘hotspots’ where land and water meet in the landscape. Photo Peter Hudson.



Stream temperature

Under natural conditions, streams were shaded by native riparian vegetation, decreasing the amount of direct and dappled sunlight reaching the water surface, and reducing daily and seasonal extremes of water temperature. Research in Australia has found that the temperature of water in streams where there is no riparian vegetation is 3–5°C warmer than in nearby vegetated sites, and the daily fluctuation in temperature is at least three times greater. The diagram below shows data on fluctuations in water temperature for a stream in south-east Queensland in summer, and shows the difference between grazed (few trees or shrubs) and restored (fully vegetated) sites.



Temperature increases of 3–5°C may seem small, but they can have large effects on the health of in-stream plant and animal communities. The growth and development of most in-stream organisms, such as algae, fish, reptiles and frogs, are in part temperature-dependent, and high temperatures can slow or halt development and result in death. Hatching of eggs, larvae and other stages in an animal's life-cycle, including determination of sex, are often triggered by precise temperature sequences, and research has shown that many in-stream plants and animals have specific temperature requirements for survival. In addition, oxygen concentrations decrease as water temperature increases, and this can limit plant and animal life and possibly contribute to fish deaths. Increased water temperature also elevates rates of bacterial breakdown of plant material and this further decreases the amount of available oxygen. High temperature also increases evaporation from the stream, and this is important in times of low natural flow.

These three riparian areas have different levels of shade. Shade is a key ingredient in improving or maintaining the health of in-stream life. Photos Peter Davies.

Canopy shade = 1%



Canopy shade = 18%



Canopy shade = 41%



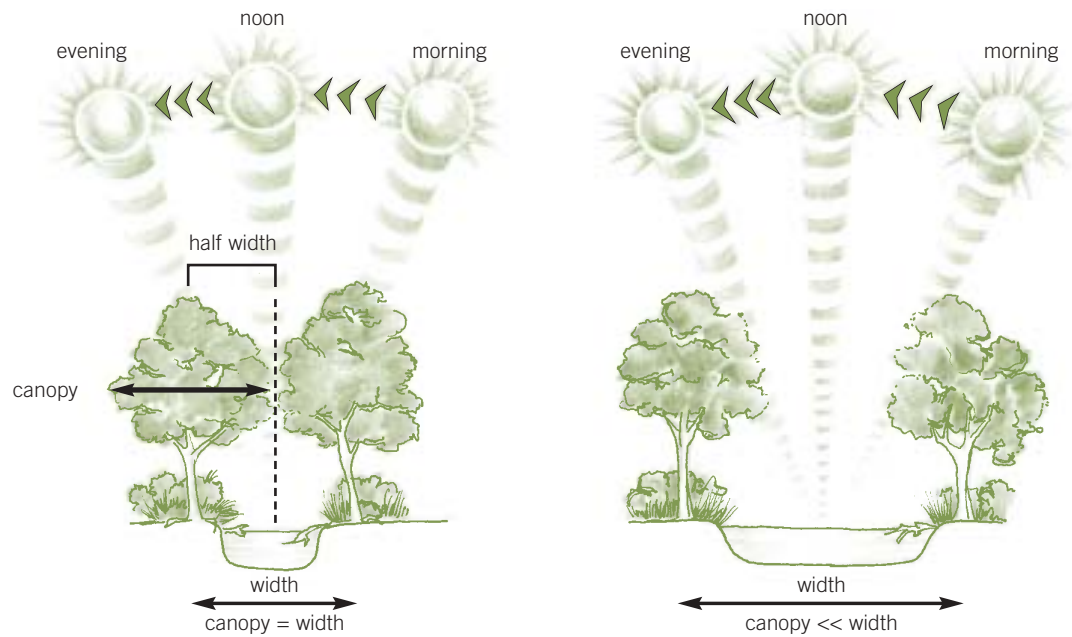


Illustration The Idea to Here.

Influence of channel width on cover. A small stream can be completely shaded if the active channel width is equal to or less than the width of the tree canopy. As channel dimensions increase, and vegetation height and width remain relatively uniform, riparian shading of the channel becomes less effective. Photos below show canopy cover increasing from left to right. Photos Amy Jansen.



Riparian shade is required to maintain the natural water temperatures that are essential for healthy and productive streams. The temperature within a stream is directly related to its orientation to the sun's trajectory as well as to the thickness and mix of riparian vegetation. Riparian vegetation has a greater shading effect in the infrared/red end of the solar spectrum, which is responsible for most of the heating of surface water. Several factors are involved in this process — for example, canopy height, vegetation thickness, channel width, channel orientation, valley topography, latitude and season. The diagram above shows how riparian vegetation can work to shade the stream from the sun at different orientations.

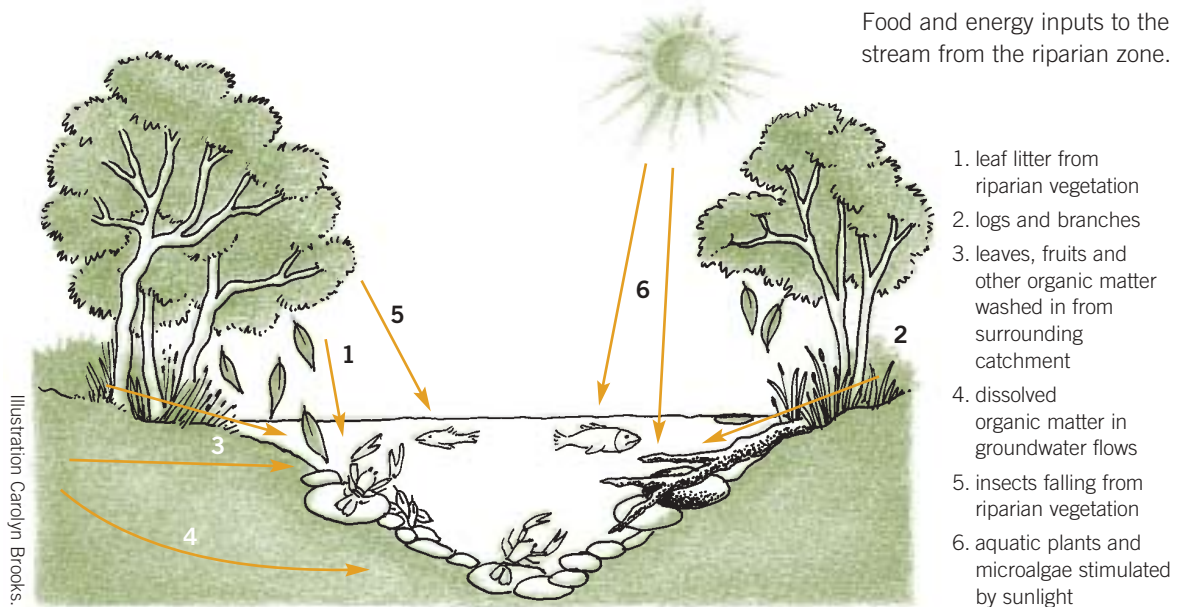
For more information about in-stream temperature and the importance of shading see: Davies, P., Cook, B., Rutherford, K. & Walshe, T., 2004. 'Managing high in-stream temperatures using riparian vegetation', *River Management Technical Guideline No. 5*, Land & Water Australia, Canberra, www.rivers.gov.au

Shade from riparian vegetation is also essential to keep natural light levels in streams. Some nuisance in-stream plants, including algae, need higher light levels before they can flourish and dominate in-stream systems. Under natural conditions, with shading from native riparian vegetation, their growth is restricted by lack of light.



Food webs and habitat

Native riparian vegetation provides the leaves, fruits and insects that support in-stream food webs. Tree roots in the water and undercut banks provide important habitat, access to food sources, and protection from predators. Woody material, such as branches and whole trunks that fall in from riparian land, are important for in-stream bacteria, fungi and some specialised animals which, in turn, are an essential food source for other in-stream life.



Wood forms complex three-dimensional structures in the water column that provide a number of different-sized spaces or habitats. The small spaces formed by sticks, twigs and other debris trapped against larger material provide refuge and feeding areas for small and juvenile fish, as well as invertebrates such as yabbies. The larger branches and logs provide space for larger species. Hollow logs provide essential habitat for such fish, and branches that extend into the water column and above its surface provide habitat at different water levels. Woody material also influences water flow, producing a range of flow speeds used by different animals to feed or rest. It has been thought that woody material in streams reduces flow capacity and increases flooding and, as a result, many streams have been 'de-snagged'. However, research has shown that woody material would need to occupy at least 10% of the cross-section of the channel before having much effect on flooding.



Vegetation increasing along river bank after stock has been excluded. Photo Lu Hogan.





Weirs such as this one restrict flow and bank up water in times of low flow. In this case, when the river has been flowing quickly erosion has resulted in engineering works being required to protect the bank. Photo Siwan Lovett.

In-stream health is also strongly influenced by water flow which includes; the total annual volume, flow levels at critical seasons, and the rate of change in flow and water levels. Together, these factors make up the flow regime. There have been significant changes to the flow regime of many rivers and streams across Australia, many of which are now regulated. The construction of dams and storages, both public and private, has changed the total annual river flow in many cases. Water that previously moved through the river system is now extracted, with seasonal flows disrupted as releases are timed in late summer or autumn in order to meet irrigation requirements. Under natural conditions peak flow in southern Australia was in spring.

An important aim of catchment and water-sharing plans is to try to reduce these negative in-stream impacts. Providing environmental flows at critical times of year (e.g. to support breeding cycles of native fish) is one example of the measures that can be used to improve conditions for in-stream plants and animals. Minimising the impacts of storage, diversion and pump structures through careful siting and operation, better management of river flow and storage volumes, monitoring and reporting of water quality, and removal of barriers to fish passage, are other actions that may be included in catchment plans. Landholders, including woolgrowers, have a vital role to play in determining catchment priorities for water management.

On-farm management practices

Assessment of streams, creeks, and riparian lands in most catchments shows that in-stream health has suffered as a result of past land and water management practices. The following recommended management approaches will assist woolgrowers to improve in-stream life on wool properties.

1. Map all streams and wetlands, including gullies that run only intermittently, on the property plan. Ensure that natural riparian vegetation is kept in these areas during farm or paddock development. The aim should be to retain full natural shade along the stream. Depending on the type of vegetation, a 25–50 metre strip will usually be sufficient to ensure that tall trees can be replaced through natural regeneration. Native species that grow down along the bank and have a spreading but dense habit, are especially valuable in providing stream shade. Where the natural riparian vegetation has been disturbed and the canopy opened up, replanting can be used to regain natural shade levels, and should include shrubs, grasses and reeds as well as trees.





In a dry and heavily-grazed landscape, these trees in the riparian area provide vital protection, food and habitat for a wide range of native plants and animals. Managing access by sheep to ensure regeneration of these areas takes place is a crucial aspect of good management. Photos Phil Price.

2. When rehabilitating a stretch of stream, visit undeveloped and natural areas in the local district, and compare the mix of riparian vegetation there with what is present on the farm. Information on revegetation of riparian areas is provided in section C of this Guide. For smaller streams, up to 10 metres wide and oriented east–west, the northern bank is particularly important for vegetation retention or replanting, as it will provide the maximum amount of shade for the stream.
3. If the woolgrower is interested, link them into the local Waterwatch network as these groups can assist with regular water quality monitoring so that changes over time can be tracked in streams, creeks and wetlands on the property.
4. Keep wood in streams so that it can provide habitat for in-stream life. In situations where large pieces of wood are a problem, they can be dragged back against the banks at an angle of 40°, where they have little effect in diverting water flow onto the banks.





Large snags repositioned if necessary to minimise their possible effects on flow downstream or onto the bank (flow is from upper left to lower right). Illustration Paul Lennon.

Best management practice is to only shift or remove logs in streams when a thorough channel survey has demonstrated that they are having a significant effect on flood level or frequency — in summary, let sleeping logs lie.

5. Make sure works on streams, e.g. for diversions or pumping stations, are approved or licensed by the relevant agency. The siting and design of these structures must take into account potential consequences on riverine systems.
6. As part of property management planning ensure that the woolgrower is aware of the natural values (for example, vegetation communities, threatened species, wildlife etc.) that the rivers and streams on their properties possess. This can then assist the woolgrower to work out how to achieve multiple benefits from developing a management strategy that maintains, enhances or protected these values.
7. Be aware of the catchment and water-sharing plans being developed in the local region and contribute to them. Many of these plans will include targets that woolgrowers will need to meet as part of wider catchment land and water management strategies (see Appendix B for more details).

Waterwatch — community based water quality monitoring

Waterwatch is a national community water quality monitoring program that has been operating since 1993. Through Waterwatch, groups and landholders can link with each other, share discoveries, compare findings and build a picture of the health of waterways across Australia.

To achieve these goals, the Waterwatch programs have chosen stream habitat, macro-invertebrate and algae surveys to monitor the biological health of the water body and surrounding land. The physical and chemical conditions of the water can be monitored using stream flow, turbidity, temperature, pH, salinity, dissolved oxygen, nitrates, phosphorus and *E. coli* tests. Just which chemical and physical conditions are measured may vary between catchments and the goal of the monitoring program.

Waterwatch Coordinators are employed in each State and Territory and can provide you with access to water quality monitoring kits, information about how to get started on your own creek or stream, and who to go to for on-ground assistance in your region. The website below provides links to all State and Territory Waterwatch Programs.



Photo David Kelly.

<http://www.waterwatch.org.au/>

For more information about wood in streams see: Cottingham, P., Bunn, S., Price, P. & Lovett, S. (eds), 2003. 'Managing wood in streams', *River Management Technical Update No. 3*, Land & Water Australia, Canberra, www.rivers.gov.au



Photo John Dowe.





Case study

Maurice and Barbara Collins, 'Ironstone Range'

Location: Mt Lofty Ranges, South Australia

Average annual rainfall: 500 millimetres

Property size: 1100 hectares

Enterprises: merino (16–18 micron) and crossbred sheep for fine wool and prime lamb production. Average wool cut 4 kg/head

Stocking rate: 9 dse/hectare

Pasture base: native grasses, introduced annual grasses and clover

Soil types: sandy loams to loam-over-clay, with large rocks covering at least half the property

River management: nearly 70 hectares of native vegetation excluded from livestock and a program to fence off 5 kilometres of creek banks and waterways now 10% complete

Farmer and grazier Maurice Collins is a passionate man when it comes to the long-term viability of his property, Ironstone Range, east of the Mount Lofty Ranges in South Australia. As part of this passion, Maurice has embraced a program to fence off more than 5 kilometres of creek beds and waterways on the family farm to allow for natural re-growth and re-vegetation. “My desire is to ensure future generations can enjoy this property,” Maurice says. “So we have embarked on a program of long-term change to ensure the whole farm’s health, including planting trees and letting the creeks and waterways go back to their natural state. We are making other changes that will effect the environment for the better, but it’s not about being a ‘greenie’. It’s about sound business management.”



Photo Currie Communications.



Maurice's re-growth and re-vegetation program is balanced by the need for the 1100 hectare farm and its flock of 16–18 micron merino sheep to remain productive. The average wool cut is 4 kilograms per head and the property is stocked at a rate of 9 dse per hectare. Pastures are mostly native grasses, but there are introduced species such as annual grasses and clovers.

Maurice runs Ironstone Range in partnership with his wife Barbara. The property has been in the family since 1880 and today is solely used for grazing merino and crossbred sheep. Topography varies considerably, ranging from 400 metres above sea level to 330 metres above sea level. The soil varies from sandy loams to loam-over-clay. There are large rocks that cover at least half of the property. The average rainfall is 500 millimetres.

Maurice's plan for sustainable farm management started in earnest about a decade ago through his involvement with a local Landcare group. Since then, his drive to reclaim native vegetation and wildlife on the property has blossomed. That's somewhat of a quantum leap for Maurice, who was raised on the farm in the belief that clearing the land was the way to go. "When we started the fencing project, we originally shut up 170 acres (68 hectares) and re-sowed it to natural vegetation. The growth was, and still is, quite amazing. Some of the trees in there are now 8–10 metres high, and that's even after they were devastated by a bush fire about five years ago. After seeing these results, I have decided that I will never put stock back in there. The areas of re-vegetation will create their own environment and I know that will be better for the farm in the long term." While Maurice has quite a way to go with his fencing program (he is about 10% through the project), he is determined to see it through. "I want to make sure of the change and while I won't see the whole benefits, the next generation certainly will."

The fencing off program started when Maurice realised that his 'old' management style of allowing stock access to the creeks was not sustainable. "While the creeks have played an important role in watering stock for many years, the long-term effects would have been a downfall of management. We decided it was time to act for a variety of reasons, including improving water quality, halting creek bank erosion and reducing the run off of fertilisers, animal excrement and chemicals and the like. We wanted to create an environmental barrier and, once the stock were removed from the creeks, we saw results almost straight away, especially in the halting of erosion."

The re-vegetation at Ironstone Range relies on the direct seeding of a variety of trees and shrubs — a mixture of 12 to 15 species of acacias and melaleucas that are collected locally. A traditional fencer, Maurice prefers to run the fence well out from the creek bank, rather than closer to it, as he likes to fence in as many straight lines as possible. "If that happens to be 50 metres from the creek bank, that's OK as this means more re-growth." The fencing is a standard star post/cyclone wire combination with two strands of barbed wire on top and one strand of barbed wire on the bottom. Main posts are about 12 metres apart with two star posts in between. Maurice did look at electric fencing, but he estimated the maintenance costs and time spent checking the fence would not be appropriate for his farm.

Once the area selected for re-growth has been fenced off, Maurice will spray the groundcover out with glyphosate a few months before seeding time. "Then we go in with the direct seeder and basically leave the rest up to nature," Maurice added. "The plants seem to respond very well to this system. The quality of the re-vegetation is tremendous."



In the long term, Maurice plans to install pumps on the creeks where there is permanent water and pump that water to holding tanks, which will in turn feed stock troughs. He is also planning to build feeder dams, but says that will happen when the budget can accommodate it. “All this work has to fit in with the running of the farm, in terms of labour and money.” And for all his work to date, Maurice (and the farm) has already reaped considerable rewards. ‘Ironstone Range’ has been a runner-up in the State Landcare awards twice in the past five years and a winner of a State Catchment Award in 2001.



Maurice checking water quality. Photo Currie Communications.

Maurice said apart from the recognition of these types of awards, he can also see marked improvements on the farm. “These types of ‘mini-ecosystems’ support a great deal of wildlife that definitely was not there before,” he says. “For example we have a great deal more birds, including some that prey on nuisance and harmful insects. “Anecdotal evidence in the district from other farmers has also shown that for locking up or fencing off 20–25% of the property for re-vegetation, a 15–20% increase in stock productivity has occurred. We are only about 10% through our fencing, so we are not at that point yet, and we intend to start looking closely at pasture management as well. Obviously there is a point where cost becomes an issue, but from the work to date, I would say the benefits absolutely far outweigh the costs.”

This case study was prepared by Currie Communications



Section K

Managing riparian areas for wildlife



Purpose

To provide habitat and passage for wildlife within and along riparian land, and thereby encourage natural control of pasture and stock pests.



Managing riparian areas for wildlife

Principles

Riparian land provides habitat, as well as a pathway (or corridor) for wildlife moving from one patch or type of vegetation to another, in both cleared and uncleared landscapes. The greater the linkages (connectivity) between these patches, the easier it is for animals to move between habitats. This helps to sustain wildlife populations in adjacent woodland and native grassland patches as well as within riparian areas. Areas of native vegetation should not be too widely dispersed or isolated. A distance of more than 500 metres may act as a barrier to many of the less mobile species like small mammals and tree-dwelling marsupials moving between patches, compared to some birds which regularly travel 1000 metres or more. Other species are unable to cross even smaller distances, for example squirrel gliders may be able to cross gaps of only 75 metres or so (Van der Rees et al., 2003). The value of riparian lands as a corridor for wildlife is an important consideration in deciding how to manage it.

The width of natural riparian vegetation needed for habitat or movement depends on the wildlife species, habitat type and landscape setting. Research provides estimates of preferred corridor widths, but not the exact corridor width in any particular case. It is known that wider is certainly better, but even narrow corridors are useful to some species. Narrow corridors in cleared landscapes have significantly more edge relative to their area, and so tend to experience negative edge effects, such as temperature changes and weed invasion. This can reduce the ecological value of the corridor itself.



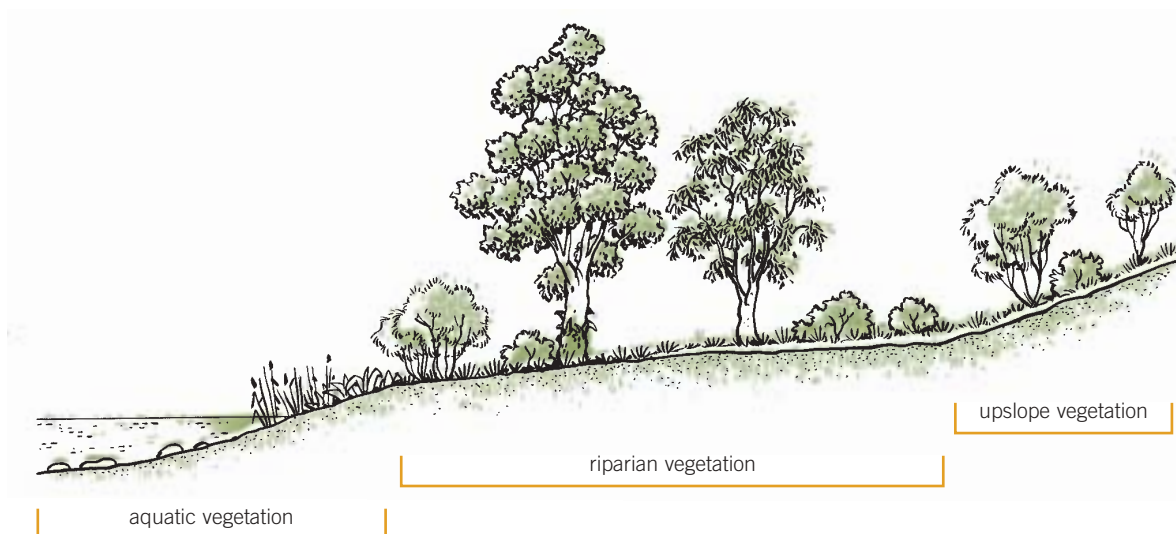
This riparian area has been fenced out to protect existing native vegetation and to allow regeneration to occur so that a wider corridor can be established for wildlife. Photo CSIRO Sustainable Ecosystems.

The width of the riparian corridor is only one consideration in the overall context of habitat requirements. For example, breeding birds require nesting sites, suitable vegetation height and structure, and tree hollows (or substitutes), together with adequate corridor width. As some riparian land acts as a temporary refuge or pathway for threatened, endangered or locally significant land or in-stream species, their specific habitat requirements need special consideration. There are likely to be local experts in your region to assist in determining the plant species and habitat requirement of particular wildlife that woolgrowers may wish to protect or maintain on the farm.

It is important to remember that if one aim of riparian management is to maintain wildlife corridors and habitat within an otherwise largely cleared catchment, the width, composition and continuity of the natural riparian vegetation is critical. Riparian plant communities often have greater plant species diversity than those of adjacent upland areas, as there is a variation in the types of vegetation because the area ranges from aquatic through to upslope trees, shrubs and grasses. It is proposed, based on ecological principles and field data, that to maintain crucial ecosystem functions and optimise pasture production, grazing properties based on grassy woodlands should maintain “a minimum of 30% woodland or forest” with woodland patches a minimum of 5–10 hectares to be viable in the long term (McIntyre et al., 2002). Retained or revegetated riparian areas should be a core part of this property-wide 30% target.

Grazing sheep on riparian lands may be compatible with maintenance of wildlife habitat, providing that grazing is planned and managed with care. Many landholders have found that the feed on riparian lands can be carefully and strategically used to improve enterprise margins and profitability. Careful grazing can also be used to reduce weed infestation and risk of fire during the early years after fencing. The key is good planning, careful monitoring of grazing impacts and prompt removal of stock at the first sign of over-grazing or damage. Section B in this Guide provides more information on managing stock access to riparian areas.

Providing on-farm habitat for wildlife can also offer direct benefits to the wool enterprise. These are in addition to the benefits of shade and shelter from native vegetation in reduced lamb losses, increased animal growth and wool production, and increased pasture growth, all described earlier (see section D). Native vegetation retained or established as wildlife habitat can also make a significant contribution to integrated pest management for both pastures and sheep.



Vegetation changes as distance from the water increases. Often there is a band of taller, denser vegetation in the riparian zone and shorter, sparser vegetation further away. Illustration Paul Lennon.





Christmas beetles on young planted white gum. Photo Richard Weatherly.



White browed treecreeper. Photo Andrew Tatnell.

It has been estimated that in New Zealand, the cost of controlling pasture scarab (Christmas Beetles) is between \$NZ48–\$200 per hectare, mainly because in pasture areas there is little vegetation left to support birds and other predators that control the scarabs. These costs would be similar in Australia for farms where the natural predators of scarabs, mainly native birds and small mammals, have been lost due to lack of habitat and alternative foods. Where no control of scarabs and other pasture pests is used, it would be expected that feed production is reduced when pest numbers are high.

There are at least 20 insect species that are pests of pastures in Australia. Some have a restricted distribution while others are more widespread throughout wool-growing regions, but most are only a major problem in improved pastures of the cooler areas of southern Australia. They include scarabs, webworm and heliothus caterpillars. These insects feed on the roots or above-ground parts of pasture plants. Losses of actual or potential dry matter can exceed 25% in clover-ryegrass pastures, so the economic effect of a bad infestation can be significant (Allen, 1987). In the New England area for example, the pruinose scarab (*Sericesthis geminate*), and the dusky pruinose scarab (*S. nigrolineata*) are the most numerous and the most damaging. *S. nigrolineata* is also a pest in the southern highlands of New South Wales in parts of Victoria and Tasmania. *Sericesthis* species have a one year life cycles and the adult Christmas Beetles feed on eucalypt foliage. The larvae damage the roots of ryegrass, clovers and other plants. Damage is frequently patchy but in severely affected patches, the roots can be entirely removed. Less severe damage can cause water stress resulting from root loss and inability to recover from grazing (Ridsdill-Smith, 1977).

Damage to pastures in the Tasmanian midlands caused by Corbie grubs was severe in the 2004 spring. The direct costs to woolgrowers included loss of summer feed and the need to buy in grain to cover the feed gap, as well as the loss of perennial pasture plants and the need for re-sowing at \$150–250 per hectare. For properties with an infestation over large areas of pasture, the only feasible option in the short-term was to reduce stocking rate and sell sheep. The opportunity cost of this, assuming 10,000 sheep on a 10 dse per hectare farm and 10% fall in stocking rate with five years required for full recover, would be around \$100,000 based on a gross margin of \$20/dse (data taken from Tasmanian 8X5 Wool Profit Program newsletter, November 2004).

There have been only a few studies in Australia to estimate the impact and value of predators of pasture pests — this is a topic where more quantitative data is badly needed. It is known that magpies can take many scarab larvae per hectare of pasture, and can vary their diet through the year to eat the most common insects. Magpies relish underground larvae which they can hear and pick out of the soil. A single bird may catch up to 42 grubs (about 35 grams) a day, and in summer a large percentage of magpies make Christmas Beetles and grasshoppers a large part of their diet. They have a territory of about 10 hectares and generally do not nest in isolated trees (because of exposure to predators). Kookaburras are also valuable pest controllers, with almost a third of their diet being insects. They are territorial, occupying at least 2.5 hectares, and require tree hollows for nesting.

Ibis consume large numbers of insects from pastures, particularly grasshoppers, larvae, crickets and caterpillars. They also eat mice. Ibis need a water source with sites for safe roosting, and will fly 25 kilometres or more to feed on insects in pastures or lucerne, or in new turned soil. Each ibis can eat over 200 insects per day — so a large flock could exert significant control on insect pests of pasture (Davidson & Davidson, 1992).

Arboreal mammals (possums and gliders) are known to be voracious predators of adult Christmas Beetles, and can reduce the population significantly, thereby reducing egg-laying and the number of scarab larvae in surrounding pastures. However, they need access to native vegetation for both alternate food sources (especially in winter) and for shelter.

Studies suggest that in healthy eucalypt woodlands birds may take about half of the insects produced (of the order of 30 kilograms per hectare per year), and more pasture insects are likely to be eaten by birds or native mammals in areas where woodland is adjacent to pasture. Woodland birds like choughs and some flycatchers, robins and wrens, as well as many species of bat, may venture into pastures to forage, where pastures are close to woodland areas. Birds and bats also take the adult stages of pasture insects like scarab larvae and grass grubs when they are in flight or feeding or resting on trees.



Photo CSIRO Sustainable Ecosystems.



There are also many insect predators of pasture pests, but little direct evidence of their impact in controlling pest numbers, enabling maximum feed production, or about their habitat and food requirements. There are also insect predators of sheep pests, including blowfly. Anecdotal evidence suggests that blowfly predators, such as dragonflies, can be found in greater numbers and hunt more effectively when natural wetlands and native vegetation are retained on-farm, but as yet there is no hard data on the benefits to stock health.

Despite the lack of complete data sets relating extent or proportion of native vegetation to benefits in pasture production or animal health, it makes sense for woolgrowers to actively manage trees to encourage pest predators in just the same way that they actively manage their pastures. When all the benefits that can be gained from carefully planned integration of native vegetation into the farm (many described in earlier sections) are added, it seems clear that retaining or establishing up to the 30% level (recommended by McIntyre et al., 2002), especially in riparian areas, can be very cost-effective.

On-farm management practices

The management of riparian lands to maintain land-based ecosystems and to conserve biodiversity must incorporate the protection of native riparian vegetation, with factors such as width, composition and continuity of vegetation vital to supporting wildlife communities. In many cases, improving riparian lands for wildlife is likely to be a secondary consequence of actions taken for other goals (for example, to improve streambank stability). However, with careful planning, riparian management undertaken to achieve other goals can be of substantial benefit to wildlife at little or no additional cost.

Protecting, maintaining and restoring riparian areas is most likely to be effective for wildlife where both the total habitat area and its links with other areas are maximised. Corridor widths suggested as suitable for wildlife habitat range from a minimum of 50 metres to several hundred metres. Whilst some broad guides are possible, the appropriate width of a riparian buffer for the farm will depend on the specific ecosystem, climate and type of wildlife to be maintained. Within cleared areas, negative edge effects are greater, so target widths for riparian rehabilitation need to be wider than in landscapes with retained native vegetation cover. On stream meander bends it may be cheaper to fence out the whole bend than to attempt to follow the bank curves, and this may provide important wildlife habitat.

Revegetation planning needs to consider the specific requirements of the in-stream (see section J) and land based species being catered for. Vegetation diversity both vertical structure and floristic composition are important as they allow a number of different species to use the area. It is important to plant or protect the full range of plant life-forms typical to the area. Reference sites that contain relatively undisturbed native vegetation should be visited, and the typical distances that separate all plants at the sites (including trees, saplings and shrubs) used as a guide for revegetation. Getting advice from wildlife experts, ornithologists (bird experts) and others familiar with local plants and animals is recommended to assist in the development of a plan for managing riparian areas for wildlife on the farm.

In general, it is recommended that at least 50 metres either side of the stream is protected or revegetated for wildlife, but even the narrowest vegetation strips are preferable to none. Restoring wider strips of riparian habitat (100 metres or more) is much more desirable if the available area and resources are sufficient. Fencing or protecting a wider area may allow natural regeneration processes to revegetate these areas. The habitat value of replanted areas can be greatly enhanced by retaining ground litter, especially logs and other plant material. Provision of nest boxes on preferred tree species can also provide additional habitat for birds and other tree dwelling species.



Case study

Jan and Neville Lubke, 'Bonnie Rise'

Location: Jindera, New South Wales

Average annual rainfall: 600 millimetres

Property size: 222 hectares

Enterprises: 700 first cross ewes (border leicester/merino), 50 Murray Grey breeders

Stocking rate: 12.5 dse/hectare (overall)

Pasture base: clover/rye with some phalaris and lucerne

Soil types: clay/loam

River management: Red Hill Creek, which feeds Bowna Creek which drains into Lake Hume

If you love the Bush Stone-curlew or are mourning their passing in your district, you should get to know Neville and Jan Lubke. From their property 15 minutes north west of Albury, they are making a massive contribution to ensuring that their property management is such that the numbers of this rare and totally captivating bird are sustained in their natural environment. Curlews are supposedly a sideline, but like some hobbies, they can be totally time consuming for Neville and Jan.

The Lubke's have protected a 12-acre patch of Blakely's Red Gum with a 6-foot high fox proof fence to enable the curlew, a ground nesting bird, to successfully raise chicks without them being attacked and killed. Curlew eggs take 25 days to incubate and the chicks are flightless for 50 days. This means they are extremely vulnerable to predation for approximately 2–3 months. In 2004 the birds raised a chick to fledging (flying) behind this fence. This was a huge achievement and one of which Neville and Jan are justifiably proud.



The Lubke's are also a part of a captive breeding program for the curlew. They currently have three breeding pairs in specially designed aviaries. These aviaries attempt to mimic the wild environment with native grasses and fallen timber present. The birds are fed a diet of raw meat, fruit, vegetables and insects. In the next couple of years it is hoped that chicks from the captive breeding program will be released into the wild, into areas where fox control is ongoing and the habitat is ideal. Curlews need the grass to be managed short, less than 15 centimetres and a native grass layer is preferable as it is sparse and therefore the birds have more visibility when crouching in their normal day-time position.

One of the curlews on the Lubke's property. Photos throughout this case study Leanne Wheaton.



Neville and Jan moved to their property in 1967. Bonnie Rise is grazing country. The original clearing, over 100 years ago, was haphazard and overdone, trees were the enemy and the scorched earth policy was applied. Bank erosion, siltation, steadily increasing salinity and declining pH levels were the greatest problems facing them when they first arrived. The creeks weren't permanent and dams were the only source of water and were barely adequate in a dry year. There was a huge undersupply of shade for the stock and only five species of small birds were present.

The first major undertaking when Neville and Jan took over the property was to subdivide the existing paddocks into smaller land management units. This gave them more control over pasture management and they now operate a semi rotational grazing system. Semi-rotational in as much as ewes with lambs aren't moved on a regular basis, but the rest of the livestock is.

They experimented with phalaris in the 1970s, but found that nutritionally "it was akin to eating cardboard, all fill and no fatten". The phalaris required a high degree of management. It was invasive in the tree corridors and it totally dominated the native pastures. However in the wetter parts of the farm, phalaris has been used to stop soil pugging up and help hold it together. The pasture program is now ongoing with different sub-clover species, and new varieties are trialed as they are developed. Lucerne is now grown on 20% of the farm, and it is found to be a low-cost lamb finishing pasture. The late spring/summer when lucerne comes into its own in the district is the perfect time for lamb finishing. However there is a distinct lack of deep rooted perennial pasture plants which survive in the long term in the district.

Dieback amongst the eucalyptus population is very common in the district. The increasing planting of annual crops and permanent exotic perennial pastures has increased the need for fertiliser. This more fertile ground breeds more the insects, which attack the isolated individual paddock trees. The clearing of the understorey has removed the shelter and food sources for the small insectivorous birds which previously had protected the eucalypts from insect attack. Without this small army of flying soldiers, the trees were dying. The tree planting program commenced in area of the property which had dead corners, where the soil type wasn't productive. However, if the Lubke's were to start their tree planting program again, they would start with the best sites creating wind breaks on the best pieces of soil.

Neville and Jan were entranced by the Western Australia flowering eucalypts, the pictures of their stunning flowers just jumped off the pages of botanical books. The planting of such species was a big mistake and one that a lot of people in southern NSW made. The Western Australia species didn't persist. They weren't adapted to the clay based soils. They blew over in the first strong winds. Now the Lubke's plant indigenous species: trees, shrubs and grasses following a very specific program of ripping, spraying, fencing well, planting on time and using small indigenous trees. They are keen on using as much material in the fence as possible as grass in the tree lots attracts the cattle, which puts pressure on the fence. "The lack of information about management of fenced off areas needs to be addressed" says Jan. "Phalaris blows into treed areas and rabbits hide in them, we need more information about chemical weed control that will not harm the trees until they are of a size that crash grazing can occur."

The tree planting on Bonnie Rise completes a major link across the property creating a wildlife corridor between Table Top Mountain and Benambra State Park. There has been a dramatic increase in small bird numbers since the program commenced. New species include: striated pardalote, white plumed honeyeater, yellow rumped thornbill, blue wren, brown quail, bronzewing pigeon, little eagle, white throated tree creeper, rufous fantail, grey shrike thrush, golden whistler, shrike tit, flame robin, red capped robin, Richards pipit, Horsefields bronze cuckoo and fantail cuckoo, white fronted chat and silver eye.





Above: Curlew eggs and hatchling. Below left: The specially designed aviaries attempt to mimic the curlew's wild environment.



A wetland created in 2002 to trap nutrient leaving the farm and improve water quality has never filled as a result of three dry years since its completion. However agricultural practices over the past 40 years have seen water quality improve dramatically with salinity levels of 305 EC coming into the property and 125 EC leaving it. This is a meaningful result and shows that works on the property are achieving the Lubke's natural resource management objectives. The wetland is surrounded by native water plants with shrubs on the perimeter. Once full it will encourage waterfowl to the property. Hopefully water-birds which once used a neighbouring wetland which was destroyed by inappropriate agricultural practices will then return to the property.

Foxes are the major threat to livestock production and the wildlife, especially the stone curlew. Foxes are baited twice a year with fox hunting year round. The Lubke's sons are very good shots and keen on putting dead foxes in key locations when visitors are arriving to view curlews.

"The curlews are one of many indicators that tell us if we are farming sustainably. While curlews co-exist and multiply with our farming enterprise we feel we are doing something right", says Neville. No insecticides are used near the curlews and fallen timber is left where it falls or moved to a more suitable location. "Ours is basically a neat and tidy farm, however we like to leave timber and leaf litter as an insect trap within the curlew habitat area. This also provides the birds with the adequate levels of camouflage they require" says Jan.

The Lubke's aim to have an agricultural enterprise that is economically viable whilst being environmentally sustainable. Their efforts to protect their wild curlews and enhance the population with captive breed juveniles are remarkable. "Our aim is more chicks on the ground" says Neville, "much to the amusement of my 20-year-old sons."

This case study was prepared by Leanne Wheaton.





Case study

Australian Wool Innovation, 'Falkiner Memorial Field Station'

Location: Deniliquin, New South Wales

Average annual rainfall: 393 millimetres

Property size: 3200 hectares

Enterprises: sheep and cattle grazing, some irrigated cropping, a 2377 megalitre water right

The Falkiner Memorial Field Station is a 3200 hectare property located 20 kilometres north of Deniliquin on the Conargo Road. The property is owned by Australian Wool Innovation and used for research and development for the wool industry. There are currently two major genetics trials running on the property.

Natural tree lines of old grey and black box timber mark the low lying ephemeral wetlands that are the natural drainage areas on the property. However, these are no longer flooded as Box Creek that runs through the property has been changed from an intermittent stream to a permanent irrigation drainage channel. Combined with sheep grazing, this has meant that the wetlands have had little change to regenerate and, as a result, are in decline.

In 2003, the Murray Wetlands Working Group offered Australian Wool Innovation an allocation of environmental water to flood two black box depressions areas on the property. The Working Group also provided funds for fencing materials (\$1500 per kilometre) and a rebate for re-seeding the area (\$250 per hectare). The NSW Murray Wetlands Working Group was established in 1992 as an initiative of the Murray and Lower Murray-Darling Catchment Management Committees to acknowledge the continuing loss and degradation of wetlands along the River Murray and to develop and implement well-researched, technically sound and community-endorsed management programs for wetlands.

Since its inception, the Wetlands Working Group has developed into a very successful community-based wetland rehabilitation group in the Murray-Darling Basin, achieving a good record of wetland investigation, community education and participation, development of management plans for priority wetlands, and liaison with government agencies, research groups and Aboriginal communities.

The Group felt that the Falkiner Memorial Field Station Wetlands could be successfully regenerated if floods were returned, and in undertaking the project they managed the reintroduction of water and charted the results. The following series of photographs shows the changes that occurred in one part of the Black box depression. The grasses were flooded out, allowing plants such as Nardoo and Spike-sedge to establish. Also new growth on the trees started to appear, as well as important wetland plants such as the flowering Lignum.

Ongoing management of these areas on the property will require further allocations of water so that the cycles of wetting and drying that wetlands need can be maintained. The project has demonstrated, however, the amazing ability of nature to recover from stressed conditions into vibrant, biological 'hotspots', as well as the expertise that is available to assist woolgrowers should they want to attempt something similar on their properties.





11 September 2003 (prior to flooding).

This series of photographs shows the changes that occurred in one part of the Black box depression. You can see the grasses being flooded out, allowing plants such as Nardoo and Spike-sedge to establish. Also, notice the new growth on the trees, and the flowering Lignum.



7 October 2003 (about 2 weeks after initial flooding).

Further information about this project can be gained from the NSW Murray Wetlands Working Group, tel: (02) 6043 0124 or www.mwwg.org.au or from Australian Wool Innovation, tel: (02) 9299 5155 or www.wool.com.au

This case study was prepared by Siwan Lovett. Photos NSW Murray Wetlands Working Group.



7 January 2004 (about 16 weeks after initial flooding).



Section L

Is my riparian land in good condition, what is the trend over time?



Purpose

To assess the condition of riparian areas on-farm so that appropriate strategies can be developed to maintain or rehabilitate them, and the effects of changed management can be monitored over time.



Is my riparian land in good condition, what is the trend over time?

Principles

Riparian areas that are in good ecological condition can perform many vital functions and provide a wide range of environmental services that support wool production and maintain the integrity of the wool industry's natural resource base. To help woolgrowers decide what are the priorities for management of the streams or creeks and associated riparian areas on their property, some type of condition assessment method is required. This should be able to provide a comparison of areas on-farm and with local areas considered to be in natural condition; it will help to pinpoint problems where management intervention is required. The method should also be suitable for periodic repeats of the assessment of the same area, so that changes can be tracked over time and management fine-tuned if necessary (an adaptive management approach).

Many different assessment methods are available to evaluate the health of riparian areas. The following assessment method (Jansen et al. 2004) has been developed for people with some technical knowledge of riparian area functions and condition; some prior training would be beneficial before using it on-farm. The method has been checked against a range of other indicators of environmental condition and its assessments shown to reflect differences in those indicators. It has proved in testing over several different regions to be robust and repeatable, with low levels on inter-operator variability (after initial training). There are details on the Land, Water & Wool website about training courses being offered and contact numbers for further details.

The RARC method described in this section was developed by Amy Jansen, Alistar Robertson, Leigh Thomson and Andrea Wilson, Charles Sturt University. It is also available as a stand alone *River and Riparian Technical Update No. 4A* from Land & Water Australia. See the www.rivers.gov.au website.



Photo Amy Jansen.



This Rapid Appraisal of Riparian Condition (RARC) index uses five important characteristics of riparian land, and indicators by which their condition can be measured. Table 1 shows the relationship between the functions of riparian areas, the components of the riparian area that performs those functions, and how these are measured in the RARC.

Table 1. Summary table showing the relationships between functions, components and indicators assessed in the Rapid Appraisal of Riparian Condition index.

Functions of the riparian zone at different levels of organisation	Components of the riparian ecosystem that perform those functions	Indicators of the functions used in the RARC
Physical:		
Reduction of erosion of banks	Roots, ground cover	Vegetation cover*
Sediment trapping	Roots, fallen logs, ground cover	Canopy cover, fallen logs, ground cover vegetation, leaf litter cover
Controlling stream microclimate/ discharge/water temperatures	Riparian forest	Canopy cover
Filtering of nutrients from upslope	Vegetation, leaf litter	Ground cover vegetation, leaf litter cover
Community:		
Provision of organic matter to aquatic food chains	Vegetation	Vegetation cover*, leaf litter cover
Retention of seeds, bulbs, stems and other sources of natural plant regeneration	Fallen logs, leaf litter	Fallen logs, leaf litter cover
Maintenance of plant diversity	Regeneration of dominant species, presence of important species, dominance of natives versus exotics	Native canopy and shrub regeneration, grazing damage to regeneration, reeds, native vegetation cover*
Provision of habitat for aquatic and terrestrial fauna	Fallen logs, leaf litter, standing dead trees/hollows, riparian forest, habitat complexity	Fallen logs, leaf litter cover, standing dead trees, vegetation cover*, number of vegetation layers
Landscape:		
Provision of biological connections in the landscape	Riparian forest (cover, width, connectedness)	Vegetation cover*, width of riparian vegetation, longitudinal continuity of riparian vegetation
Provision of refuge in droughts	Riparian forest	Vegetation cover*

* Vegetation cover = canopy, understorey and ground cover



Table 1 can then be distilled into five RARC components, with each having a number of indicators by which it can be measured (scored) visually (see Table 2). In summary they cover:

1. Habitat continuity and extent (HABITAT).
2. Vegetation cover and structural complexity (COVER).
3. Dominance of native versus exotic plants (NATIVES).
4. Standing dead trees, fallen logs and leaf litter (DEBRIS).
5. Special indicative features (FEATURES).

Table 2. Sub-indices and indicators of the Rapid Appraisal of Riparian Condition, the range within which each is scored, the method of scoring for each indicator, and the maximum possible total for each sub-index.

Sub-index	Indicator	Range	Method of scoring	Total
HABITAT				11
	Longitudinal continuity of riparian vegetation (≥ 5 m wide)	0–4	0 = $< 50\%$, 1 = 50–64%, 2 = 65–79%, 3 = 80–94%, 4 = $\geq 95\%$ vegetated bank; with 1/2 point subtracted for each significant discontinuity (≥ 50 m long)	
	Width of riparian vegetation (scored differently for channels $<$ or ≥ 10 m wide)	0–4	<i>Channel ≤ 10 m wide:</i> 0 = VW < 5 m, 1 = VW 5–9 m, 2 = VW 10–29 m, 3 = VW 30–39 m, 4 = VW ≥ 40 m <i>Channel > 10 m wide:</i> 0 = VW/CW < 0.5 , 1 = VW/CW 0.5–0.9, 2 = VW/CW 1–1.9, 3 = VW/CW 2–3.9, 4 = VW/CW ≥ 4 , where CW = channel width and VW = vegetation width	
	Proximity to nearest patch of intact native vegetation > 10 ha	0–3	0 = > 1 km, 1 = 200 m–1 km, 2 = contiguous, 3 = contiguous with patch > 50 ha	
COVER				12
	Canopy (> 5 m tall)	0–3	0 = absent, 1 = 1–30%, 2 = 31–60%, 3 = $> 60\%$ cover	
	Understorey (1–5 m tall)	0–3	0 = absent, 1 = 1–5%, 2 = 6–30%, 3 = $> 30\%$ cover	
	Ground (< 1 m tall)	0–3	0 = absent, 1 = 1–30%, 2 = 31–60%, 3 = $> 60\%$ cover	
	Number of layers	0–3	0 = no vegetation layers to 3 = ground cover, understorey and canopy layers	

dbh = diameter at breast height, $<$ less than, \leq less than or equal to, $>$ greater than, \geq greater than or equal to.

continued over



Sub-index	Indicator	Range	Method of scoring	Total
NATIVES				9
	Canopy (> 5 m tall)	0–3	0 = none, 1 = 1–30%, 2 = 31–60%, 3 = > 60% cover	
	Understorey (1–5 m tall)	0–3	0 = absent, 1 = 1–5%, 2 = 6–30%, 3 = > 30% cover	
	Ground (< 1 m tall)	0–3	0 = none, 1 = 1–30%, 2 = 31–60%, 3 = > 60% cover	
DEBRIS				10
	Leaf litter	0–3	0 = none, 1 = 1–30%, 2 = 31–60%, 3 = > 60% cover	
	Native leaf litter	0–3	0 = none, 1 = 1–30%, 2 = 31–60%, 3 = > 60% cover	
	Standing dead trees (> 20 cm dbh)	0–1	0 = absent, 1 = present	
	Hollow-bearing trees	0–1	0 = absent, 1 = present	
	Fallen logs (> 10 cm diameter)	0–2	0 = none, 1 = small quantities, 2 = abundant	
FEATURES				8
	Native canopy species regeneration (< 1 m tall)	0–2	0 = none, 1 = scattered, 2 = abundant; with 1/2 point subtracted for grazing damage	
	Native understorey regeneration	0–2	0 = none, 1 = scattered, 2 = abundant; with 1/2 point subtracted for grazing damage	
	Large native tussock grasses	0–2	0 = none, 1 = scattered, 2 = abundant	
	Reeds	0–2	0 = none, 1 = scattered, 2 = abundant	

dbh = diameter at breast height, < less than, ≤ less than or equal to, > greater than, ≥ greater than or equal to.



Photo 1. A site in excellent condition on the Edward River (RARC Score = 50; note continuous canopy of native trees, standing dead trees and fallen logs, native shrub understorey, reeds and regeneration of canopy trees).



Photo 2. A site in very poor condition on the Murrumbidgee River (RARC Score = 14; note discontinuous canopy, lack of shrubs, small amounts of leaf litter, lack of native ground cover and reeds, little regeneration of canopy trees).

Photos 1 and 2 show contrasting sites in excellent and very poor condition. Details of the scoring for these sites can be found in the box below.

Example of scoring indicators for the sites shown in Photos 1 and 2 (see Table 2 for indicators and details)

Sub-index	Excellent condition site (Photo 1)	Very poor condition site (Photo 2)
Habitat	4 + 4 + 3 = 11	0 + 0 + 0 = 0
Cover	3 + 3 + 3 + 3 = 12	1 + 0 + 3 + 2 = 6
Natives	3 + 3 + 3 = 9	1 + 0 + 1 = 2
Debris	3 + 3 + 1 + 1 + 2 = 10	1 + 1 + 1 + 1 + 1 = 5
Features	2 + 2 + 2 + 2 = 8	1 + 0 + 0 + 0 = 1
Total	50	14

Applying the RARC: Steps in assessing riparian condition

The Rapid Appraisal of Riparian Condition index can be used for a variety of applications. Examples include determining relationships between riparian condition and management practices, as in the studies mentioned in this Guide, or surveying overall condition within a catchment to determine priorities for future rehabilitation works in the catchment. Whatever the application, care should be taken to clearly define the question to be answered, determine the sampling design and select sites appropriately to answer the question. This may require help from a consultant with experience in experimental design and data analysis. In general, sampling of sites should be *random**, rather than only sampling sites which are easily accessible by road.

* If you were interested in surveying overall catchment condition, you could choose sites randomly by laying a grid over a map of the catchment, locating and numbering all squares which contain a riparian zone, then putting these numbers in a hat and pulling out as many sites as you wish to sample.

A single observer should conduct all assessments, and they should undertake some training beforehand, to ensure consistency of data collection. The observer will need to have some experience in discriminating native and exotic plant species, and may benefit from previous experience in habitat surveys.

All sites should be surveyed at a similar time of year. Use a separate scoring sheet for each site. Allow 20–60 minutes per site, depending on size and accessibility.

1. Determine site size

Site size must be determined according to the size of the management unit of interest. For example, our studies have examined impacts of grazing management on riparian condition, so management units have been individual paddocks. On the Murrumbidgee River, where paddocks are relatively large, a 1 kilometre length of the riparian zone was defined as a 'site', while in Gippsland, where paddocks are much smaller, a 150 metre length was used. Ideally, sites should be at least 200 metres long, with 500 metres being the preferred length where practicable. On larger rivers, only one side of the river is surveyed, while at smaller sites where it is practicable to do so, both sides may be surveyed (provided they are subject to the same management regime).



The transects at each site should ideally traverse the width of the riparian zone. However, this is not always easy to determine in the field. To simplify this, we use a transect length determined by the width of the river channel — 40 metres long for channels less than 10 metres wide, and four times the channel width for larger rivers. A minimum width of 40 metres should be assessed, unless there is a very clear distinction between riparian and non-riparian areas. Where the riparian zone is clearly narrower than 40 metres or four times the channel width (for example, in a gorge), the transect length should be adjusted accordingly. Where the riparian zone is much wider than this (for example, on a lowland floodplain river), four times the channel width should be adequate to represent the riparian zone. Figure 1 illustrates a hypothetical river with the layout of the survey area and the transects indicated.

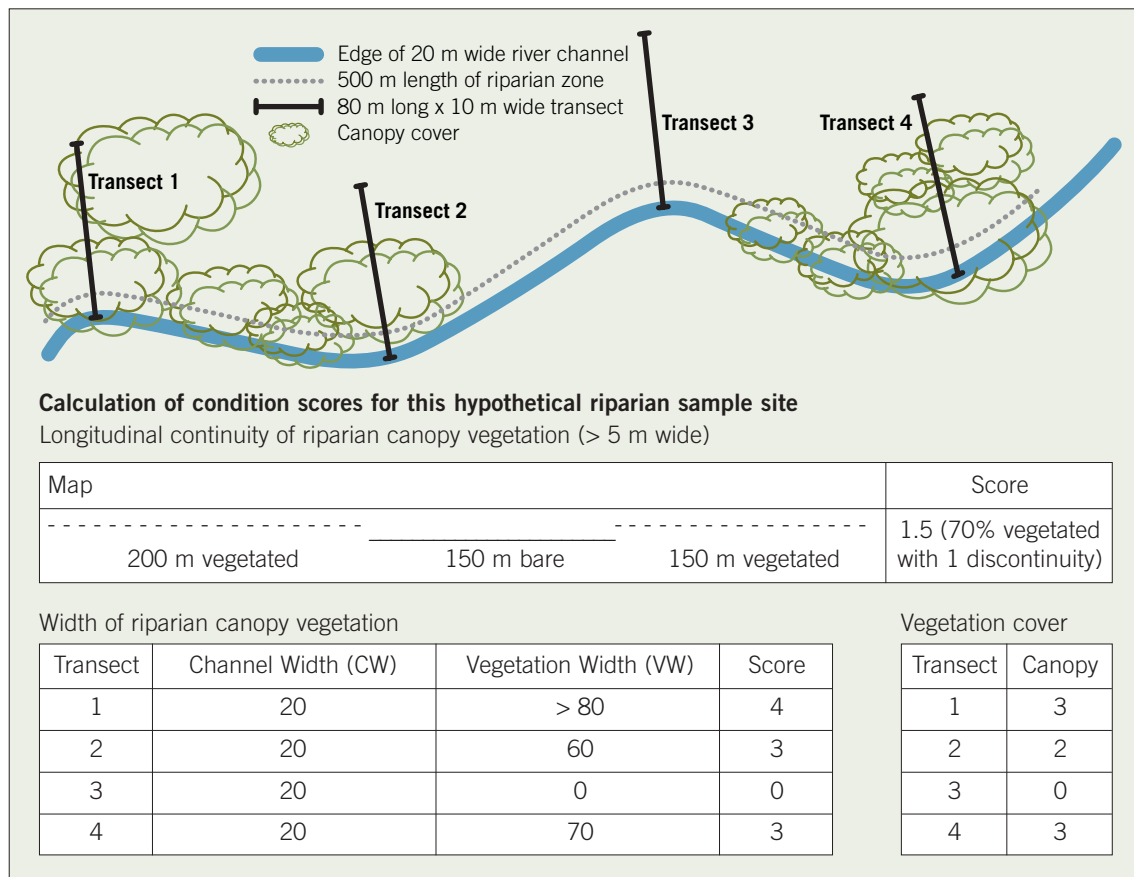
2. Score indicators

A sample scoring sheet can be found on page 167 of this Guide. The complete scoring system is summarised in Table 2. Longitudinal continuity and proximity are given single values for the whole site. All other indicators are scored along four transects (10 metres wide; perpendicular to the direction of river flow) evenly spaced along the bank.

HABITAT

Longitudinal continuity of riparian canopy vegetation: at each site, canopy vegetation along the bank is mapped to show the length and number of any discontinuities (gaps of more than 50 metres) in canopy cover (the bank is considered to be vegetated if the riparian canopy vegetation is at least 5 metres wide). Longitudinal continuity is then scored as follows:

Figure 1. Hypothetical river with length and transects marked. The scoring for the indicators shown in this diagram is shown (see page 167 for full score sheet).



0 = < 50%, 1 = 50–64%, 2 = 65–79%, 3 = 80–94%, 4 = ≥ 95% vegetated bank; with 1/2 point subtracted for each significant discontinuity (> 50m long)

Proximity: an assessment is made of the shortest distance to the nearest patch of at least 10 hectares of relatively intact native vegetation (with an extra point if the area being assessed is within a patch of at least 50 hectares of relatively intact native vegetation). This can be assessed on-site or later using aerial photographs. Proximity is then scored as follows:

0 = > 1 kilometre, 1 = 200 metres–1 kilometre, 2 = contiguous, 3 = contiguous with patch > 50 hectares

A patch of relatively intact native vegetation should have at least the dominant overstorey vegetation remaining. This may not be trees, if the area is a natural grassland or shrubland.

Width of riparian vegetation: The channel width is defined by the area normally lacking any terrestrial or bankside vegetation. The width of the riparian canopy vegetation is the distance from the bank to the first gap of > 50 metres in the canopy vegetation. Channel width (CW) and width of the riparian vegetation (VW) are estimated to the nearest 5 metres in the field. For channels less than 10 metres wide, the vegetation width is converted directly to a score, while for channels more than 10 metres wide, the vegetation width is divided by the channel width to obtain the score as follows:

Channel ≤ 10 metres wide: 0 = VW < 5 metres, 1 = VW 5–9 metres, 2 = VW 10–19 metres, 3 = VW 20–39 metres, 4 = VW ≥ 40 metres

Channel > 10 metres wide: 0 = VW/CW < 0.5, 1 = VW/CW 0.5–0.9, 2 = VW/CW 1–1.9, 3 = VW/CW 2–3.9, 4 = VW/CW ≥ 4

For example, for a channel 12 metres wide and a vegetation width of 30 metres, VW/CW = 2.5, giving a score of 3.

COVER

Vegetation cover within each layer is scored as follows:

Ground cover (lichens, mosses, grasses, herbs, reeds and sedges to 1 metre tall): 0 = none, 1 = 1–30%, 2 = 31–60%, 3 = > 60%

Understorey cover (herbs, reeds, shrubs and saplings 1–5 metre tall): 0 = none, 1 = 1–5%, 2 = 6–30%, 3 = > 30%

(Note that understorey cover is scored on a different scale to the others, since it is normally less dense.)

Canopy cover (trees > 5 metres tall): 0 = none, 1 = 1–30%, 2 = 31–60%, 3 = > 60%



Photo 3. Canopy cover increasing from 1–3 (left to right). Photos Amy Jansen.

The number of layers of vegetation is scored as follows:

0 = no vegetation layers to 3 = ground cover, understorey and canopy layers

Tussocky perennial (long-lived) grasses tend to be native species while annual (short-lived) grasses tend to be exotic species (with a few obvious exceptions such as *Phalaris* which is a perennial exotic species).

NATIVES

Native vegetation cover within each layer is scored as for cover, but excluding the contribution of exotic species (to estimate cover of native species, imagine removing all exotic species and re-estimating vegetation cover with only the native species):

Ground cover (lichens, mosses, grasses, herbs, reeds and sedges to 1 metre tall): 0 = none, 1 = 1–30%, 2 = 31–60%, 3 = > 60%

Understorey cover (herbs, reeds, shrubs and saplings 1–5 metres tall): 0 = none, 1 = 1–5%, 2 = 6–30%, 3 = > 30%

Canopy cover (trees >5 metres tall): 0 = none, 1 = 1–30%, 2 = 31–60%, 3 = > 60%



Photo 4. Exotic annual ground cover (left) versus native perennial tussock ground cover (right). Photos Amy Jansen.

DEBRIS

Cover of leaf litter on the ground, and cover of native leaf litter are scored as follows:

0 = none, 1 = 1–30%, 2 = 31–60%, 3 = > 60% cover



Photo 5. Leaf litter cover increasing from 1–3 (left to right). Photos Amy Jansen.

Standing dead trees > 20 centimetres diameter at breast height, and hollow-bearing trees (look for dead branches and broken-off branch stubs in large trees which may have developed hollows) are scored as follows:

0 = absent, 1 = present



Fallen logs (> 10 centimetres diameter) are scored as follows:

0 = none, 1 = small quantities, 2 = abundant (where small quantities = one or two logs, and abundant = three or more logs)

FEATURES

The abundances of native canopy species regeneration (< 1 metre tall) and native understorey regeneration are scored as follows:

0 = none, 1 = scattered, and 2 = abundant, with 1/2 point subtracted for grazing damage (where scattered = one or two seedlings, and abundant = three or more seedlings; grazing damage is evidence that any of the seedlings have been browsed by grazing animals such as domestic livestock or kangaroos)

The abundances of large native tussock grasses (species such as *Poa labillardieri*) and reeds (species such as *Phragmites*, *Typha* (Cumbungi) and *Carex* which are normally only found on riverbanks or in swampy areas) are scored as follows:

0 = none, 1 = scattered, and 2 = abundant (where scattered = one or two plants, and abundant = three or more plants)



Photo 6. *Poa labillardieri*, an example of a large native tussock grass found in riparian zones. Photo Amy Jansen.

3. Analyse data

The indicators are averaged across transects, then summed into sub-indices. The final index score is then the sum of the sub-indices, with a possible maximum of 50 indicating best condition. To examine the results, it is helpful to categorise the index scores, e.g. less than 25 very poor, 25–30 poor, 30–35 average, 35–40 good and more than 40 excellent. It is also helpful to examine sub-index scores, and to determine which sub-indices contribute most to the final condition score. This can be done by regression of sub-index scores on the total index score.

4. Benchmarking

The scoring system given here has been developed for a generalised riparian area in south-eastern Australia, and may need to be adjusted for particular situations. Ideally, a number of relatively pristine sites in the region should be surveyed to provide a benchmark for the scoring system. The scores for each indicator can then be checked to ensure that all indicators are present, and that the maximum score can be achieved for each indicator. For example, in wet forests with a dense canopy, there may be no large tussock grasses but ferns could be used as an indicator instead. Also, ground cover may never reach > 60% due to shading, so this indicator may need to be adjusted accordingly (for example, the scores given for different levels of ground cover could be rescaled similarly to those given for understorey cover). Benchmarking against relatively pristine sites is not always possible in highly modified catchments. In these situations, we can only make a ‘best guess’, based on local knowledge and historical information, about the appropriate scoring for each indicator in these catchments.

Limitations of the RARC

While the condition index outlined in this Guide has been tested in a number of catchments and situations, it has some limitations:

- The RARC has been designed and tested on creeks and rivers in south-eastern Australia. Its usefulness in other regions is yet to be explored.
- The RARC is designed for riparian zones that are naturally dominated by trees, with at least 60% canopy cover.
- The RARC is intended as an indicator of *current* condition. Thus for restored areas, it will not indicate the potential for recovery of ecosystem function.

Further information

We will be continuing to refine and update the RARC so to get the most recent version check the website www.rivers.gov.au and www.landwaterwool.gov.au. There is an Excel spread sheet available on these websites which includes a copy of a field data sheet for printing, and a data entry sheet. If you enter the data for a site, it will automatically calculate the averages for each transect and the final sub-index and total scores for you. If you have a number of sites, you will need to save a separate copy of the worksheet for each site. There is also a field calculation sheet which you can print on the reverse of the field data sheet if you wish to calculate scores as you go in the field (you may need a calculator to take the averages across the transects).

The method was developed by Amy Jansen, Alistar Robertson, Leigh Thomson and Andrea Wilson. It is also available as a stand alone *River and Riparian Technical Update No. 4A* from Land & Water Australia. See the www.rivers.gov.au website for details.



Sample scoring sheet for the Rapid Appraisal of Riparian Condition

Site: _____ Site number: _____
 Observer: _____ GPS start: _____
 Date: _____ GPS end: _____

Longitudinal continuity of riparian canopy vegetation (> 5 m wide)

Map	Score

0 = < 50%, 1 = 50–64%, 2 = 65–79%, 3 = 80–94%, 4 = ≥ 95% vegetated bank, with 1/2 point subtracted for each significant discontinuity (> 50 m long)

Width of riparian canopy vegetation

Transect	Channel Width (CW)	Vegetation Width (VW)	Score
1			
2			
3			
4			
Average			

Proximity

Score

Nearest patch of native vegetation > 10 ha:
 0 = > 1 km, 1 = 200 m–1 km,
 2 = contiguous, 3 = contiguous with patch > 50 ha

Channel ≤ 10 m wide: 0 = VW < 5 m, 1 = VW 5–9 m, 2 = VW 10–19 m, 3 = VW 20–39 m, 4 = VW ≥ 40 m

Channel > 10 m wide: 0 = VW/CW < 0.5, 1 = VW/CW 0.5–0.9, 2 = VW/CW 1–1.9, 3 = VW/CW 2–3.9, 4 = VW/CW ≥ 4

Vegetation cover: Canopy > 5 m, Understorey 1–5 m, Ground cover < 1 m

Transect	Canopy	Native canopy	Understorey	Native understorey	Ground cover	Native ground cover	Number of layers
1							
2							
3							
4							
Average							

Canopy and ground cover: 0 = none, 1 = 1–30%, 2 = 31–60%, 3 = > 60%

Understorey cover: 0 = none, 1 = 1–5%, 2 = 6–30%, 3 = > 30%

Debris

Transect	Leaf litter	Native leaf litter	Standing dead trees	Hollow-bearing trees	Fallen logs
1					
2					
3					
4					
Average					

Leaf litter and native leaf litter cover: 0 = none, 1 = 1–30%, 2 = 31–60%, 3 = > 60%

Standing dead trees (> 20 cm dbh) and hollow-bearing trees: 0 = absent, 1 = present

Fallen logs (> 10 cm diameter): 0 = none, 1 = small quantities, 2 = abundant

Features

Transect	Native canopy species regeneration	Native understorey regeneration	Large native tussock grasses	Reeds
1				
2				
3				
4				
Average				

Regeneration < 1 m tall: 0 = none, 1 = scattered, 2 = abundant with 1/2 point subtracted for grazing damage.

Reeds and large tussock grasses: 0 = none, 1 = scattered, 2 = abundant



Calculation of scores

Site number: _____

Longitudinal continuity of riparian canopy vegetation

Score	A
-------	---

Width of riparian canopy vegetation

Average	B
---------	---

Proximity

Score	C
-------	---

Vegetation cover

	Canopy	Native canopy	Understorey	Native understorey	Ground cover	Native ground cover	Number of layers
Average	D	H	E	I	F	J	G

Debris

	Leaf litter	Native leaf litter	Standing dead trees	Hollow-bearing trees	Fallen logs
Average	K	L	M	N	O

Features

	Native canopy species regeneration	Native understorey regeneration	Large native tussock grasses	Reeds
Average	P	Q	R	S

Totals

Site #	Habitat	Cover	Natives	Debris	Features	Total
(out of)	11	12	9	10	8	50
	A+B+C	D+E+F+G	H+I+J	K+L+M+N+O	P+Q+R+S	

Appendix A

Resources



Appendices

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Resources

When working with wool growers there are a number of organisations that produce useful information. For river and riparian management the most comprehensive range of fact sheets, technical guidelines and manuals can be accessed at www.rivers.gov.au. This website also has a number of interactive catchment diagrams that show well managed and poorly managed riparian areas in relation to a particular topic. The diagram below relates to water quality and agriculture and can be downloaded from the website for use in PowerPoint presentations.



www.rivers.gov.au

Other useful contacts at the National and State level are listed below:

National contacts

Organisation	Telephone	Website
Australian Legal Information Institute (free access to Australian legal documents)		www.austlii.edu.au
Australian Wool Innovation	1800 070 099	www.wool.com.au
Birds Australia		www.birdsaustralia.com.au
Bureau of Rural Sciences	(02) 6272 4282	www.affa.gov.au/brs/
Department of Agriculture, Fisheries and Forestry	(02) 6272 3983	www.affa.gov.au
Department of the Environment and Heritage	(02) 6274 1111	www.deh.gov.au
Environmental Defenders Office	State contacts provided	www.edo.org.au
Greening Australia	(02) 6281 8585	www.greeningaustralia.org.au
Land & Water Australia	(02) 6263 6000	www.rivers.gov.au www.lwa.gov.au
Land, Water & Wool		www.landwaterwool.gov.au
Murray-Darling Basin Commission	(02) 6279 0100	www.mdbc.gov.au
National Farmers Federation	(02) 6273 3855	www.nff.org.au
National Land and Water Resources Audit	(02) 6263 6000	www.nlwra.gov.au
National Plan for Salinity and Water Quality	State contacts provided	www.napswq.gov.au
National Resource Management	1800 552 008	www.nrm.gov.au
Natural Heritage Trust	1800 065 823	www.nht.gov.au
Waterwatch	State contacts provided	www.waterwatch.org.au
Weeds Australia	(03) 6344 9657	www.weeds.org.au



New South Wales

Department of Infrastructure, Planning and Natural Resources (DIPNR)

Tel: (02) 9762 8044

DIPNR have produced a number of fact sheets covering natural resource management issues, that can be accessed at the website.

Website: www.dipnr.nsw.gov.au

New South Wales Agriculture

Tel: (02) 9372 0100

Website: www.agric.nsw.gov.au

Catchment Management Authorities

- Central West Catchment Management Authority, Tel: (02) 6721 9810, Website: www.cw.cma.nsw.gov.au
- Border Rivers-Gwydir Catchment Management Authority, Tel: (02) 6339 4900, Website: www.brg.cma.nsw.gov.au
- Hunter-Central Rivers Catchment Management Authority, Tel: (02) 4930 1030, Website: www.hcr.cma.nsw.gov.au
- Lachlan Catchment Management Authority, Tel: (02) 6341 1600 and 1800 885 747 (freecall), Website: www.lachlan.cma.nsw.gov.au
- Murray Catchment Management Authority, Tel: (03) 5881 9200, Website: www.murray.cma.nsw.gov.au
- Murrumbidgee Catchment Management Authority, Tel: (02) 6923 0479, Website: www.murrumbidgee.cma.nsw.gov.au
- Namoi Catchment Management Authority, Tel: (02) 6742 9220, Website: www.namoi.cma.nsw.gov.au
- Lower Murray Darling Catchment Management Authority, Tel: (03) 5021 9460, Website: www.lmd.cma.nsw.gov.au

Environment Protection Authority

Tel: 131 555

Website: www.epa.nsw.gov.au

NSW Fisheries

Tel: (02) 9527 8411

www.fisheries.nsw.gov.au

NSW Parks and Wildlife Service

Tel: (02) 9585 6444

Website: www.npws.nsw.gov.au

Greening Australia

Tel: (02) 9560 9144

Website: www.greeningaustralia.org.au

NSW legislation can also be viewed at the website: www.legislation.nsw.gov.au

Streamwatch

Tel: (02) 9228 6111

Website: www.streamwatch.org.au

Atlas of NSW Wildlife (contains sightings of plants and animals, not fish, on a regional basis)

Website: www.nationalparks.nsw.gov.au/wildlifeatlas

New South Wales Farmers' Association

Tel: (02) 8251 1700

Information sheets entitled 'Legislation relevant to NSW Landholders' and 'NSW Landholders and Environmental Planning Instruments'.

Website: www.nswfarmers.org.au/policy/conservation/legislation



Queensland

Department of Natural Resources, Mines and Energy (DNRME)

Tel: (07) 3896 3111

DNRME has a number of fact sheets covering natural resources management issues that can be accessed via the website.

Website: www.nrme.qld.gov.au

Department of Primary Industries

Tel: 132 523

Website: www.dpi.qld.gov.au

Regional Natural Resources Management Groups

For more information on regional NRM groups group visit the website: www.regionalnrm.qld.gov.au

- Burnett Mary Regional Group for NRM Inc, Tel: (07) 4132 8333, Website: www.burnettmarynrm.org.au
- Condamine Alliance, Tel: 1800 181 101, Website: www.condaminealliance.com.au
- Fitzroy Basin Association, Tel: (07) 4999 2800, Website: www.fba.org.au
- Natural Resource Management South East Queensland Inc, Tel: (07) 3211 4404, Website: www.nrmseq.com
- Queensland Murray Darling Committee, Tel: (07) 4637 6270, Website: www.qmdc.org.au
- South East Queensland Western Catchments Group, Tel: (07) 3816 9700
- South West Natural Resource Management Group; Tel: (07) 4654 7382.

Environment Protection Agency

Tel: (07) 3227 7111

Website: www.env.qld.gov.au

Greening Australia

Tel: (07) 3902 4444

Website: www.greeningaustralia.org.au

Queensland Landcare and Catchment Management

Regional contacts are provided on the website of those involved in Landcare activities

Website: www.landcareqld.org.au

Waterwatch

Tel: (07) 3896 9625

Website: www.qld.waterwatch.org.au

Environmental Defenders Office

Tel: (07) 4031 4766

Website: www.edo.org.au/edonq.html

Queensland Farmers Federation

QFF has put out Fact Sheets covering the implications of the *Vegetation Management Act 1999*, and it can be accessed via the website.

Website www.qff.org.au/Policies/Environment

Agforce

Tel: (07) 3236 3100

Website: www.agforceqld.org.au



South Australia

Department of Water, Land and Biodiversity Conservation (DWLBC)

Tel: (08) 8463 6800

Website: www.dwlbc.sa.gov.au

Department for Environment, Heritage and Aboriginal Affairs

Tel: (08) 8204 9000

Website: www.dehaa.sa.gov.au

Department of Primary Industries and Resources South Australia

Tel: (08) 8226 0222

Website: www.pir.sa.gov.au

Integrated Natural Resources Management Groups

- Northern and Yorke Agricultural District Integrated Natural Resources Management Group, Tel: (08) 8260 1266, Website: www.dwlbc.sa.gov.au/nrm/delivery/plans/yorke.html
- Adelaide and Mount Lofty Ranges Integrated Natural Resources Management Group, Tel: (08) 8303 9712, Website: www.dwlbc.sa.gov.au/nrm/delivery/plans/mtlofty.html
- Eyre Peninsula Integrated Natural Resources Management Group, Tel: (08) 8688 3400, Website: www.dwlbc.sa.gov.au/nrm/delivery/plans/eyre.html
- Kangaroo Island Natural Resources Board, Tel: (08) 8553 4940, Website: www.dwlbc.sa.gov.au/nrm/delivery/plans/ki.html
- Arid Lands (formerly Rangelands) Integrated Natural Resource Management Group, Tel: (08) 8648 5173, Website: www.dwlbc.sa.gov.au/nrm/delivery/plans/arid_lands.html
- SA Murray Darling Basin Integrated Natural Resources Management Group, Tel: (08) 8536 4809, Website: www.dwlbc.sa.gov.au/nrm/delivery/plans/murray.html
- South East Natural Resources Consultative Committee, Tel: (08) 8762 9120, Website: www.dwlbc.sa.gov.au/nrm/delivery/plans/southeast.html

Environment Protection Authority

Tel: (08) 8204 2004

Freecall: (country) 1800 623 445

Website: www.epa.sa.gov.au

Government Information Centre

Tel: (08) 8204 1900

Freecall (country): 1800 182 234

Legislation may be viewed on www.parliament.sa.gov.au

Environmental Defenders Office (SA) Inc

Tel: (08) 8232 7599 for advisory service

Freecall: (country) 1800 337 566

Website: www.edo.org.au

Legal Services Commission of South Australia

'The Law Handbook' contains information on environmental law and can be accessed via the website

Website: www.lawhandbook.sa.gov.au

South Australian Farmers Federation

Tel: (08) 8232 5555

Website: www.saff.com.au



Tasmania

Department of Primary Industries, Water and the Environment (DPIWE)

Tel: (03) 6233 8011

Wetlands and Waterways Works Manual covers works on waterways and methods often undertaken by farmers and community groups. Can be accessed along with other information on river management from the website by clicking on 'water' and then via the A–Z Guide.

Website: www.dpiwe.tas.gov.au

Regional Natural Resources Management Committees

- Cradle Coast NRM Committee, Tel: (03) 6431 6285, Website: www.nrmtas.com.au
- Northern Tasmania NRM Regional Committee, Tel: (03) 6336 5371, Website: www.nrmtas.com.au
- Southern Regional NRM Committee, Tel: (03) 6234 2248, Website: www.nrmtas.com.au

Environmental Defenders Office

Tel: (03) 6223 2770

Website: www.tased.edu.au/tasonline/edo

Parks and Wildlife Service

Tel: (03) 6233 8011

Website: www.parks.tas.gov.au

Tasmanian Conservation Trust

Tel: (03) 6234 3552

Website: www.tct.org.au

Tasmanian Farmers' and Graziers' Association

Tel: (03) 6332 1800

Website: www.tfga.com.au

Victoria

Department of Sustainability and Environment (DSE)

Tel: 136 186

The DSE website has a list of all the legislation administered by the department. Go to 'About Us' and click on 'legislation'. They also have a series of brochures including: *Changes to riparian vegetation* and *Sedimentation*. Go to 'Plants and Animals' and click on publications.

Website: www.dse.vic.gov.au

Department of Primary Industry

Tel: 136 186

The *Notes Information Series* includes information on a number of relevant topics e.g. willow control and declared noxious weeds.

Website: www.dpi.vic.gov.au

Catchment Management Authorities

- Wimmera Catchment Management Authority, Tel: (03) 5382 1544, Website: www.wcma.vic.gov.au
- Glenelg-Hopkins Catchment Management Authority, Tel: (03) 5571 2526, Website: www.glenelg-hopkins.vic.gov.au
- Corangamite Catchment Management Authority, Tel: (03) 5571 2526, Website: www.ccma.vic.gov.au
- Goulburn Broken Catchment Management Authority, Tel: (03) 5822 2288, Website: www.gbcma.vic.gov.au
- Port Philip and Westernport Catchment Management Authority, Tel: (03) 9785 0183, Website: www.pppwca.vic.gov.au
- North East Catchment Management Authority, Tel: (03) 6043 7600, Website: www.necma.vic.gov.au
- North Central Catchment Management Authority, Tel: (03) 5448 7124, Website: www.nccma.vic.gov.au
- West Gippsland Catchment Management Authority, Tel: (03) 5175 7800 and 5662 4554, Website: www.wgcma.vic.gov.au

Victorian legislation can be accessed on

Website: www.dms.dpc.vic.gov.au



Gateway to environment matters: A–Z guide to Victorian and Commonwealth matters

Website: www.environment.vic.gov.au

Environmental Defenders Office

Tel: (03) 9328 4811

Website: www.edo.org.au/edovic/

Victorian Farmers Federation

Tel: 1300 882 833

Website: www.vff.org.au

Western Australia

Department of Environment

Tel: (08) 9278 0300

Website: www.environment.wa.gov.au

Department of Conservation and Land Management

Tel: (08) 9334 0333

Website: www.calm.wa.gov.au

Department of Agriculture WA

Tel: (08) 9368 3333

Website: www.agric.wa.gov.au

Catchment Councils

- Avon Catchment Council, Tel: (08) 9690 2250, Website: www.avonicm.org.au
- Northern Agricultural Catchment's Council, Tel: (08) 9973 1444, Website: www.nacc.com.au
- South Coast Regional Initiative Planning Team, Tel: (08) 9892 8537, Website: www.script.asn.au
- South West Catchments Council, Tel: (08) 9780 6193, Website: www.swcatchmentscouncil.com
- Swan Catchment Council, Tel: (08) 9374 3333, Website: www.swancatchmentcouncil.org

Department of Environmental Protection

Tel: (08) 9222 7000

Website: www.environ.wa.gov.au

Department of Planning and Infrastructure

Tel: (08) 9264 7777

Website: www.dpi.wa.gov.au

Environmental Protection Authority

Tel: (08) 9222 7000

Website: www.epa.wa.gov.au

Commissioner of Soil and Land Conservation

Tel: (08) 9368 3282

Website: www.agric.wa.gov.au

State Law Publisher (for copies of legislation)

Tel: (08) 9321 7688

Website: www.slp.wa.gov.au

Environmental Defender's Office WA Inc

Tel: (08) 9221 3030

They provide legal advice on environmental issues and has a number of useful Fact Sheets

Website: www.edo.org.au/edowa

Statewide NRM Groups: www.nrm.org.au

Pastoralists' and Graziers' Association of WA

Tel: (08) 9478 4599

Website: www.pgaofwa.org.au



Appendix B

Legislation that governs the management of streams, creeks and riparian land





Legislation that governs the management of streams, creeks and riparian land

This section provides a summary of the key pieces of legislation at the Commonwealth, State and Territory level that governs or affects what woolgrowers can do near a stream, creek or other waterbody. This information has been summarised against particular issues, so some of the multi-purpose acts appear more than once. This is intended to be a general guide only, and woolgrowers are encouraged to check with local agencies for specific information about any intended works or changed management in riparian areas.

Definition of watercourse/riparian zone

Content	Legislation	Comment
<p>New South Wales</p> <p>'River' includes any watercourse, whether perennial or intermittent and whether comprising a natural channel or a natural channel artificially improved, and any tributary, branch or other watercourse into or from which a watercourse flows.</p> <p>'Lake' includes a wetland, a lagoon, a saltmarsh and any collection of still water, whether perennial or intermittent and whether natural or artificial.</p> <p>'Waterfront land' means the bed of any river together with any land lying between the bed of the river and a line drawn parallel to and 40 metres inland of, the highest bank of the river (or the shore of a lake).</p>	<p><i>Water Management Act 2000</i></p>	<p>NEW SOUTH WALES</p>
<p>New South Wales</p> <p>In this context, 'waterways' means a river, creek or naturally flowing stream of water, whether flowing regularly or intermittently and includes any lagoon or other body of water that is intermittently subject to tidal influence or that intermittently flows into a river, creek or stream.</p>	<p><i>Fisheries Management Act 1994</i></p>	
<p>Queensland</p> <p>The land comprising the bed and banks of a non-tidal boundary watercourse or lake to be the property of the State. A boundary watercourse (or lake) is one that forms part of the boundary of a land parcel irrespective of the ownership of the parcels.</p>	<p><i>Water Act 2000</i></p>	<p>As the terms 'bed' and 'bank' are difficult to define, there is debate as to the extent of the State's ownership where the adjoining land is freehold. The State's interpretation of the Act is that it applies to all the land between the high banks of the watercourse or lake. Exactly where the high banks occur is also open to interpretation.</p> <p>QUEENSLAND</p>



Content	Legislation	Comment
<p>South Australia</p> <p>A watercourse can be a river, creek other natural watercourse (whether modified or not). It can also include a dam or lake or a channel into which water from a watercourse has been diverted.</p> <p>'Lake' means natural lake, pond, lagoon or spring (whether modified or not).</p> <p>'Wetland' means an area that comprises land that is permanently or periodically inundated with water (whether through a natural or artificial process) where the water may be static or flowing.</p> <p>A natural resource can also be designated as a waterway or wetland or a body of water as a lake by an NRM plan.</p>	<p><i>Natural Resource Management Act 2004</i></p>	SOUTH AUSTRALIA
<p>Tasmania</p> <p>'Riparian tenement' means land that adjoins a watercourse or through which a watercourse runs, or that adjoins a lake or on which a lake is situated.</p> <p>'Watercourse' means a river, creek or other natural stream of water (whether modified or not) flowing in a defined channel, or between banks, notwithstanding that the flow may be intermittent or seasonal or the banks not clearly or sharply defined, and includes dams, lakes, channels and floodplains.</p> <p>This does not include drains, or drainage depressions used to relieve land of excess water in times of major precipitation.</p>	<p><i>Water Management Act 1999</i></p>	TASMANIA
<p>Victoria</p> <p>A waterway includes a river, creek, stream or a watercourse and a water channel where water regularly flows, whether or not the flow is continuous.</p>	<p><i>The Water Act 1989</i></p>	VICTORIA
<p>Victoria</p> <p>'Waters' includes any reservoir, tanks, billabong, anabranch, canal, spring, swamp, natural or artificial channel, lake, lagoon, waterway, dam, tidal water, coastal water or groundwater.</p>	<p><i>Environment Protection Act 1970</i></p>	
<p>Victoria</p> <p>Riparian land is defined as the area of land that adjoins, regularly influences or is influenced by, a river.</p> <p>Past administrative definition of riparian land is the land within some fixed width (generally between 20 and 60 metres) running alongside specific rivers). Under the Strategy, widths will be determined at the local level to reflect the ecological functions of that particular riparian land.</p>	<p><i>Victorian River Health Strategy 2002</i></p>	
<p>Western Australia</p> <p>'Watercourse' means:</p> <ul style="list-style-type: none"> any river, creek, stream or brook in which water flows (regularly or intermittently); any collection of water (including a reservoir); and any place where water flows that is prescribed by local by-laws to be a watercourse. <p>The definition includes the bed and banks of the above whether natural or artificially improved or altered.</p>	<p><i>Rights in Water and Irrigation 1914</i></p>	WESTERN AUSTRALIA

Duty of care

Content	Legislation	Comment
<p>Queensland</p> <p>The Act imposes a general duty of care on all persons requiring them to take all reasonable care to prevent or minimise likely environmental harm.</p>	<p><i>Environment Protection Act 1994</i></p>	QUEENSLAND
<p>Queensland</p> <p>The purpose of the Act is the preservation of the natural values of rivers that have all, or nearly all of their natural values intact. The Act regulates activities which could impact on declared rivers. It affects activities regulated by other Acts, for example development applications for the material change of use of premises for agricultural activities and operational work under the <i>Integrated Planning Act 1997</i> as well as activities regulated by the <i>Environment Protection Act 1994</i> (see above).</p>	<p><i>Wild Rivers Act 2005</i></p>	
<p>South Australia</p> <p>The Act places a General Environmental Duty on individuals not to harm the environment and imposes severe penalties for causing serious environmental harm either intentionally or unintentionally. See also 'Water Quality Issues'.</p>	<p><i>Environment Protection Act 1993</i></p>	SOUTH AUSTRALIA
<p>South Australia</p> <p>The owner of land has a statutory duty to employ land management practices that will not result in unreasonable degradation or risk unreasonable degradation of land.</p> <p>It is the duty of the owner and occupier of land on which a watercourse is situated, or that adjoins a watercourse, to take reasonable steps to prevent damage to the bed and banks of that watercourse and to prevent contamination of the waterway. Failure to maintain a watercourse in good condition may result in penalties.</p>	<p><i>Natural Resources Management Act 2004</i></p>	
<p>Tasmania</p> <p>Recent amendments to the Act place a general environmental duty on everyone to take reasonable steps to prevent environmental harm.</p>	<p><i>Environmental Management and Pollution Control Act 1994</i></p>	TASMANIA
<p>Tasmania</p> <p>In taking water as provided by this Act, it is the duty of the owner and occupier of land on which a watercourse or lake is situated, or that adjoins a watercourse or lake, and any other person permitted to take water on or from that land, to take reasonable steps to prevent damage to the bed and banks of the watercourse or the bed, banks or shores of the lake and to the exosystems that depend on the watercourse or lake.</p>	<p><i>Water Management Act 1999</i></p>	
<p>Tasmania</p> <p>The protection of vulnerable land is regarded as a duty of care. Vulnerable land includes land that is within a streamside reserve and the Forest Practices Code prescribes the following buffer widths:</p> <p>Class 1 river: 40 metres either side of stream channel Class 2 stream: 30 metres either side of stream channel Class 3 stream: 20 metres either side of stream channel Class 4 stream: 10 metres either side of stream channel</p>	<p><i>Forest Practices Act 1985</i></p>	



Content	Legislation	Comment
<p>Victoria</p> <p>Under this Act, Catchment Management Authorities (CMA) are responsible for developing regional catchment strategies that set out how the catchment in the region is to be managed.</p> <p>The Act sets out the general duty of land owners which includes:</p> <ul style="list-style-type: none"> • to avoid causing land degradation; • to conserve soil; • to protect water resources; • to eradicate and prevent the spread of regionally prohibited weeds; and • to prevent the spread of, and as far as possible eradicate, established pest animals. 	<p><i>Catchment and Land Protection Act 1994</i></p>	<p>Where a landowner is not complying with the Act, a CMA may issue a land management notice requiring certain activities to be undertaken. If negotiations are not successful and the landowner fails to comply with a notice, the landowner may be penalised.</p>
<p>Victoria</p> <p>Catchment Management Authorities are the caretakers of river health, responsible for regional and catchment planning and coordination, and waterway, floodplain, salinity and water quality management.</p>		<p><i>Securing our Water Future Together</i>, Victorian Government White Paper, published by the Victorian Department of Sustainability and Environment, June 2004.</p>

Access to water, riparian rights

Content	Legislation	Comment
<p>New South Wales</p> <p>The Act specifies:</p> <ul style="list-style-type: none"> • that water must be provided for the fundamental health of a water source or dependent ecosystems as a first priority; • secure property rights including the framework for trading rights and compensation for change; • licensing of water users; and • a planning process with locally representative water management committees and community input. <p>Water Sharing Plans set out the rules for water management on a river valley basis.</p> <p>Water can be taken for domestic consumptive use and for stock without a licence.</p>	<p><i>Water Management Act 2000</i> and <i>Water Management Amendment Bill 2003</i></p>	<p>The Department of Infrastructure, Planning and Natural Resources has developed a series of publications on how surface and groundwater resources are managed and allocated to users in the State's river valleys. Website: www.dipnr.nsw.gov.au/care/water/</p>
<p>Queensland</p> <p>The Act grants the owner or occupier of lands adjoining non-tidal boundary water course or lake, certain rights over the lands within the watercourse or lake to the water's edge. These include the right of access over the land for the person, family, agents and stock, and the right of grazing for that person's stock.</p> <p>Water allocations are separated from the land and entitlements and are established under a Resource Operations Plan. Allocations can be traded. Licenses specify the conditions under which water may be taken.</p>	<p><i>Water Act 2000</i></p>	

Content	Legislation	Comment	
<p>South Australia</p> <p>The Act controls water entitlements, licensing and permits. Water entitlements are issued in 22 prescribed areas (and other areas where the resource is under stress) of the State and specify the quantity of water that can be taken from surface water, a watercourse or groundwater. Licenses are required to take water from these areas other than for stock and domestic purposes although licenses are required for stock water in some areas.</p>	<p><i>Natural Resources Management Act 2004</i></p>	SOUTH AUSTRALIA	
<p>Tasmania</p> <p>Some of the key elements of the Act are to:</p> <ul style="list-style-type: none"> • guarantee minimum water allocation for the environment; • provide for water allocations (that are tradeable); • issue licences to water users; • provide a charging system; and • enable the community to be involved in the management of the resource. <p>Enforceable <i>Water Management Plans</i> are progressively being drawn up for each catchment. These set out the rules by which water will be managed in that catchment including meeting the needs of the environment. Wetlands are also protected.</p> <p>A licence must be obtained from the Department of Primary Industries, Water and Environment (DPIWE) before water can be taken from a river or stream or stored in a farm dam for commercial purposes. An allocation may be attached to the licence.</p> <p>Rights to water are predominantly for riparian landholders wishing to take water for stock, domestic house and garden purposes.</p>	<p><i>Water Management Act 1999</i></p>	TASMANIA	
<p>Victoria</p> <p>This Act:</p> <ul style="list-style-type: none"> • establishes rights and obligations in relation to water resources; • provides mechanisms for the allocation of water resources; • governs the statutory powers and functions of all water authorities outside the metropolitan area; • and provides for integrated management of the water resource and for environmental and consumer protection. <p>The Victorian water allocation framework is set out in the Strategy and includes providing users with entitlements to water that are explicit, exclusive, enforceable and tradable.</p> <p>A person has the right to take water, free of charge, for domestic and stock use from a waterway that flows through the property or is adjacent to the property.</p>	<p><i>Water Act 1989 and the Victorian River Health Strategy 2000</i></p>	VICTORIA	
<p>Western Australia</p> <p>The Act was amended in 2001 to include major reform in the system of water allocation.</p> <p>The management of water resources is guided by statutory plans made at a regional, sub-regional and local level.</p> <p>It is an offence to take water from a watercourse in a 'proclaimed area', 'irrigation district' or 'prescribed area' unless taken in accordance with a riparian right, public right or licence issued by the Department of Environment (formerly 'Water and Rivers Commission'). Many of the State's major rivers are within one of these areas and details are available from the Department.</p> <p>Water licences and entitlements can be traded.</p> <p>Riparian rights allow water to be taken for domestic use and for watering stock (other than those being raised under intensive conditions) from a waterway or wetland that is on, or contiguous to the property.</p>	<p><i>Rights in Water and Irrigation Act 1914</i></p>	<p>Brochures on the changes to the Act can be accessed on the Water and Rivers Commission website: www.wrc.wa.gov.au/using/law_reform_brochures.htm, or via the Department of Environment website.</p>	WESTERN AUSTRALIA



Activities for which permits are required

Content	Legislation	Comment
<p>New South Wales</p> <p>Approvals are necessary for any water supply work (such as construction of banks or levees that have the effect of diverting water from the water source), drainage work or flood work in or in the vicinity of a river or lake, or within a floodplain.</p> <p>Approvals are also required for a 'controlled activity' proposed in waterfront land.</p> <p>Controlled activities are:</p> <ul style="list-style-type: none"> • the construction of buildings or carrying out of works; • the removal of material or vegetation; • the deposition of material on land; or • any activity that affects the quantity or flow of water. 	<p><i>Water Management Act 2000</i></p>	<p>NEW SOUTH WALES</p>
<p>New South Wales</p> <p>A permit is required for any dredging or reclamation work and fishways must be provided in the construction, alteration or modification of a dam, weir or reservoir on a waterway.</p> <p>See also 'Definition of watercourse/riparian zone.'</p>	<p><i>Fisheries Management Act 1994</i></p>	
<p>Queensland</p> <p>Examples of developments for which a permit application has to be made are:</p> <ul style="list-style-type: none"> • artesian bore/subartesian bore; • watercourse pump; • weir, barrage, dam or excavation in a watercourse; • gravity diversion; • referable dam; • stream diversion; and • removal of sand and gravel. <p>Installation of watercourse pumps or gravity diversions used to supply stock or domestic water are self assessable but must be completed in accordance with the relevant development code.</p>	<p><i>Water Act 2000 and Integrated Planning Act 1997</i></p>	<p>Recent changes to the <i>Water Act 2000</i> mean that most water related developments now require assessment and approval by local authorities under the <i>Integrated Planning Act 1997</i>. Many of these developments will also require a Water Licence under the <i>Water Act</i>.</p> <p>QUEENSLAND</p>
<p>Queensland</p> <p>A permit is generally required for clearing riparian vegetation apart from essential management (e.g. maintaining a fire break), routine management in areas other than those protected by the Act (e.g. construction of a necessary fence) or regrowth.</p> <p>See also 'Vegetation Management Near Watercourses'</p>	<p><i>Integrated Planning Act 1997</i></p>	
<p>Queensland</p> <p>The Act controls a wide range of activities (called environmentally relevant activities) by way of licence or permit, many of which could impact on riparian lands, for example releasing a contaminant into a waterway.</p> <p>See also 'Water Quality Issues'</p>	<p><i>Environment Protection Act 1994</i></p>	

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Legislation

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South Australia

Some of the activities that may require a permit are:

- the erection, construction or enlargement of a dam, wall or other structure that will collect or divert water flowing in a watercourse.

All the other activities come under:

A person must not undertake any of the following activities contrary to an NRM plan applying in the region in which the activity is undertaken:

- depositing or placing an object or solid material on the floodplain of a watercourse or near the bank or shore of a lake to control flooding from the watercourse or lake;
- excavating or removing rock, sand or soil from a watercourse or lake or the floodplain of a watercourse or an area near to the banks of a lake so as to damage, or create the likelihood of damage to, the banks of the lake.

Natural Resources Management Act 2004

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South Australia

A person wanting to clear native vegetation must apply to the Native Vegetation Council for permission unless he/she is engaged in certain activities e.g. clearing for the construction of buildings or a dam or clearing to prevent or reduce the risk of injury to people or damage to property, including fire.

The Council will rarely consent to the clearing of wetlands.

Native Vegetation Act 1991

Woolgrowers need to consult the legislation and/or the Department of the Environment, Heritage, and Aboriginal Affairs before commencing any clearing

Tasmania

Local government regulates land use and development through planning schemes and a planning permit system. Examples of uses and developments that may require a planning permit include works in wetlands and waterways that involve:

- stormwater and erosion control;
- clearing of debris and vegetation from streams and banks;
- development of drainage and river works schemes (not routine maintenance);
- stream channel modification;
- structures such as pump stations;
- road and pipeline crossings;
- off-stream storages less than 1 megalitre; and
- works ancillary to dam construction (not dams themselves).

Land Use Planning and Approvals Act 1993

Planning schemes must be prepared in accordance with the *State Policy on Water Quality Management 1997*. These requirements are achieved in some recent planning schemes through incorporation of a *Wetlands and Waterway Schedule*

TASMANIA

Tasmania

Building a dam, weir or levee across a natural watercourse or if it will hold more than 1 megalitre of water, requires approval from the Water Resources Branch of the Department of Primary Industries, Water and the Environment (DPWIE).

Water Management Act 1999

Where a dam is placed across a river, the Inland Fisheries Commission may require a 'fish-pass' to be constructed if fish passage will be impeded.



Content	Legislation	Comment
<p>Victoria</p> <p>Examples of activities for which a planning permit is required:</p> <ul style="list-style-type: none"> • sub-dividing land; • clearing native vegetation; and • changing the use of a property. <p>However, even minor matters may need a planning permit and woolgrowers need to check with their local council before proceeding with a development or activity that might have an effect on the riparian zone</p>	<i>Planning and Environment Act 1987</i>	VICTORIA
<p>Western Australia</p> <p>Permits are needed for the construction or alteration of a dam on private land in irrigation districts, proclaimed or prescribed areas and on Crown land. The Department requires the adoption of good resource management practices such as causing minimal impact on riparian vegetation, allowing minimal flows to bypass the dam and making every effort to ensure that sediments do not enter the watercourse as a result of the construction.</p>	<i>Rights in Water and Irrigation Act 1914</i>	WESTERN AUSTRALIA
<p>Western Australia</p> <p>Clearing of native vegetation requires a permit unless clearing is for an exempt purpose. When assessing application consideration will be given to the impact of clearing on biodiversity, water and soil resources, salinity and other environmental issues. Some activities, for example, day-to-day activities involving clearing and situations where other statutory approvals have been granted such as works approval, do not require a permit.</p>	<i>Environment Protection Act 1986</i>	

Works in or adjacent to a watercourse

Content	Legislation	Comments
<p>Queensland</p> <p>Specifically, this Act provides for protection against disturbances that may adversely affect the stability of the bed or banks of streams or lakes, for example, the clearing of native vegetation, excavation, and placement of fill. It also relates to activities outside of these features that may adversely impact on water quality, for example, the dumping of waste that may wash into a watercourse or lake and degrade water quality or cause and obstruction to flow. Protection of these areas is managed through a permitting system that has powers to issue 'stop work' notices.</p>	<i>Water Act 2000</i>	QUEENSLAND
<p>Queensland</p> <p>This gives River Trusts the power to impose a notice on woolgrowers or other persons to prevent them from undertaking work or activity that may be detrimental to the condition of the stream or may adversely affect the works of the River Trust.</p>	<i>River Improvement Trust 1940</i>	
<p>Tasmania</p> <p>Local by-laws may have control over the execution of works in wetlands, waterways or riparian zones. There may be a requirement that the works be undertaken by a qualified person and in the manner specified by the Council.</p>	<i>Local Government Act 1993</i>	Wetlands and Waterways Works Manual can be downloaded from the DPIWE website
<p>Tasmania</p> <p>This Act aims to maintain fish passage and protect fish habitat. A person may not place or use in any inland waters any equipment or object likely to hinder or obstruct free passage of fish in that water, without the consent of the Director of Inland Fisheries.</p>	<i>Inland Fisheries Act 1995</i>	

Content	Legislation	Comment
<p>Tasmania</p> <p>A license is required to construct a dam or levee. If banks are lines with rock and that rock raises the height of the streambank above floodplain level this could be regarded as a levee.</p>	<i>Water Management Act 1999</i>	TASMANIA
<p>Tasmania</p> <p>Local government can require a development application to be lodged for a range of activities, including installing structures and the removal of woody weeds such as willows.</p>	<i>Local Government Planning Schemes</i>	
<p>Victoria</p> <p>Catchment Management Authorities may make recommendations, based on their regional catchment management strategies, to a planning authority and parts of the strategy may be incorporated in a State environment protection policy. This may include riparian zone management.</p>	<i>Catchment and Land Protection Act 1994</i>	VICTORIA
<p>Western Australia</p> <p>A person needs approval from the Department of Environment (or authority under another Act) before interfering with a water course (including wetlands):</p> <ul style="list-style-type: none"> • on land within a proclaimed area; • on land prescribed by local by-laws to be subject to this provision; and • on Crown land outside a proclaimed area. <p>'Interfering' would include such activities as undertaking earthworks, dumping material in a watercourse, damaging vegetation or destabilising the banks of watercourse.</p>	<i>Rights in Water and Irrigation Act 1914</i>	WESTERN AUSTRALIA

Water quality issues

Content	Legislation	Comments
<p>New South Wales</p> <p>This is the central piece of environment protection legislation in NSW. The Act provides a single licensing system to regulate activities that generate air, water or noise pollution and enables the government to make 'protection of the environment' policies through which it can set environmental goals, standards and guidelines. Offences under the Act include to:</p> <ul style="list-style-type: none"> • cause any substance to spill or leak in a way that harms or is likely to harm environment; • pollute waters or permit waters to be polluted; • dispose of waste in a way that harms, or is likely to harm the environment • transport waste to an unauthorised disposal site; and • the unauthorised use of land as a waste facility. 	<i>Protection of the Environment Operations Act 1997</i>	NEW SOUTH WALES
<p>New South Wales</p> <p>This Act aims to protect human health, the environment, property and trade in relation to the use of pesticides. It is an offence to pollute waters — e.g. by runoff or drift. Polluting waters is identified very widely to include that of placing of any matter in a position such that it ends up in any natural or man-made waters. Recirculation of tailwater is a condition of surface water irrigation licences in the State.</p>	<i>Pesticides Act 1999</i>	There are new mandatory requirements for recording information about pesticide applications. From September 2005, pesticide users will also have to undergo mandatory pesticide training.



Content	Legislation	Comment
<p>Queensland</p> <p>In assessing an application to undertake an activity, the Department of Natural Resources, Mining and Energy will consider the possible effects of the activity on water quality.</p>	<i>Water Act 2000</i>	QUEENSLAND
<p>Queensland</p> <p>The following substances must not be deposited or released into a roadside gutter, stormwater drain or a water; or in a place where it could reasonably be expected to move or be washed into a roadside gutter, stormwater drain or a water:</p> <ul style="list-style-type: none"> • rubbish; • scrap metal, motor vehicle parts, motor vehicle bodies or tyres; • building waste; • sawdust; • solid or liquid waste from an on-site domestic waste water treatment system; • cement or concrete; • a degreasing agent, paint, varnish or paint thinner; • any manufactured product, or any by-product or waste from a manufacturing process, that has a pH less than 6 or greater than 9; • an insecticide, herbicide, fungicide or other biocide; or • oil. <p>Sand, silt or mud should not be deposited in a roadside gutter, stormwater drain or water</p>	<i>Environment Protection Act 1994, Environmental Protection (Water) Policy 1997 and Environmental Code of Practice for Agriculture</i>	
<p>Queensland</p> <p>The Act requires pesticide users to follow label direction, to dispose of pesticides and pesticide containers in a way that does not harm people, property or the environment. There are particular responsibilities if using aerial sprays. The Queensland Code of Practice for Agriculture includes a list of sensitive place (includes waterways) and how nearby agricultural activities should be managed.</p>	<i>Chemical Usage (Agriculture and Veterinary) Control Act 1988</i>	
<p>South Australia</p> <p>The policy establishes water quality objectives and sets down general obligations, such as the obligation to avoid discharges to water, to not contravene the water quality criteria set down in the policy and to not cause environmental harm.</p> <p>A person must not, by discharging or depositing a pollutant into any waters, cause any of the following:</p> <ul style="list-style-type: none"> • loss of seagrass or other native aquatic vegetation; • a reduction in numbers of any native species of aquatic animal or insect; • an increase in numbers of any non-native species of aquatic animal or insect; • a reduction in numbers of aquatic organisms necessary to the health of aquatic organism; • an increase in algal or aquatic plant growth; • the water to become toxic to vegetation on land; • the water to become harmful or offensive to humans, livestock or native animal; or • an increase in turbidity or sediment levels. <p>Certain listed pollutants must not be discharged into any waters or onto land from which it is reasonably likely to enter any water.</p>	<i>Environment Protection (Water Quality) Policy 2003</i> is one of a number of policies that come under the <i>Environment Protection Act 1993</i>	SOUTH AUSTRALIA

Content	Legislation	Comment
<p>South Australia</p> <p>Releasing wastewater from drilling into a watercourse (even if it is temporarily dry), a wetland channel or well or close to the bank of a watercourse may be causing environmental harm, which is an offence under the Act.</p>	EPA Guidelines- Pollutant management for water well drilling (reissued September 2003) are linked to the <i>Environment Protection (Water Quality) Policy 2003</i>	The Guidelines lists a number of mitigation measures that could be adopted and also deals with exemptions and permits to discharge.
<p>South Australia</p> <p>Failure to maintain a watercourse in good condition may result in penalties. It is the duty of the landholder to prevent contamination of the waterway by soil sediments, nutrients such as phosphorus and nitrogen, plant material such as leaf litter, animal manure and chemicals, fertilisers and pesticides.</p>	<i>Water Resources Act 1997</i>	Fact Sheet 27, <i>Watercourses Section 9 Permits</i> — <i>Water Resources Act 1997</i> is available on the DWLBC website and it outlines obligations in relation to protecting the riparian zone.
<p>Tasmania</p> <p>This Act is the central piece of legislation that deals with pollution. Its aim is to prevent, reduce and undo harm to the environment. Causing serious environmental harm is an offence and involves having an adverse effect on the health or safety of human beings that is of a high impact or on a wide scale, or on the environment that is of a high impact or on a wide scale or resulting in actual loss of, or property damage exceeding a threshold amount. Local government authorities are responsible for environmental regulation of smaller scale activities.</p>	<i>Environmental Management and Pollution Control Act 1994</i>	
<p>Tasmania</p> <p>The Policy assigns protected environmental values to each water body and appropriate water quality objectives can be set according to this designation. Codes of Practice for activities, such as minimising the impact of runoff from agricultural land, that can affect riparian areas are developed under the Policy. The implementation of the Code of Practice could be used as a means of showing compliance with the regulation of <i>Environmental Management and Pollution Control Act 1994</i></p>	<i>State Policy on Water Quality Management</i>	
<p>Tasmania</p> <p>The Act prohibits the flow into inland waters containing fish, any substance likely to harm fish or spawning grounds or food — this includes sediment.</p>	<i>Inland Fisheries Act 1995</i>	

SOUTH AUSTRALIA

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Content	Legislation	Comment
<p>Victoria</p> <p>A person is not allowed to pollute waters so that the condition of the water is changed to make it:</p> <ul style="list-style-type: none"> • noxious or poisonous; • harmful to human beings; • harmful to animals, birds, wildlife, fish or other aquatic life; • harmful to plant or other vegetation; or • detrimental to any beneficial use made of those waters. <p>It is an offence to cause or permit a pollutant to be placed in any waters or in a place where it may gain access to waters. It is also an offence to cause or permit waste to be placed in a position from which it could reasonably be expected to gain access to a waterway or the dry bed of a waterway.</p>	<p><i>Environment Protection Act 1970</i></p>	<p>The <i>State Environment Protection Policy (Waters of Victoria) 1988</i> (SEPP) is the statewide statutory policy framework for water quality protection in Victoria. It has been updated to take account of the recent regional catchment management arrangements.</p>
<p>Western Australia</p> <p>Two levels of offences are created by the Act.</p> <ul style="list-style-type: none"> • Material environmental harm is harm that is not trivial or negligible or results in loss or damages that exceed \$20,000; • Serious environmental harm refers to high impact, irreversible damage in an area of significant conservation value or where the cost of damage or losses exceeds \$100,000 — such as demolishing a wetland. <p>Both are subject to heavy penalties with the more serious offence being treated like a pollution offence.</p>	<p><i>Environmental Protection Act 1986</i></p>	<p>When the <i>State Water Quality Management Strategy</i> is implemented, environmental values for water quality will be assigned to each significant water resource. These values will be linked to appropriate water quality objectives and benchmarks and will be incorporated into policies and conditions for activities regulated by the <i>Environment Protection Act</i>.</p>
<p>Western Australia</p> <p>Waste must be at least 100 metres from a waterbody and all waste must be retained on site and not allowed to enter a waterbody.</p>	<p>Environmental Protection (Rural Landfill) Regulation</p>	
<p>Western Australia</p> <p>The Act is concerned with controlling land degradation in agricultural and pastoral land and correcting any such problems.</p> <p>Land degradation includes soil erosion, salinity, eutrophication (deterioration of water quality resulting from the accumulation of nutrients), flooding, and detriment to present or future use of land due to the removal or deterioration of natural or introduced vegetation.</p> <p>Failure to comply with the Act may result in a Soil Conservation Order being issued.</p> <p>Proposals to build drains or discharge saline water directly into a watercourse or a wetland are subject to a notification process.</p>	<p><i>Soil and Land Conservation Act 1945</i></p>	

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In-stream health and wildlife

Content	Legislation	Comment
<p>Commonwealth</p> <p>This Act is the main Commonwealth environmental law. It protects matters of national environmental significance and Commonwealth land. It also covers actions taken by the Commonwealth.</p> <p>There are seven matters of national environmental significance that are triggers for Commonwealth assessment and approval. The ones of greatest relevance to rural landholders are:</p> <ul style="list-style-type: none"> • World Heritage properties; • National Heritage places; • Ramsar wetlands of international importance; • Nationally listed threatened species and communities; and listed migratory species. 	<p><i>Environment Protection and Biodiversity Act 1999</i></p>	<p>The National Farmers' Federation has produced Fact Sheets on the Act and also has an Information Officer who will provide assistance. E-mail: vhodges@nff.org.au</p> <p>Website: http://www.nff.org.au/pages/EPBC.html</p> <p>The Department of the Environment and Heritage has a number of Fact Sheets available on line as well as a page showing relevant links to make is to work with the Act. http://www.deh.gov.au/epbc/industrylinks/farming/index.html</p>
<p>New South Wales</p> <p>A licence is required to carry out activities that may have significant effect on threatened species, populations, ecological communities or their habitats. A licence is not generally required to carry out routine agricultural activities.</p>	<p><i>Threatened Species Conservation Act 1995</i></p>	
<p>New South Wales</p> <p>Of particular relevance to farmers is the part dealing with the conservation of threatened species, populations and ecological communities of fish. The Act includes nominations and listing of threatened and vulnerable species. See also 'Activities for which permits are required'</p>	<p><i>Fisheries Management Act 1994</i></p>	
<p>Queensland</p> <p>The Act gives full protection to:</p> <ul style="list-style-type: none"> • endangered regional ecosystems; • declared areas of high nature conservation value; and • declared areas vulnerable to land degradation (e.g. soil erosion, salinity, stream bank instability etc). <p>The Act also requires the protection of 30% of remnant vegetation across a bioregion.</p> <p>See also 'Vegetation management near watercourses'</p>	<p><i>Vegetation Management Act 1999</i></p>	



Content	Legislation	Comment
<p>Queensland</p> <p>The aim of this Act is the conservation and management of the State's native flora and wildlife. Under this Act, areas can be declared 'protected' with management of these subject to approval. The Queensland Environment Protection Agency administers this Act. Where woolgrowers adjoin declared parts of reserves or other protected areas, property plans and management practices should take account of the need to maintain the ecological health of these areas.</p>	<p><i>Nature Conservation Act 1992</i></p>	<p>QUEENSLAND</p>
<p>Tasmania</p> <p>In Tasmania there are 14 species of freshwater plants, over 30 riparian plant species and 76 species of freshwater fauna listed under the Act. The Minister can also make an interim protection order to conserve the habitat, or part of the habitat of a listed species on both private or crown land. The Act makes it an offence to knowingly take, destroy, injure, trade, keep or disturb listed flors or fauna without a permit</p>	<p><i>Threatened Species Act 1995</i></p>	<p>TASMANIA</p> <p>The presence of threatened flora or fauna can be determined by contacting the Threatened Species Unit, Parks and Wildlife Service or by electronically accessing GT Spot (www.gisparks.tas.gov.au)</p>
<p>Tasmania</p> <p>The Act enables the creation of fauna reserves within inland waters and the placement of restrictions upon activities within such reserves.</p>	<p><i>Inland Fisheries Act 1995</i></p>	<p>For further information contact the Inland Fisheries Service</p>
<p>Tasmania</p> <p>Any person taking water is required to take reasonable steps to prevent damage to the relevant water resource or associated ecosystems. A person may be directed to rectify any damage caused. The Act also protects wetlands.</p>	<p><i>Water Management Act 1999</i></p>	
<p>Tasmania</p> <p>This Act makes provision for the creation of conservation covenants for the protection of biodiversity on private land. Covenanted land is not subject to land tax and landowners may be eligible for certain compensation payments when they enter the covenant.</p>	<p><i>National Parks and Wildlife Act 1970</i></p>	
<p>Victoria</p> <p>The Act is concerned with the conservation of Victoria's communities of flora and fauna and the management of potentially threatening processes. The degradation of native riparian vegetation is listed as a potential threatening process under the Act. The Act also provides a list of threatened species.</p> <p>If an area is considered to be critical to the survival of a particular species it may be the subject of an interim conservation order. A landholder is entitled to compensation for financial loss suffered as a result of the interim conservation order.</p>	<p><i>Flora and Fauna Guarantee Act 1988</i></p>	<p>VICTORIA</p>
<p>Victoria</p> <p>The Act makes it possible for landowners to enter into land management co-operative agreements for the conservation of particular areas on their farm.</p>	<p><i>Conservation, Forests and Lands Act 1987</i></p>	<p>Grants, loans and rate relief may be provided in return for specified conservation land management practices.</p>

Content	Legislation	Comment
<p>Western Australia</p> <p>The 2003 amendments to the Act use the concept of 'environmental harm' to cover acts of unauthorised environmental vandalism that are more than trivial or negligible, but not considered to be pollution. 'Environmental harm' includes the direct or indirect harm to the environment involving removal or destruction of, or damage to:</p> <ul style="list-style-type: none"> • the habitat of native vegetation or indigenous aquatic or terrestrial animals; • alteration of the environment to the detriment or potential detriment of an 'environmental value'; and • alteration to the environment of a prescribed kind. 	<p><i>Environmental Protection Act 1986</i></p>	<p>The 'environmental value' terminology includes the ecosystem health condition and thus gives protection to the environment itself. This will come into effect through Environmental Protection Policies</p>
<p>Western Australia</p> <p>There are two Environment Protection Policies (EPP) directed towards protecting the environmental values of wetlands in the Swan coastal plan and within the south west agricultural zone. These EPPs are legally enforceable and include penalties for an offence. See also 'Water Quality issues'.</p>	<p><i>Environmental Protection Act 1986</i></p>	
<p>Western Australia</p> <p>Under this Act, individual species of plants and animals are protected with the level of protection varying depending on whether the species is rare or endangered. Aquatic species may also be protected by the <i>Fish Resources Management Act 1994</i>. However, ecological communities and their habitats are not protected under this Act.</p>	<p><i>Wildlife Conservation Act 1970</i></p>	<p>This Act will be replaced with a new Act. Submissions on a consultation paper entitled <i>A Biodiversity Conservation Act for Western Australia</i> closed in 2003.</p>

WESTERN AUSTRALIA

Vegetation management near watercourses

Content	Legislation	Comments
<p>New South Wales</p> <p>The Act sets a framework for the:</p> <ul style="list-style-type: none"> • management of native vegetation on a regional basis; • prevention of broadscale clearing unless it improves or maintains environmental outcomes; • protection of high conservation value native vegetation; and • encouragement of revegetation and rehabilitation of land with appropriate native vegetation. <p>The Act provides clear definitions of different classes of native vegetation and what constitutes broadscale clearing. Landholders will also be supported to voluntarily develop individual or group Property Vegetation Plans that will have a 15 year tenure.</p>	<p><i>Native Vegetation Act 2003</i></p>	<p>A set of supporting Regulations is currently being developed and until these come into effect, existing arrangements under the <i>Native Vegetation Conservation Act 1997</i> will remain in place.</p>
<p>New South Wales</p> <p>The authorities engage regional communities in key natural resource management issues facing their catchment. Their duties include funding catchment activities. In 2005, Catchment Management Authorities will have the powers to assess clearing applications and make consent decisions for on-farm activities.</p>	<p><i>Catchment Management Authority Act 2003</i></p>	

NEW SOUTH WALES



Content	Legislation	Comment
<p>New South Wales</p> <p>This Act is the primary piece of land use and planning legislation in NSW. Local environmental plans, development control plans and codes of practice are developed by local government to control land use and planning in the municipality. These may include stipulations regarding riparian zone management.</p>	<p><i>Environmental Planning and Assessment Act 1997</i></p>	
<p>Queensland</p> <p>This is the principal piece of legislation relating to the State's native vegetation on freehold land. Vegetation clearing comes under the category of 'assessable development' under the <i>Integrated Planning Act 1997</i>. A permit is generally required for clearing apart from essential management (e.g. maintaining a fire break), routine management in areas other than those protected by the Act (e.g. construction of a necessary fence) or regrowth. A <i>Property Vegetation Management Plan</i> is required as a part of the tree clearing permit application. The Plan must be consistent with an approved <i>Regional Vegetation Management Plan</i>. Regional codes should also be checked as they determine the extent of riparian vegetation that should be retained.</p> <p>Clearing should not isolate wetlands, lakes or springs or within a specified distance (depending on the region) of the static high water mark of these water bodies.</p> <p>See also 'Works in or adjacent to a watercourse'</p>	<p><i>Vegetation Management Act 1999</i> and <i>Integrated Planning Act 1997</i></p>	<p>In this context, 'regrowth' means vegetation that covers less than 50% of the undisturbed canopy, averaging less than 70% of the undisturbed height and composed of species characteristic of the undisturbed predominant canopy.</p>
<p>Queensland</p> <p>This is the principal legislation for the management of State owned (Crown) lands, including leases, reserves etc. A permit is required from the local Department of Natural Resources Mines and Environment office to undertake clearing within a critical area, which includes riparian land, unless the clearing is for isolated trees as part of routine property maintenance, for example, replacement fence posts.</p>	<p><i>Land Act 1994</i></p>	
<p>South Australia</p> <p>Landowners who have native vegetation growing on their properties may enter into a 'heritage agreement' with the government and agree to manage the land in a certain way.</p> <p>See also 'Duty of care' and 'Activities for which a permit is required'.</p>	<p><i>Native Vegetation Act 1991</i></p>	
<p>Tasmania</p> <p>See page 183 under 'duty of care' for definition of vulnerable land as this also relates to vegetation adjacent to watercourses.</p>	<p><i>Forest Practices Act 1985</i></p>	
<p>Victoria</p> <p>The Victorian Healthy Rivers Strategy establishes the CMAs as the 'caretakers' of riparian land, where their role is to be responsible for the coordination of the required planning and implementation of programs for protection and restoration activities.</p> <p>CMAs now undertake Stream Restoration Plans to provide direction for specific work programs on stream erosion control, in-stream and riparian revegetation and habitat restoration. Contact your local CMA for more details.</p>	<p><i>Victorian River Health Strategy 2000 (VRHS) and Catchment and Land Protection Act 1994</i></p>	<p>A Fact Sheet <i>Managing Riparian Land</i> is available on the DSE website www.dse.vic.gov.au</p>

NEW SOUTH WALES

QUEENSLAND

SOUTH AUSTRALIA

TASMANIA

VICTORIA



Content	Legislation	Comment
<p>Victoria</p> <p>Native Vegetation Retention Controls implemented by local government through the State planning schemes control the removal or destruction of native vegetation.</p>	<p><i>Planning and Environment Act 1987</i></p>	VICTORIA
<p>Western Australia</p> <p>A permit is required for the removal of trees or land clearing on Crown land other than that permitted under the lease.</p>	<p><i>Land Administration Act 1997</i></p>	WESTERN AUSTRALIA

Control of weeds and pests

Content	Legislation	Comment
<p>New South Wales</p> <p>The Act specifies the control measures (according to its control category) that have to be undertaken by public and private landholders. The occupier of the land is responsible for the control of noxious weeds on that land and a local authority may issue the occupier with a weed control notice to carry out specific control measures. Willows are declared noxious weeds in some areas.</p>	<p><i>Noxious Weeds Act 1993</i></p>	<p>Willow clearing in State Protected Land (for riparian land this is 20 metres from the bank or any part of the waterway) requires a pre-application site visit by a local DIPNR officer.</p>
<p>Queensland</p> <p>This is the principal legislation for the management and control of pests and weeds in the State. Certain plant and animals can be declared in various categories under the Act for the purposes of control (destroy, reduce, or contain). The Act requires occupiers of private land to control all declared plants and animals.</p>	<p><i>Rural Lands Protection Act 1985</i></p>	QUEENSLAND
<p>South Australia</p> <p>The purpose of this Act is to deal with pest animals and plants. The Act places restrictions on the movement and sale of pests and also makes the landowner responsible for carrying out the instructions of the local Animal and Plant Control Board in respect of their control or destruction.</p>	<p><i>Animal and Plant Control (agricultural protection and other purposes) Act 1986</i></p>	SOUTH AUSTRALIA
<p>Tasmania</p> <p>A plant considered a serious economic, environmental and/or social risk, is declared under the Act, allowing legally enforceable actions to be undertaken to control it. Examples of declared riparian weeds are willows and blackberries. The Weed Management Plans developed for each weed species contain information on the legally enforceable management of that weed and includes measures to control, eradicate or restrict the spread of the weed.</p> <p>See also 'Works in or adjacent to a watercourse'</p>	<p><i>Weed Management Act 1999</i></p>	TASMANIA
<p>Tasmania</p> <p>Chemicals can only be used for control when it can be demonstrated that chemical control poses less net environmental risk than other means.</p>	<p><i>Agricultural and Veterinary Chemicals (Control of Use) Act 1995</i></p>	<p>See also 'Works on or adjacent to a watercourse'</p>



Content	Legislation	Comment
<p>Victoria</p> <p>The Act establishes the Victorian Catchment and Land Protection Council, Regional Catchment and Land Protection Boards and the Pest Animal Advisory Committee.</p> <p>The Act makes provisions for the classification and control of noxious weeds and pest animals and the enforcement of penalties for non-compliance with a direction.</p> <p>See also 'Duty of Care'</p>	<p><i>Catchment and Land Protection Act 1994</i></p>	<p>A list of declared noxious weeds can be found on the Department of Primary Industry Website under their Notes Information Series (www.dpi.vic.gov.au)</p>
<p>Western Australia</p> <p>The Act is the main legislation dealing with pest plants and animals and it is administered by the Protection Board. Classes of plants and animals may be 'declared' by the Board. If the occupier of any private land finds a declared plant and animal on the land the Protection Board must be notified. The occupier must then take appropriate steps to control it. Local government may also make local laws prescribing as a pest plant any plant that is likely to adversely affect the district or its inhabitants. Where such a plant occurs, a notice may be served on the owner/occupier of the land to control that pest plant. If the owner/occupier does not comply, the local government may take measures to control the pest plant at the expense of the owner/occupier.</p>	<p><i>Agriculture and Related Resources Protection Act 1976</i></p>	

VICTORIA

WESTERN AUSTRALIA

Appendix C

Management issues related to streams, creeks and riparian areas, as listed in regional catchment management plans





Management issues related to streams, creeks and riparian areas, as listed in regional catchment management plans

In this section we have listed some of the high-priority management issues that have been identified in catchment plans in higher-rainfall or tableland areas where wool production is an important land use. Parts of the Murrumbidgee (NSW) catchment plan are summarised in more detail as one example of how some communities are setting catchment targets. The significance of the priority issues and catchment targets listed here, is that woolgrowers who are interested in tackling these problems can access assistance from their local catchment management agency.

Water quality

Actions to address contamination of streams by salt, sediment and nutrients:

- Improve surface water management on farms through graded banks, adopting no till practices, grassed waterways, revegetation, less clearing
- Control in-stream gravel abstraction, dam construction, roads and mining
- Identify location of major contributors to sedimentation
- Ensure better compliance with point source pollution regulations
- Adoption of best management practices in relation to pollution of waterways by agriculture and industry
- Decrease export of phosphorus and nitrogen particularly from over clearing, poor land management, poor use of fertilisers, and change from native to exotic vegetation

Streambank erosion

Actions to address streambank erosion:

- Target bed and banks erosion and implement rehabilitation works
- Protect watercourses and regulate drainage infrastructure to minimise erosion
- Stabilise banks and reduce extent and severity of erosion in priority waterscapes

Acidification

Actions to reduce acidification of water resources to lessen harmful effect on fish and other aquatic organisms:

- Avoid draining of water logged areas

Riparian vegetation

Establish/restore native riparian vegetation to:

- Provide aquatic habitat
- Control strong sunlight, rise in water temperature, infestation by exotic fish and loss of native vegetation
- Protect and rehabilitate riparian vegetation whilst protecting cultural and heritage values
- Develop riparian revegetation program and increase riparian management works

Conservation

- Support and effectively maintain conservation reserves on private land
- Increase the extent of and improve the condition of native riparian vegetation along priority waterways
- Consider voluntary management of priority sites to improve riparian vegetation
- Maintain or increase populations of threatened aquatic flora and fauna and protect key habitats

Weeds and feral animals

- Control nuisance fauna and flora
-



Ground water

Primary concern about increased salinity of water, decline in ground water levels and adverse effect on water dependent ecosystems. Actions to address issue:

- Stabilise aquifers and modify ground water licenses to prevent further decline
-

River health

- Protect assigned environmental values of waterways
 - Ensure achievement of targets for riverine quality meets targets set under NAP
 - Protect and rehabilitate degraded rivers, wetlands and floodplains
 - Protect aquatic biota and maintain or improve overall health of rivers
 - Reverse trend of declining water quality
-

Wetlands

- Maintain current areas of biodiversity of wetlands
 - Assess the condition of wetlands and identify isolated wetlands of high value
 - Modify impeding structures to ensure floods reach important wetlands
 - Minimise off site effects on wetlands
-

Flow regimes

Actions to improve management of flows:

- Identify required allocation for fish passage, floodplain, wetland, and health of in-stream organisms
 - Manage water extraction for irrigation to safeguard riverine ecosystems
 - Set up a system of equitable water use and water trading
 - Provide environmental flow
 - Improve the control of water discharge peaks from dams
-

Floodplain management

- Coordinate flood management by local government and farmers
 - Ensure that management is responsible in terms of the environment, and economic and social development
 - Consider floodplain management plans, and wetland health when assessing flood plans for cropping
-

Water use

- Ensure there is community access to water resources to enhance industry, lifestyle and community benefit
 - Ensure regional water balance is achieved through sustainable management of quantity and quality of water to optimise productive use whilst providing for the needs of aquatic ecosystems
-

Stock management

Better management of stock

- Fence waterways including minor streams
 - Limit stock access
 - Educate community about responsible stock management in the riparian zone
-

Incentives

- Provide incentives for better management of stock including fencing
 - Develop cost sharing packages and incentive schemes to encourage adoption of best management practices
-

Planning, monitoring and assessment

- Develop and implement management plans, water sharing plans
 - Develop and implement monitoring programs
-

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Integrated Catchment Management Plan for the Murrumbidgee Catchment

Catchment Plans are now completed or in the process of being completed for all the major agricultural catchments. Whilst they do not all follow the same format they typically revolve around targets that are specific, measurable and to be achieved within a specified period of time. The Murrumbidgee Plan is given as an example.

The Murrumbidgee Plan consists of a hierarchy of targets and actions from the broad catchment level down to the local action required to achieve the desired outcome. The information provided below relates only to Catchment Targets, Management Targets and examples of actions that have implications for the riparian zone

Water quality and flow targets

The intent of the water quality and flow targets is to improve river and tributary health, particularly through an improvement in riparian and aquatic habitat and ecological process, which will be reflected in an improvement in water quality, including reduced suspended sediment levels and a more natural flow regime. Water Sharing Plans will ensure equity and certainty for landholders and provision for environmental needs. The Plan seeks to achieve:

- Environmental benefits: Improving the quality and diversity of riparian and aquatic habitat and supporting the maintenance of aquatic ecological processes and therefore enhance biodiversity.
- Social benefits: Improved quality of water for industry, recreation, towns and landholders; including clear and equitable water access rules.
- Economic benefits: A viable irrigation industry through improved security of access (quantity) and enhanced water quality. Reduced costs in treating blue-green algae outbreaks, and reduced pump maintenance costs.

Murrumbidgee catchment target

By 2012, in the Murrumbidgee River and its main tributaries, suspended sediment levels will be reduced so that they meet National Standards. Flows and water extractions will be managed to maintain or improve river health consistent with the River Flow Objectives and the Murray-Darling Basin Cap.



Below are a number of Management Targets (MT) together with some of the actions required to meet those targets.

MT 1. Protect and enhance 1500 kilometres of streambank using native riparian vegetation for bank stabilisation and runoff filtration.

- protect, enhance and re-establish existing riparian native vegetation e.g. by developing incentives to encourage land managers to implement riparian zone actions and works;
- manage stock access e.g. by investing in off-stream watering points; and
- manage problem weeds e.g. black willows.

MT 2. Along those stream reaches, which yield the highest sediment and nutrient loads, control streambank and gully erosion using structural control works covering a total length of 50 kilometres.

- construct streambank and gully erosion control works e.g. by prioritising gullies and streambanks for erosion control works and developing and implementing gully control works on a property scale.

MT 3. Improve native vegetation condition in 90% of the floodplain billabongs to restore their natural capacity to filter sediment.

- restore (or improve) the hydrological regime to billabongs e.g. negotiate with land managers the requirements for each priority floodplain billabong;
- manage stock access to billabongs e.g. by developing incentives to encourage land managers to manage floodplain billabongs for water quality outcomes;
- manage problem weeds and pest animals.

MT 4. Reduce pollution from point sources

- ensure appropriate regulation of point sources;
- encourage local government to reduce water quality impacts of rural residential development.

MT 5. Implement Water Sharing Plans for the Murrumbidgee River and each of its subcatchments and priority groundwater systems, which are classified under the Water Management Act 2000 as 'high risk' 'high stress' or "high conservation value" by 2012.

- by 1 December 2007 complete and commence implementation of Water Sharing Plans for the Lower Murrumbidgee Groundwater Management Area, the Murrumbidgee River and Tarcutta and Adelong creeks.

Biodiversity MT

Maintain diversity of indigenous aquatic biota and processes by a reduction in the species diversity ratio of alien to native fish by 25%, a 10% increase in aquatic invertebrate diversity, and establishment and long term maintenance of native aquatic plants for 10 linear kilometres of Murrumbidgee River.

- retain, enhance and revegetate riparian and aquatic native vegetation;
- investigate river flows, seasonality and water quality to optimise suitable locations for aquatic plant establishment in the Murrumbidgee River;
- enhance aquatic connectivity;
- protect sites of relatively intact aquatic biodiversity; and
- manage instream habitat complexity by maintaining and improving channel complexity and instream vegetation.

Salinity Catchment Target

A year 2010 target of less than 245 EC for 50% of the time and less than 320 EC for 80% of the time at Balranald. A salt load of less than 145,000 tonnes per year for 50% of the time and less than 325,000 tonnes per year for 80% of the time by 2010.

This target will be achieved by better land management practices and will result in improved river and wetland ecosystems, and improved water quality for stock and domestic users.



Appendix D

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This River Guide aims to assist Australian woolgrowers and those who work with them to better manage water courses and riparian land on farms. It provides practical advice and examples of how woolgrowers can improve wool production and profit, and at the same time achieve and demonstrate sound environmental management. It is designed primarily for audiences with some technical knowledge of natural resource management, but its contents are also suitable as base materials for local workshops and field days.



SHEEP/WHEAT ZONES