Managing Riparian Land for Multiple Uses

By
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Rural Industries Research & Development Corporation
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A collaborative venture between:
The Joint Venture Agroforestry Program (RIRDC)
Native Vegetation R&D Program (L&WA)
National Riparian Lands R&D Program (L&WA)
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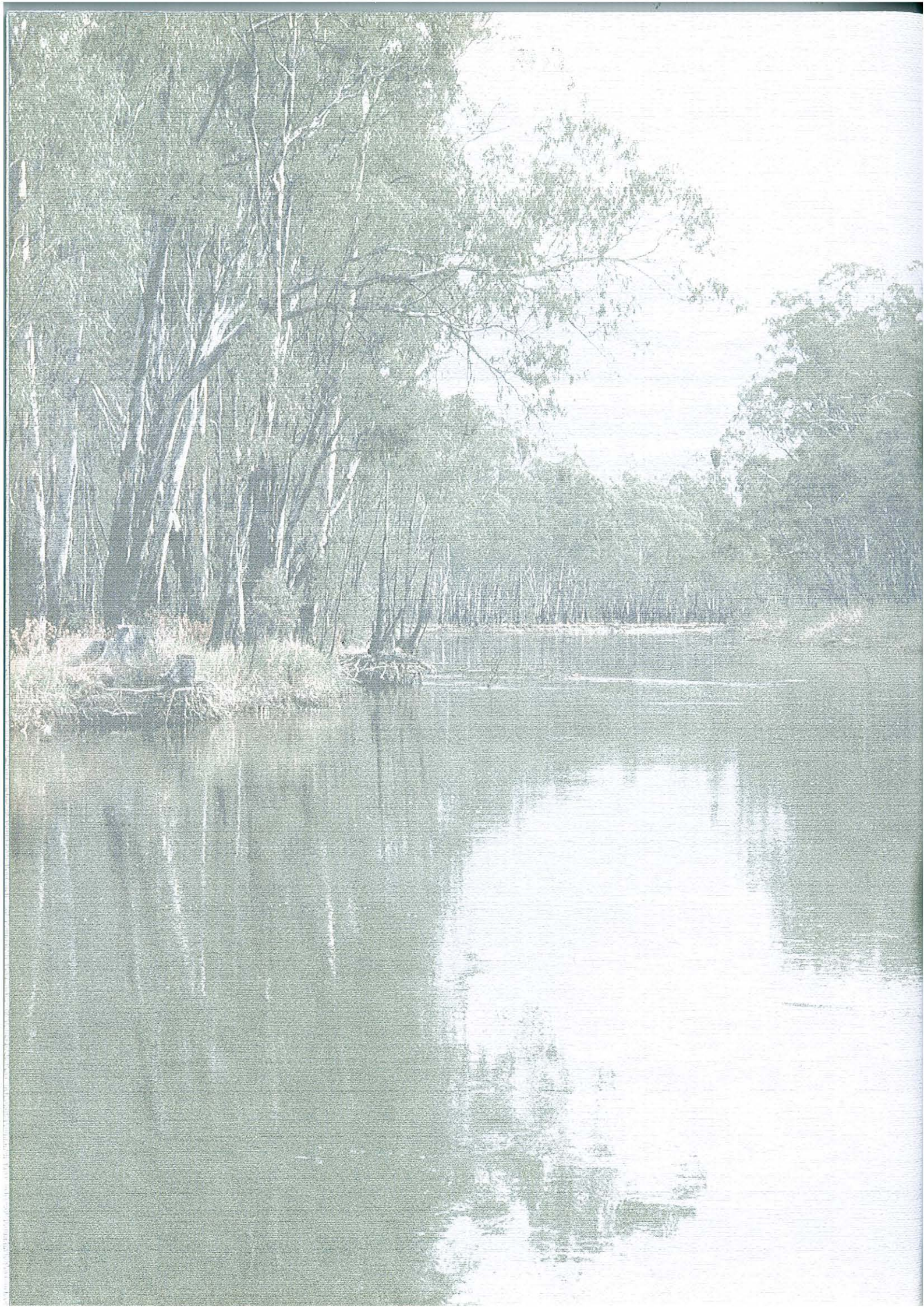

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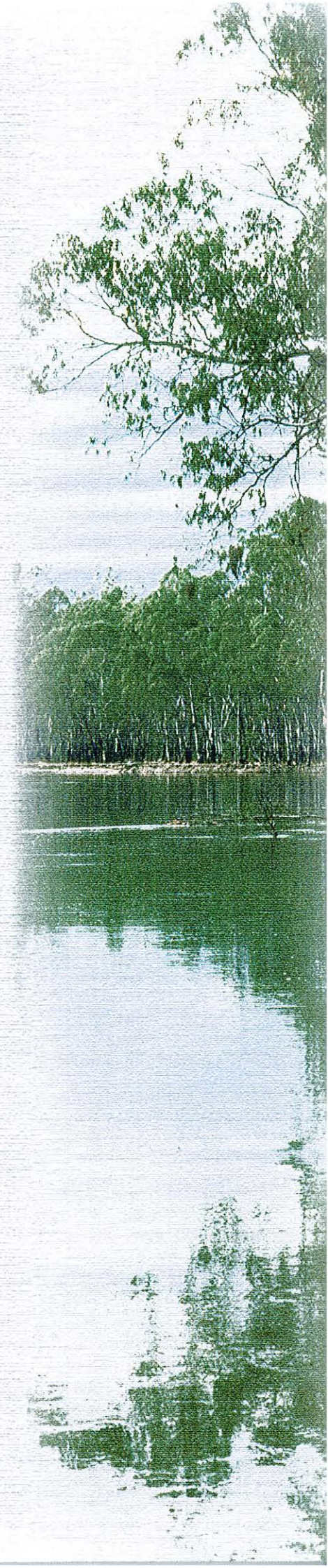

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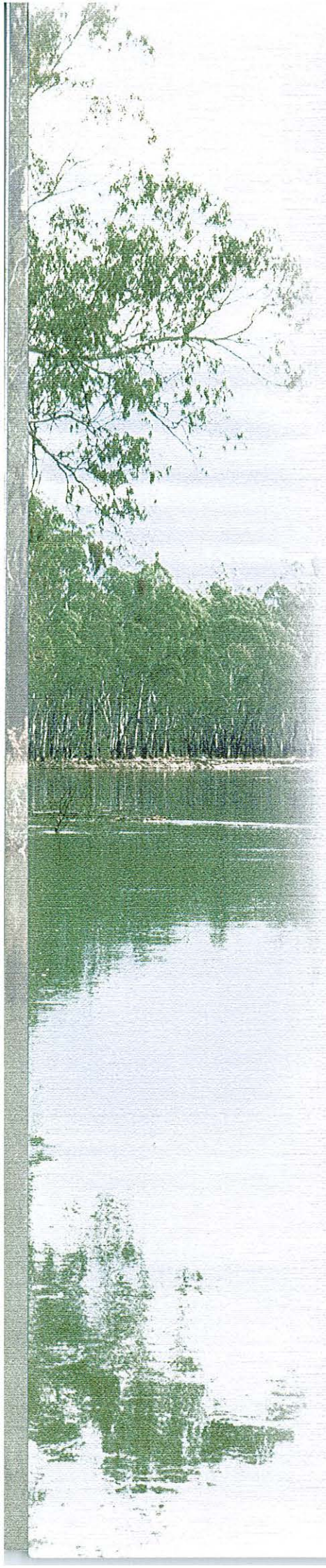

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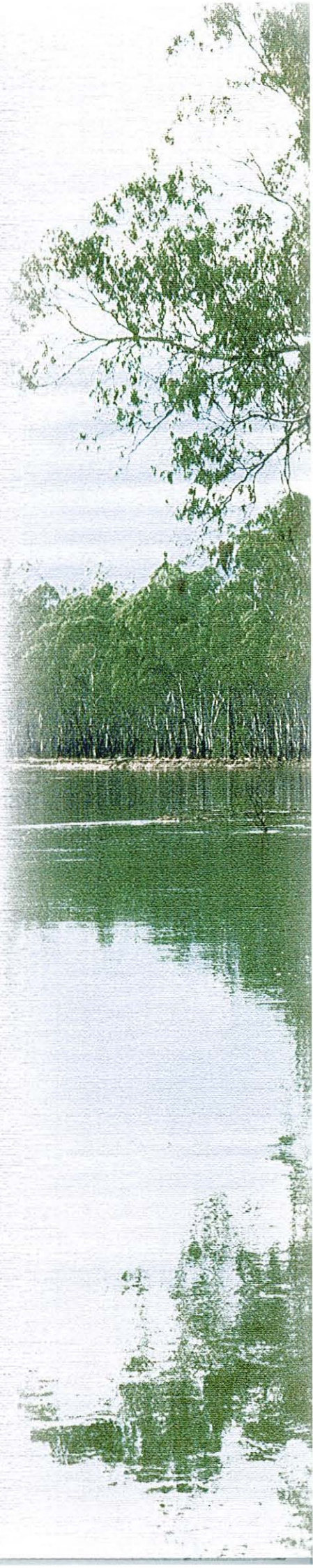

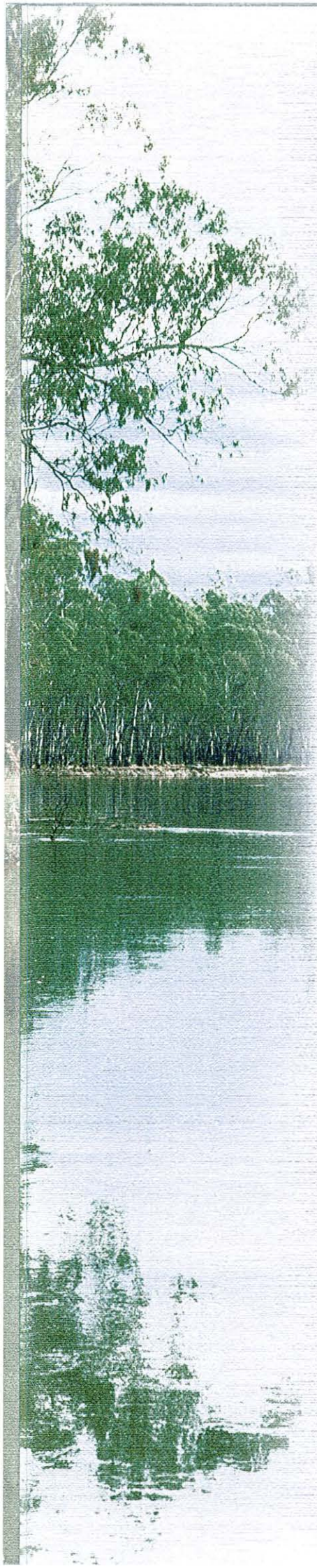

Preface

This Guide provides information to farm managers, advisers, catchment and landcare facilitators on how to gain both economic and environmental outcomes from riparian land. The potential uses of riparian land are outlined, together with management principles and practices. A summary of the research underpinning these principles and practices is provided to support on-farm decision-making with the best available information. It mainly draws on information about southern Australia, but can be adapted for use more broadly.

This report is a collaborative venture between Land & Water Australia, the Rural Industries R&D Corporation and the Murray-Darling Basin Commission. It is the first in an integration initiative that brings together and collates recent findings from different research and development R&D programs, and suggests how they can be used to improve on-ground management.

This Guide summarises a range of more detailed information on riparian management, with key references noted in the text so that you may access further information about particular topics. You may use information and diagrams to develop other products and materials, providing the original source of the material is acknowledged.

For example, the material could be used for:

- courses and training
- seminars and workshops
- fact sheets and newsletters
- codes of practice

As scientific and experiential knowledge grows, it is anticipated that this Guide will be reviewed and updated. Your feedback is vital to this process – we welcome any comments or suggestions for improvement, and any relevant examples and case studies of using the riparian zone to achieve multiple objectives in Australia. The following people have worked closely with the author to integrate the research findings of their respective programs in this report:

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Chapter 1
The Values of Riparian Land

Managing riparian land for multiple uses

Riparian land is any land that adjoins, directly influences, or is influenced by a body of water. It therefore includes:

- the land immediately alongside small creeks and rivers, including the riverbank itself
- gullies and dips which sometimes flow with surface water
- land adjacent to drains and channels that discharge into streams or wetlands
- areas surrounding lakes
- wetlands, billabongs and floodplains, which interact with the river in times of flood
- vegetation dependent on groundwater supplied by a river.

Riparian land has no absolute dimensions. The key issue when managing riparian land is to consider the function that you want it to play. By way of example, the riparian area affecting stream stability may be far narrower than the area impacting on water quality. This Guide sets out the management principles and practices according to potential functions. It will help you to think about the management of riparian land in all its dimensions.

Why are riparian lands important?

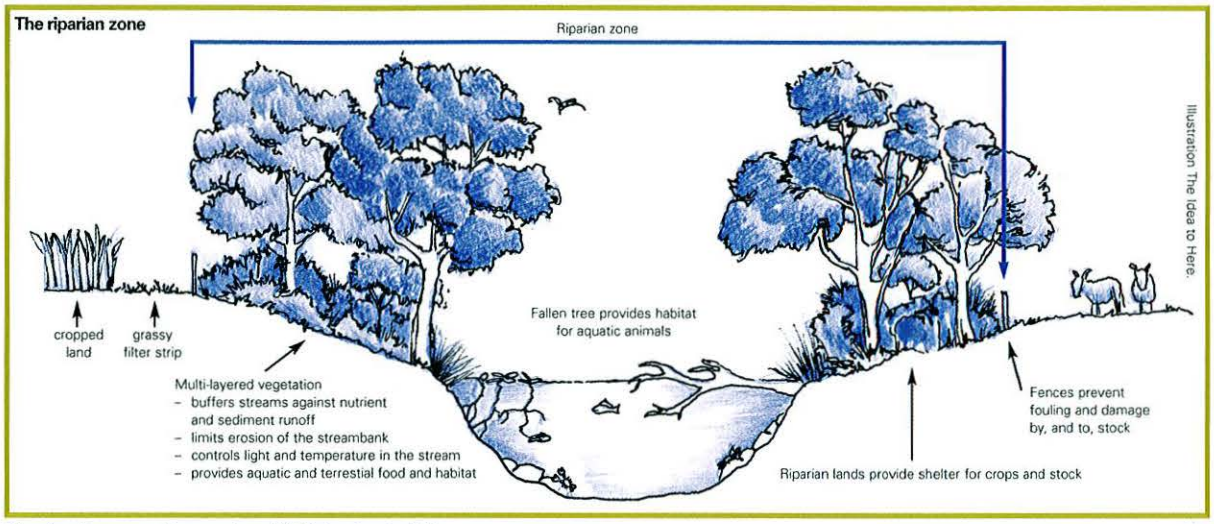
Riparian land usually supports a higher diversity of plants and animals than non-riparian land, and sometimes harbours endangered or vulnerable plants. It provides habitat for wildlife, and acts as a corridor for their movement between patches of vegetation. It is generally more fertile and productive, with better quality soils, and is the last line of defence for the protection of water quality and in-stream life. Riparian plant life is in itself unique and diverse, with vegetation that is often taller, denser, and more structurally complex than the surrounding native vegetation. Its microclimate is often more humid, and this is strongly influenced by the width of the riparian vegetation.

Riparian vegetation has a close association with in-stream life. Bank vegetation is a key source of food supporting in-stream life. The vegetation shades some, or all of the stream, lowering water temperature and light levels, and affecting in-stream plant growth. Freshwater fish and vertebrates feed on animals and fruits coming from riparian land. Large woody debris (the branches, large limbs and whole trees that fall on the ground and into streams) is an important source of food and habitat, and enters streams from neighbouring or upstream riparian land. Floodplains bridge land and water environments and are important for food supply and breeding. Flooded riparian vegetation provides shelter to fish and other in-stream animals from being washed away during high flows, as well as providing feeding or spawning grounds.

Increased sediment and nutrients (primarily phosphorus and nitrogen) in streams can lead to loss of habitat, smothering of stream life, murky waters, and changes to the mix of in-stream plants and animals. Riparian vegetation protects streams by slowing surface runoff, using nutrients and trapping sediment and other contaminants.

As well as protecting the neighbouring stream, riparian vegetation also protects 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, broombush, 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. 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.

This diagram shows the key functions performed by riparian land



The riparian zone. (Source: Land & Water Australia)

Checklist of potential functions performed by riparian land

- √ harbours important and unique vegetation communities, including endangered and vulnerable species
- √ provides food, refuge and passage for wildlife
- √ supplies food and habitat for in-stream life
- √ buffers the stream against nutrient, sediment and other contaminants in surface runoff and groundwater
- √ protects stream bank stability
- √ shelters crops and pastures from wind and windborne materials, and provides habitat for beneficial animals, including pollinators
- √ protects livestock from extreme temperatures, and provides a feed reserve
- √ provides wood and non-wood products that may be harvested for use or sale
- √ delivers ecosystem services that benefit the community and may be traded at some time in the future

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Riparian areas are where land and water meet. (Photo: Siwan Lovett.)

Chapter 2
Looking at Riparian Land Management within the Catchment Context

Managing Riparian Land for Multiple Uses

There are lessons to be learnt (and money saved) from starting with the big picture view of your catchment before deciding on specific management objectives for your riparian land. Four pieces of information can help you to make a judgement about the broader values of, and threats to, your riparian land – asset protection, target-setting, groundwater flow systems, and salinity and salt stores. This information might influence your choice of management objectives described in the core practices section of this guideline, as it enables you to identify a broader catchment issue that requires special management of your riparian land. It also assists you to place the riparian land on your property within the broader catchment context.

Some examples of the sorts of plans and strategies that should be considered

- Recovery plans for rare, threatened and endangered species or communities; National Action Plan on Salinity and Water Quality; Integrated Catchment Management in the Murray-Darling Basin 2001-2010; Basin Salinity Management Strategy 2001-2015; Plantations 2020 vision; NSW catchment blueprints

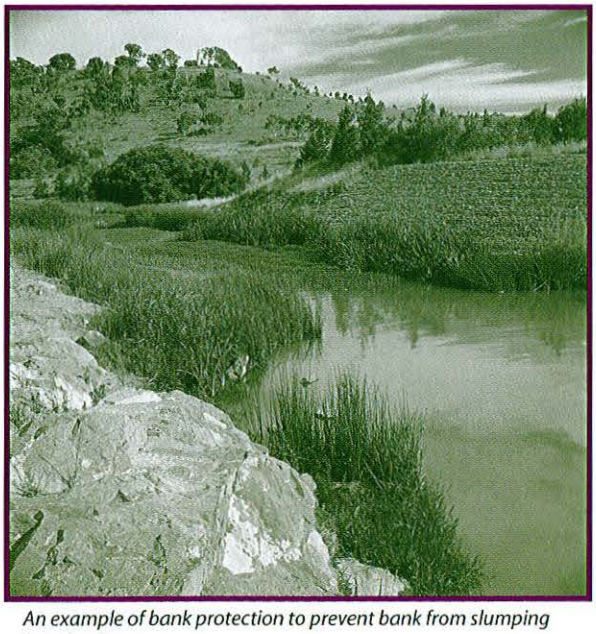
Some examples on the diversity of property and catchment 'assets'

- Catchment assets – town drinking water supply; high value irrigation areas; bridges, roads, railways; locally significant wetland; unique open woodland; habitat for migratory/mobile species; sewerage and stormwater drains; fish habitat to support recreational angling; visual amenity to underpin tourism; houses and commercial buildings; recreational swimming hole or river
- Property assets – dams, pasture for grazing, cropping land; land value, irrigation channels, sheds, farmhouses, native plants and animals, beneficial insects, shade for stock, fresh groundwater resources, roads, fences, soil.

Asset protection

Property or catchment management aims to protect values that you or the community consider to be important. These values or 'assets' may be economic, environmental, social or cultural. A farm dam is an example of an asset. Once you have identified an asset it is easier to see how riparian land helps to protect or enhance its value. The areas on your farm or in your catchment that are best set aside for non-productive or low impact production purposes will then become more apparent to you.

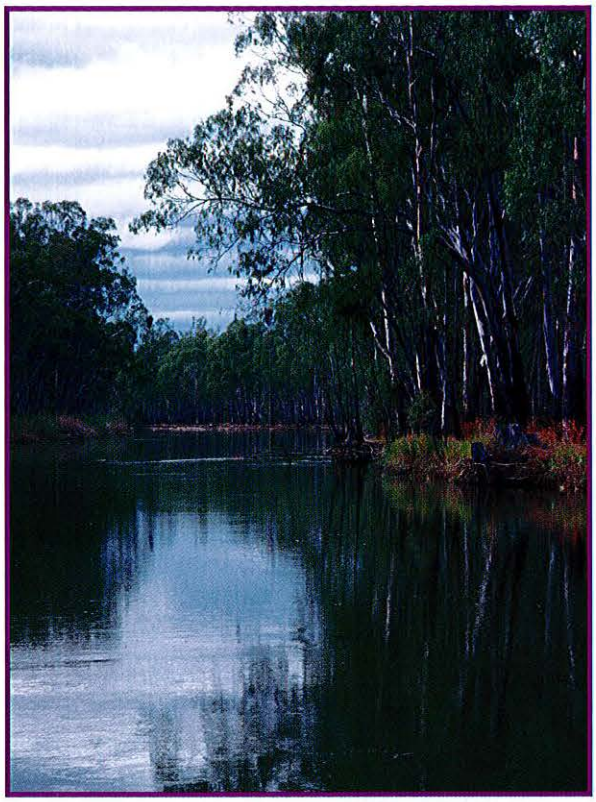
Plans and strategies on the management of natural resources will give you some insight about the assets in your catchment. A good plan should provide a vision for the catchment, and its riparian lands, and the likely direction and pace of change. Failing to protect an asset can be costly to you and/or the broader community. Information on these sorts of costs is increasingly becoming available for both property and catchment scale resources.



An example of bank protection to prevent bank from slumping into the river.

Target-setting

Once you have identified the assets of your farm and catchment, you need to decide on the level of protection they need (target-setting) and how this will be measured. Target-setting processes at the catchment level often use the condition of streams as an indicator of broader catchment health. Riparian land is a focal point for target-setting because it is where land and water meet and interact. This interaction means that riparian land performs many different functions and any management decisions can impact on whether these functions continue or decline. You should be aware of any targets set in your catchment, and ensure that your use and management of riparian land is complementary. Target-setting is likely to be a permanent feature of the way we manage our catchment resources in Australia in the future.



Riparian environments like this one are worth protecting as a key catchment asset. (Photo; MDBC)

Groundwater flow systems

Understanding how groundwater behaves may indicate whether your riparian land is at risk from fresh or saline high watertables. Groundwater is the water stored beneath the soil surface. It usually discharges to a stream or wetland (in the lowest parts of the catchment). It delivers salts, nutrients and sometimes sediment, which can be used or trapped by riparian plants. High watertables caused by land clearance can lead to soil waterlogging, poor plant growth and function, and potentially the death of plants (and their associated wildlife). Where the groundwater is also salty, the root zone and soil surface can gather salt to the extent that local native plants are unable to survive, and costly site rehabilitation and/or use of salt tolerant plants is needed. You can use the 'National classification of groundwater flow systems' to see how water moves in your catchment, where and when (*response time*) salinity is expressed at the soil surface and how it might be addressed. It is not suitable for assessment at a farm level, but it will give you an idea about the sorts of options appropriate to your catchment. It is also a good idea to speak to the local government agency in your area that is responsible for monitoring groundwater flows across the catchment, as they are generally an excellent source of information and advice.

Salinity and salt stores

Knowing where salt is stored in your catchment and its potential for movement will pinpoint a threat to the stream and your riparian land. Electromagnetic devices have been widely used to detect salt stores, but the process is slow and labour intensive. A technology previously used in mineral exploration called 'airborne geophysics' is being trialed for use in salinity management. It has been described as an 'ultrasound of the earth', as it sees through the earth's crust to map the salt stores that lie beneath. Once areas of high salt stores with potential for movement have been mapped, vegetation can be retained or replanted to keep it in place.

See www.ndsp.gov.au – click on 'Airborne geophysics' icon – for maps and information

See www.ndsp.gov.au – click on 'Catchment classification' and 'Tools' icon – for maps

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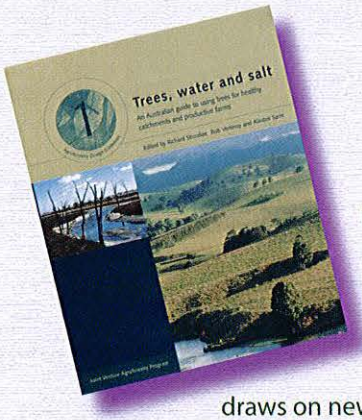
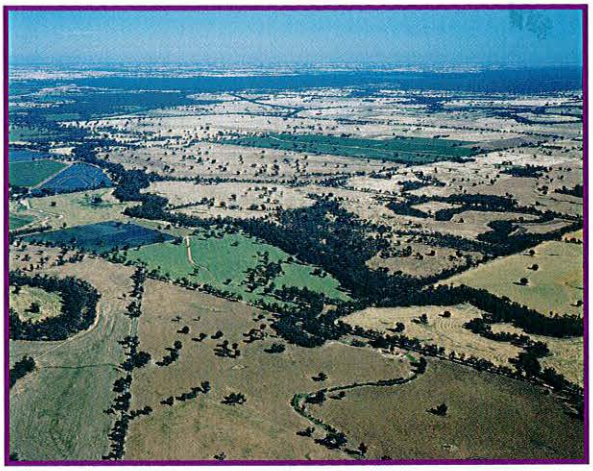


Dryland salinity presents a great challenge to Australian agriculture. This book draws on new and existing research to show how trees can be used successfully to combat salinity while also providing farmers with income. It gives an insight into catchment hydrology, how this might vary between catchments, and why it must be understood for successful salinity management of trees for both watertable control and tree growth. *2002, 168pp, RIRDC Pub No. 01/086; $27.*



When approaching planning and management of your riparian zone, you need to consider the area from both a property and catchment perspective. (Photo: CSIRO Ecosystem Services Project.)

Example of the diversity of regulations that relate to riparian management

- The Flora & Fauna Guarantee Act (Vic); The Native Vegetation Conservation Act (NSW); The River and Improvement Trust Act (Qld); Forest Practices Act (Tas); RAMSAR wetlands (Commonwealth); The Heritage Rivers Act (Vic)

Summary

You can use catchment level information to inform your objectives for the management of your riparian land. This chapter described four key information layers – asset protection, target-setting, groundwater flow systems, and salinity and salt stores. This information is not always available, however, where it exists, you will benefit from using it to inform your riparian management. Bear in mind that this list is not exhaustive, so look out for other useful information at the catchment scale.

The following guiding principles for defining your objectives for the management of your riparian land within the broader catchment have been outlined in this chapter:

- √ Approach planning and management from both a property and catchment perspective
- √ Identify values or assets that need protection
- √ Consult relevant plans and strategies
- √ Establish targets to protect the identified assets
- √ Understand the type of groundwater flow system, its quality, response time and management options
- √ Retain or replace vegetation at sites in the catchment with significant salt stores of high mobility in the soil profile.

Chapter 3
Managing for Multiple Objectives

How to achieve production and environmental benefits on riparian land

Most people have a view about how riparian land should be used and managed, and some of these views are conflicting. They can be views about public issues (like protection of riparian land for biodiversity or for town water supply) or private issues (like land values or financial returns). You may also have in mind more than one management objective – for example, clean water + biodiversity conservation + firewood harvesting.

To manage for these different objectives, you need to think and plan about the management of your riparian land at the property and catchment scale. Some of the catchment scale issues were discussed in the previous section. This section looks at ten possible management objectives for riparian land, and allows you to compare their similarities and differences when it comes to putting them into practice.

The table over page shows the ten management objectives discussed. Management principles and core practices are described for each objective. The first five objectives (a to e) focus on conservation. The conservation values of your riparian land will be maximised by implementing the core practices described. The next four objectives (f to i) are production-oriented. The associated core practices aim to achieve a balance between production and conservation outcomes on your riparian land. The final objective (j) looks at ecosystem services.

There is a matrix at the end of each section listing the core practices and comparing them against the other management objectives, with the exception of ecosystem services. In this way, it is easier to see where a particular core practice complements another objective or conflicts with it. You can use this as a tool for making trade-offs when trying to achieve your multiple management objectives.

The following rating system is used:

++	**The core practice will always make a positive contribution to the management objective**
+	**The core practice is most likely to have a positive impact on the management objective**
−	**The core practice is most likely to have a negative impact on the management objective**
N	**The core practice is most likely to have no impact on, or is not relevant to, the management objective**
?	**The effect of the core practice on the management objective unkown**

When interpreting the ratings, it is helpful to keep referring back to the objectives stated. A rating may appear 'wrong' at first glance — for example a core practice for 'wildlife corridors' is 'link patches of native vegetation by vegetation strips, preferably more than 50 m wide and at least 30 m wide on banks of waterbodies'. This gets a + rating for 'crops and pastures' — that is, the core practice is most likely to have a positive impact on the management objective. While a 30+ m wide corridor will remove land from cropping or pastures, the management objective is 'to shelter adjacent crops and pastures from wind and windborne materials, and provide habitat for beneficial animals, including pollinators'. A 30+ m wide corridor certainly does this.

In fact, you will see that the four production-oriented objectives have very few − ratings due to the fact that conservation principles have already been integrated into the core practices described. That said, there are few ++ ratings, as any intensive production-related activity in the riparian area almost always precludes such a high rating.

A **?** means that the effect of the core practice on the management objective is not known. This may be either because there is no information available, or because the particular circumstance cannot be predicted – for example, the effect of a core practice on a non-wood product such as honey is completely different to a product which requires harvest of all parts of the tree.

The 10 management objectives discussed in this guideline

	Riparian Value	Management Objective	Page
(a)	Conserving riparian plants and animals	To conserve or restore the diversity and structure of riparian vegetation and its associated wildlife.	9
(b)	Wildlife corridors	To provide refuge and passage for wildlife within and along riparian land.	12
(c)	In-stream life	To conserve or restore the diversity of in-stream plants and animals.	15
(d)	Water quality	To protect and improve the quality of surface waters by using riparian vegetation to filter sediment, nutrients and other contaminants.	17
(e)	Stream stability	To maintain bank stability that is sufficient for the stream to recover quickly from small flooding events.	24
(f)	Crops and pastures	To shelter adjacent crops and pastures from wind and windborne materials, and provide habitat for beneficial animals, especially pollinators.	27
(g)	Livestock	To protect and improve the condition of livestock by using riparian vegetation for shade, shelter and feed.	30
(h)	Non-wood products	To supplement farm income through harvesting non-wood products from riparian land for sale or on-farm use.	33
(i)	Wood products	To supplement farm income through harvesting wood products from riparian land for sale or on-farm use.	36
(j)	Ecosystem services	To maximise the ecosystem services provided by the riparian environment.	42

Conserving riparian plants and animals

Management Objective

To conserve or restore the diversity and structure of riparian vegetation and its associated wildlife.

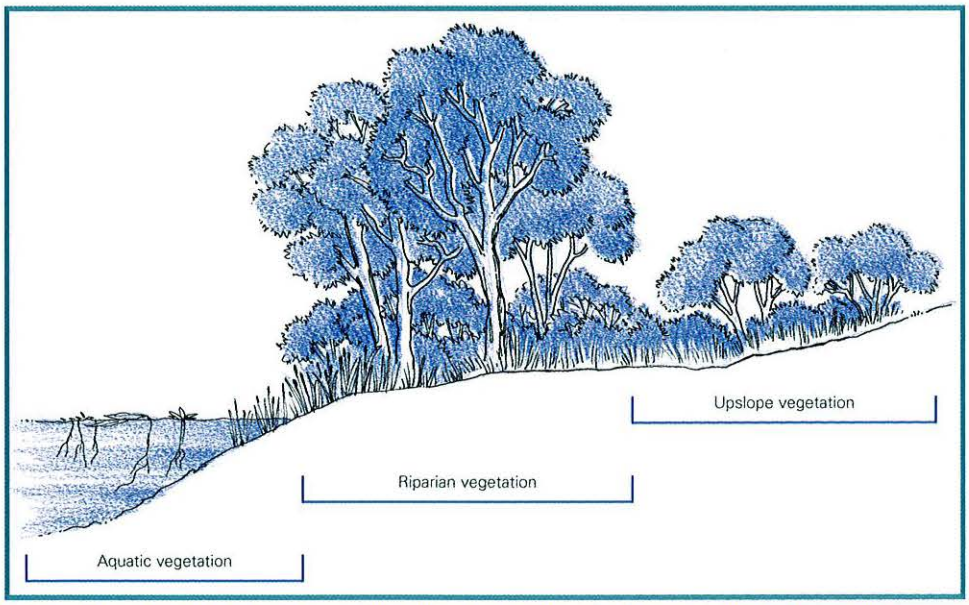
Core Practices

Riparian plant life is in itself unique and diverse. You can observe that it is often taller, denser, and more structurally complex than the surrounding native vegetation. It usually supports a higher diversity of plants and animals than non-riparian land, at the genetic, species and ecosystem levels. It is an important refuge for endangered or vulnerable plants – sometimes even in small, weed-infested remnant patches. The diversity of plants changes from the headwaters to the river mouth, and from the land to the water. Although its area is relatively small, riparian vegetation makes a major contribution to biodiversity conservation, in terms of both function and species diversity. This is why it needs special management.

There are three broad categories of riparian animals – land-based species, riparian specialists, and in-stream species that only live in the riparian area. Many mobile animals move in and out of the riparian environment throughout their lifetime. Riparian land provides habitat (food, water, shelter, and safe sites for nesting and roosting) and acts as a corridor for the movement of wildlife from one patch of vegetation to another. These riparian resources may be needed for the entire lifetime of some animals, while others may depend upon them at certain times of the day, in certain seasons, or during specific life stages.

Leaf litter, fallen timber and flood debris that gathers in the riparian area provide foraging sites and retreats for invertebrates (worms, gadflies, mayflies), small mammals (possums, gliders), reptiles (snakes, lizards) and amphibians (frogs, toads, salamanders). Soils in the riparian area provide ideal conditions for burrowing and nesting by ground-dwelling animals, ranging from insects to mammals.

The riparian environment on your farm does not exist in isolation from the surrounding land and waters. Its plant life and associated animals are affected by what goes on around it – like land use and the status (nature, extent, condition, interdependencies) of other land-based and in-stream biodiversity. In Australia, the natural condition of riparian land and its catchment has been significantly disturbed, particularly in the south. Once the original vegetation is removed it is very difficult and expensive to recreate it.



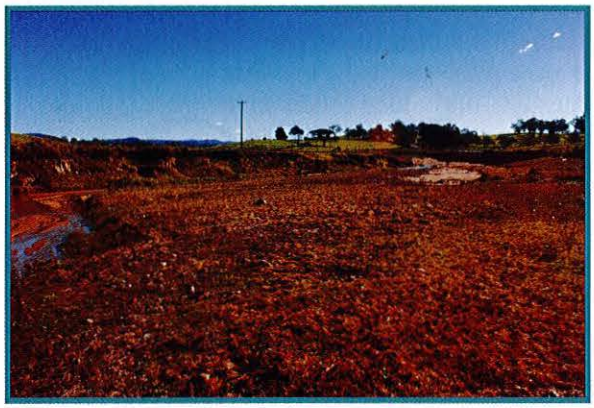
Vegetation changes as distance from the water increases. Often there is a band of taller, denser vegetation in the riparian zone and shorter, sparser vegetation further away. (Source: Land & Water Australia, redrawn from Thomas et al. (1979))

All remnant vegetation provides some biodiversity. Where large animals are concerned, a bigger remnant is likely to be more valuable, but even small and isolated patches and individual trees are important. Isolated remnants should not be cleared simply because they are isolated.

It is not only the size of the remnant that is relevant, but also its condition. This includes factors such as tree health, understorey diversity, structural diversity, the number of tree hollows and weediness. Isolated remnant or planted vegetation (particularly at the boundary between riparian and agricultural land) tends to suffer from edge effects – species loss, weed invasion and nutrient enrichment. You should be aware of the full range of processes that can threaten your riparian land and manage each accordingly. For example, the removal of large trees for timber can reduce the number of hollows available for native animals and the 'cleaning up' of fallen dead trees can remove habitat for ground-dwelling animals.

Riparian vegetation is adapted to the cycle of flooding and drying, and the disturbance that results. Extensive bare areas are caused by rare, episodic or atypical flooding (and, in the north, cyclonic) events. In Australia today, the natural cycle of flooding is affected by over 400 major dams and thousands of smaller in-stream and off-stream regulation measures, influencing vegetation establishment and survival. Your riparian environment will tend to cope with disturbance that resembles a natural event. This capacity is reduced by impacts that degrade the soil fertility, remove roots and seeds, or create gaps that exceed plant colonisation distances.

It is useful to consider the natural stresses that your riparian environment has been exposed to over evolutionary timeframes, and the differences or similarities with current day stresses. This might provide a clue about its potential for natural recovery. For example, hardy pioneer species are sometimes used to protect newly planted rainforest seedlings that are sensitive to temperature, sunlight, frost and wind, and are harvested for wood products (timber, rails, posts) when their protective role is completed. 'Tools' like fire, flooding and grazing may also be appropriate for kick-starting or managing your riparian land.



Large scale clearing of vegetation has degraded riparian lands and increased stream erosion. (Photo: Siwan Lovett.)

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Management objectives

A. Conserving riparian plants and animals

Core practices

Core practices	Wildlife corridors	In-stream life	Water quality	Stream stability	Crops & pastures	Livestock	Non-wood products	Wood products
Consult your local vegetation expert (such as Greening Australia)	++	++	++	++	++	++	+	+
Check relevant laws and regulations – especially on vegetation clearance	++	++	++	++	++	+	+	+
Retain existing native riparian vegetation, where possible, including small and isolated remnants and individual trees	+	++	++	++	+	+	N	N
Regenerate or replant cleared riparian land, where possible, and re-create local conditions (using local, native riparian species as a first choice) - site preparation is very important for success	+	++	++	++	+	+	+	+
Manage riparian lands within the context of other vegetation communities across the property and catchment, with: √ a minimum tree cover of 10% to protect the diversity of bird species √ local native vegetation covering at least 30% of the total farm area, with at least 10% of the farm area managed primarily for wildlife and at least 30% excluded from high-impact land uses √ a minimum of 30% of a landscape or property under woodland or forest cover is needed to avoid serious ecological damage √ patches of native vegetation across the catchment of preferably more than 10 ha, however, patches as small as 0.5 ha can be valuable habitat for wildlife, especially for birds and reptiles √ native vegetation patches in the landscape of 80 ha or greater – and particularly those with structural diversity in the understorey – have been shown to be important for bird species diversity in southern Australia	++	+	+	+	+	+	?	?
Maintain native vegetation around all natural waterbodies	++	++	++	++	+	+	?	?
Maintain a range of tree ages, and leave fallen trees to break down naturally	++	++	++	+	+	+	?	?
Leave (don't harvest) dead standing trees and those with hollows	++	+	N	N	+	N	N	N
Retain neighbouring native grasslands and avoid heavy grazing	+	+	++	+	N	N	N	N
Manage threatening processes – particularly salinity, weed and pest animal infestation	++	++	++	++	++	++	++	++
Fence off the vegetation patches and strips, and remove or minimise access by livestock, vehicles and equipment	++	++	++	++	++	-	+	+
Exclude grazing from native vegetation along creeks and gullies for at least 5 years	++	++	++	++	++	-	+	+
Use 'tools' like fire, flooding and grazing to maintain a healthy and diverse pattern of vegetation, where appropriate	+	+	+	+	+	+	+	+

++	The core practice will always make a positive contribution to the management objective
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Using riparian land as wildlife corridors

Objective

To provide refuge and passage for wildlife within and along riparian land.

Management principles

Riparian land provides habitat, as well as a pathway for wildlife moving from one patch of vegetation to another, both in cleared and uncleared landscapes. The greater the 'connectivity' (or linkages) between these patches, the easier it is for animals to move between habitats. This helps to sustain wildlife populations in forest and woodland patches as well as in the riparian environment itself. Areas of remnant vegetation should not be too widely dispersed or isolated. A distance of more than 500 metres may act as a barrier to less mobile species like small mammals and tree-dwelling marsupials moving between patches, compared to many birds which may regularly travel 1,000 metres or more. The value of your riparian land 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 impacts significantly on the effectiveness of the corridor itself.

The width of your 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. However, corridors can also aid the movement of feral animals, so this, too, requires careful management.

Particular care should be taken when choosing non-local plant species for revegetation (such as for wood production) to connect parts of the landscape. Genetic pollution of the local remnant patch can result through the cross-fertilisation of closely related plants brought into close proximity by the wildlife corridor. Pollen transfer has been recorded in native eucalypt forest remnants connected to corridors established using non-local species. However, in most cases the risk of genetic pollution to eucalypts is small. This is because there are strong barriers to hybridisation (cross-breeding) between distantly related species, differences in flowering time, or differences in other characteristics of the

Riparian lands are highly productive and provide a range of habitat components for wildlife. (Source: Land & Water Australia. (Photo: Peter Walton Photography))

Some animals, for example many frog species, are dependent on riparian habitats throughout their life. (Source: Land & Water Australia. (Photo: Has Wapstra))

flowers. There is little risk of hybridisation between species from the major eucalypt sub-groups (genera/subgenera).

The sorts of vegetation communities most at risk of genetic pollution are those that are naturally small or remnant populations. In these cases, acceptable isolation distances need to be defined, and will depend on factors like the movements of the birds, insects, marsupials and other mammals that pollinate them or disperse seed. Predominantly bird (and flying fox) pollinated eucalypts are likely to require larger buffer distances to prevent unwanted gene flow than those mainly pollinated by insects. Isolation distances need to increase as the size of the 'source' (corridor) increases relative to the 'sink' (remnant patch). While species choice is the most important factor, there are genetic and silvicultural (tree management) opportunities that can help minimise the risk of genetic pollution. For example, close spacing is known to reduce the abundance of flowers, and flowering on the corridor edges may be countered with guard rows of non-hybridising trees.

Remnant populations of the main plantation species in rural landscapes will be particularly at risk from genetic swamping of exotic provenances. Photo shows remnant stands of E. globulus *ssp.* globulus *in southern Gippsland. (Photo: B. Potts)*

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Management objectives

B. Wildlife corridors

Core practices

Core practices	Rip. plants & animals	In-stream life	Water quality	Stream stability	Crops & pastures	Livestock	Non-wood products	Wood products
Consult your local vegetation expert (like Greening Australia)	++	++	++	++	++	++	+	+
Check relevant laws and regulations – especially on vegetation clearance	++	++	++	++	++	++	+	+
Reserve riparian land for conservation where it provides a critical pathway for wildlife or connects significant habitat	++	++	++	++	++	-	-	-
Link patches of native vegetation by vegetation strips, preferably more than 50 m wide and at least 30 m wide on banks of waterbodies	++	++	++	++	++	+	?	N
Determine the distance between remnants necessary to support the movement of local species – a rule of thumb is 500 m for small mammals and tree-dwelling marsupials, and 1,000 m for birds	++	+	N	N	+	N	N	N
Preferably use local native species when replanting riparian corridors	++	++	+	N	+	N	?	?
Provide overhanging vegetation to shelter in-stream life, and provide food and breeding sites	++	++	+	+	+	N	N	N
Maintain a range of tree ages, and leave fallen trees to break down naturally	++	++	++	+	+	+	?	?
Leave (don't harvest) dead standing trees and those with hollows	++	+	N	N	+	N	N	N
Fence off the vegetation patches and strips, and remove or minimise access by livestock, vehicles and equipment	++	++	++	++	++	-	+	+
Select species carefully if using non-local native species to avoid genetic pollution of remnant patches of vegetation – determine the genetic importance and conservation value of the local stand (including the extent to which the local provenance is unique and endangered)	++	+	N	N	+	N	?	?
Assess the likelihood and impact of cross-breeding (the possibility of the local species breeding with the new species) - it is possible to predict the likelihood of crossing between trees and to check whether the different trees flower in the locality and whether they have a common flowering season.	++	+	N	N	+	N	?	?
Manage to reduce the chances of cross-breeding – either reduce the production of flowers or pollen √ Flower and pollen production will be reduced if the trees are closely spaced √ Use genetic control to reduce the intensity of flowering by selecting trees that flower poorly √ Choose material that flowers at a different time from the local stands √ Use species or individual trees that only flower late in life, delaying the risk √ Control pollination - small flowered species pollinated by insects don't usually receive pollen from large flowered species pollinated by birds √ Select and breed from trees with naturally sterile pollen or genetically engineer such sterility	++	+	N	N	+	N	?	?
Estimate the isolation distance required - one kilometre is considered sufficient to prevent significant genetic pollution	++	+	N	N	+	N	-	-

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Maximising the health and diversity of in-stream life

Objective

To conserve or restore the diversity of in-stream plants and animals.

Management principles

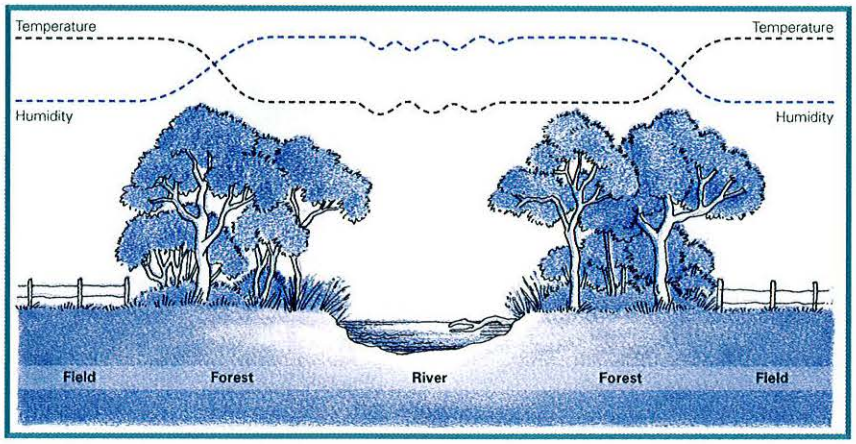
The condition of your riparian habitat is important to in-stream life. Riparian specialists (land-based or semi-aquatic) need specific riparian conditions throughout their life. The riparian microclimate is often humid, which is important to species sensitive to drying out. Undercut banks and their fibrous root mats shelter in-stream animals from predators and high flows. Many fish seek shelter among the roots of overhanging trees. In-stream animals feed on fruits (especially in tropical and sub-tropical regions) and insects that come from riparian land. Fish gain access to this food from overhanging vegetation, particularly in small streams where fruit, leaves or insects fall, or are washed into the water.

The riparian vegetation of small streams is more closely connected to in-stream life than lower in the catchment. Native vegetation that grows on stream banks is the main source of food supporting in-stream life in these small streams. The vegetation shades most or all of the stream, keeping water temperatures and light intensity low and thus limiting in-stream plant growth. Changes to shade through vegetation clearing or degradation can greatly increase the growth of in-stream plants. This plant growth can restrict flow, trap sediment, and markedly change habitat and water quality. A change in temperature of as little as 2°C can reduce the breeding success of fish like perch. The water temperature of a small stream can be controlled by maintaining or establishing vegetation on both its banks. The width of this vegetation is important. Higher water temperatures have been recorded where this width is less than 30m. However, even a narrow strip of native trees and shrubs has benefits.

The importance of riparian inputs to wider streams lower in the catchment is less well understood. The water that flows in these streams mainly comes from upstream. Only a small amount enters the channel directly from neighbouring land. This means that riparian vegetation in the lower catchment is generally less important in protecting water quality.

Riparian vegetation lower in the catchment shades only a small part of the stream. This enables significant in-stream plant growth to take place, in addition to the food that is supplied from upstream. Large woody debris (or snags) fall or wash into the stream from riparian land, providing both food and shelter to in-stream life. Upstream sources of large woody debris are thought to be a lot more significant than from riparian land in the lower catchment.

It is probably during floods that the riparian lands in the lower catchment provide the greatest contribution to the health and diversity of in-stream life. It is at this time that in-stream life has access to the wealth of food, shelter and breeding sites offered by the floodplain and billabongs of the Australian riparian environment.



Riparian vegetation has a moderating effect on air temperature and humidity, creating a special microclimate for wildlife. (Source: Land & Water Australia. ((Illustration: Carolyn Brooks.))

In undisturbed rivers there is often a large amount of woody debris present on streambanks and in the channel — this provides for a range of habitats for fish, birds and other plant and animal species. (Source: Land & Water Australia. (Photo: Ian Rutherfurd.))

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Management objectives **C. In-stream life** **Core practices**	Rip. plants & animals	Wildlife corridors	Water quality	Stream stability	Crops & pastures	Livestock	Non-wood products	Wood products
Consult your local expert on stream ecology	++	++	++	++	+	+	+	+
Check relevant laws and regulations – especially on vegetation clearance	++	++	++	++	+	+	+	+
Limit the disturbance of riparian vegetation on both banks of small streams	++	++	++	++	+	–	–	–
Maintain or replant native vegetation around all natural waterbodies, and re-create local conditions – retain or replant vegetation on the northern bank of an east-west oriented stream if resources are limited and you can't do both sides	++	++	++	++	+	+	?	–
Retain or establish overhanging vegetation with fibrous root mats to shelter in-stream life, and provide food and breeding sites	++	++	++	++	+	N	N	N
Maintain a range of tree ages, and leave fallen trees to break down naturally	++	++	++	+	+	+	?	?
Minimise modifications to large woody debris	++	++	++	+	+	N	?	–
Maintain a grass filter strip between paddocks adjoining riparian vegetation of at least 10 m	+	+	++	+	N	N	N	N
Fence off the vegetation patches and strips, and remove or minimise access by livestock, vehicles and equipment	++	++	++	++	++	–	+	+
Minimise the drift of chemical sprays into the riparian vegetation and the waterway	++	++	++	++	++	++	++	++

++	The core practice will always make a positive contribution to the management objective
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Using riparian land to improve water quality

Objective

To protect and improve the quality of surface waters by using riparian vegetation to filter sediment, nutrients and other contaminants.

Management principles

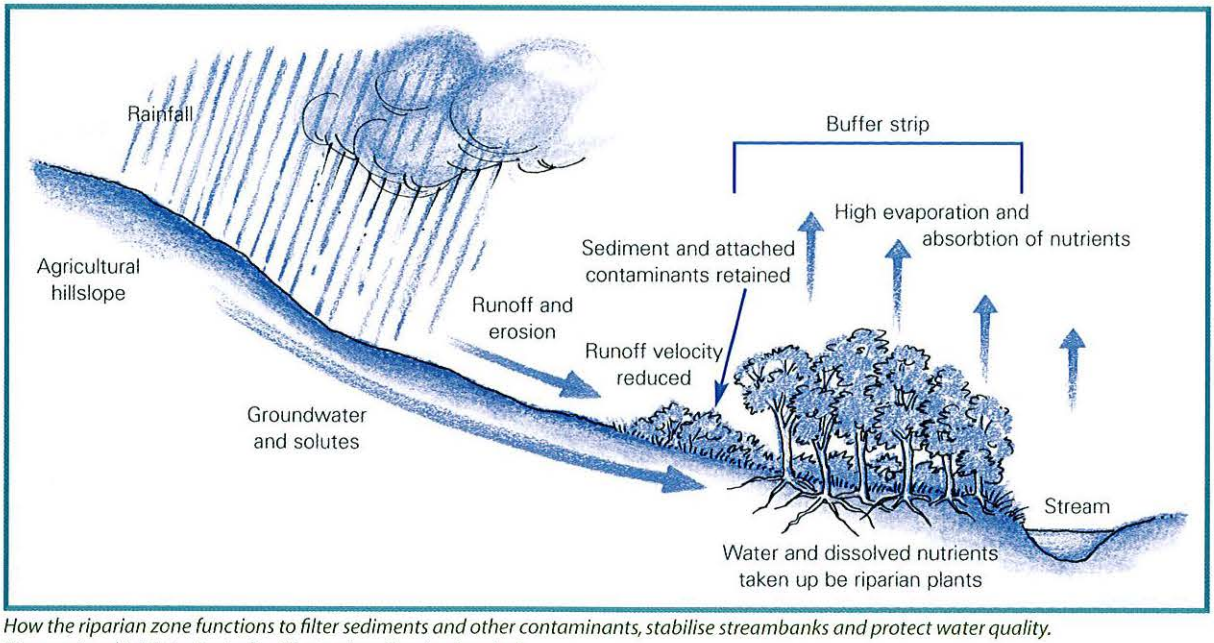
Controlling the movement of sediment, nutrients and other contaminants (e.g. manure, herbicides) from your farm and catchment is important for water quality and protecting the assets that rely on clean water. The National Land and Water Resources Audit has estimated that the amount of stream sediment in Australia is 10 to 50 times above natural levels.

The water quality of small streams is particularly prone to degradation when disturbed. Small streams comprise about 70% of the total stream length in a catchment and have the strongest link with their catchment. They collect all of their water from local catchment runoff and from groundwater. Riparian vegetation, therefore, has a particularly important role in filtering both surface and sub-surface contaminants along small streams, especially where the catchment has been cleared.

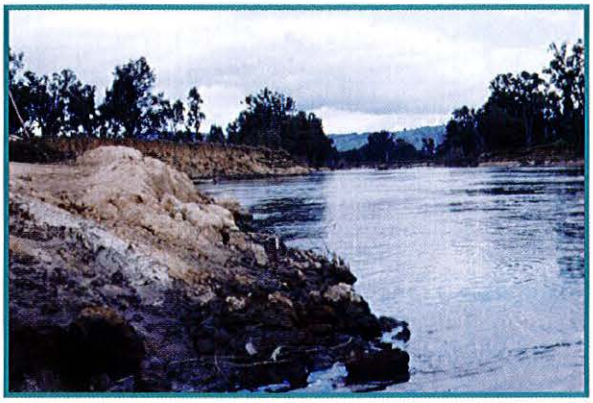
Streams in the lower catchment are often isolated from the surrounding hillslopes by wide floodplains and terraces. Surface runoff only reaches the stream when in full flood, and even then the speed of flood waters is usually low enough for the settling of sediment to occur. These factors explain why floodplains build up and why they have very fertile soils.

The main sources of sediment and nutrients are from the erosion of hillslopes, stream banks and gullies, and from groundwater. Often 90% of eroded sediment comes from only 20% of the catchment. Erosion of soil by raindrops is small where groundcover is more than 70%. Wind can also carry materials and fertiliser sprays for some distance.

In many Australian environments, sediment and nutrient inputs to streams from stream bank erosion or groundwater is greater than that from hillslope erosion. Hillslope erosion has traditionally been regarded as the chief source but gully erosion inputs far exceed that of hillslope erosion in areas with an active gully network. Most gully expansion in south-east Australia is now complete. Water quality continues to degrade because their steep, bare banks expose highly erodible soils. Most gullies are connected to streams and deposit nearly all eroded sediment there.



How the riparian zone functions to filter sediments and other contaminants, stabilise streambanks and protect water quality. (Source: Land & Water Australia. (Illustration: Carolyn Brooks.))

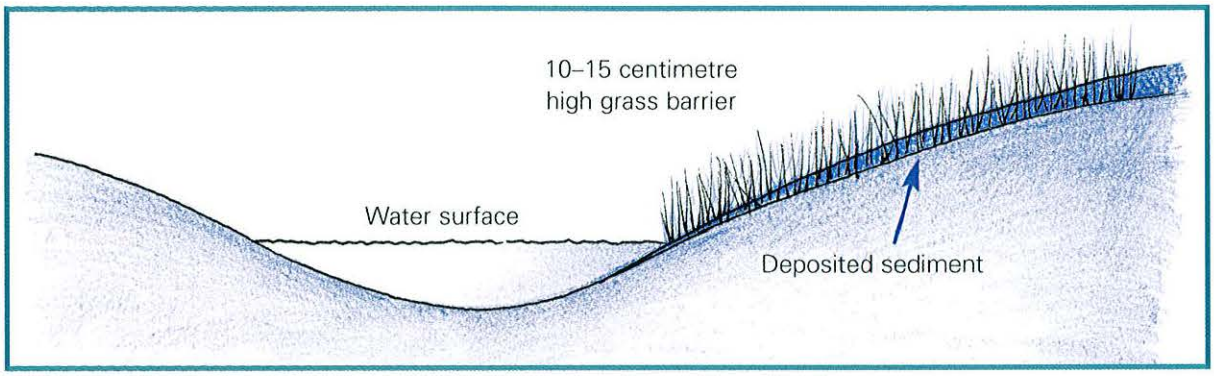


These photos show different erosion processes occurring along streambanks as a result of the removal of protective riparian vegetation. (Source: Land & Water Australia. (Photos: Ian Rutherfurd.))

Groundwater carries dissolved and, to a lesser extent, suspended substances. These substances come from the surface and from the soil and rock that the groundwater passes through. Only a small amount of sediment is delivered to streams by groundwater, except where eroded 'pipes' or large soil spaces (>1 cm in diameter) exist. Nutrients in groundwater (nitrate and dissolved phosphorus) are immediately available to in-stream life. Nutrients in groundwater can be used by riparian plants, released to the atmosphere (denitrification), or attached to soils (in the case of phosphorus). Phosphorus readily attaches itself to clays, but much less so to sands.

You can look at the history of land use and management practices in your groundwater flow system (see page 4-6) to make an educated guess about the quality of the underlying groundwater. You can use information on fertiliser application rates to estimate groundwater nitrate levels, as the impact of recent rates of nitrate loss from agricultural soils on water quality may not be observed for several years to come. Where groundwater quality records have been collected, a more accurate assessment of condition may be available.

You can use a filter strip of grass and/or shrubs and trees to trap surface runoff, sediment, nutrients and other contaminants. It should be maintained or established at points where surface waters enter small streams. In most catchments, this does not mean a strip of set width along both banks. A wider filter strip is needed where flow gathers, for example at dips and gullies. Grasses are more effective at slowing runoff and trapping material. Grass filters generally need to be at least 10 m wide to store the sediment carried by runoff. A forested filter strip needs to be wider as runoff tends to be more channelled and the soil cover more sparse. Runoff quickly channels around tree trunks, roots and stock tracks. Wide spaced trees which maintain a grass understorey would be good for filtration.



How a grass buffer strip functions to trap sediment. (Source: Land & Water Australia. (Illustration: The Idea to Here.))

A grass riparian buffer trapping sediment downslope of a ploughed paddock. (Source: Land & Water Australia. (Photo: Ian Prosser.))

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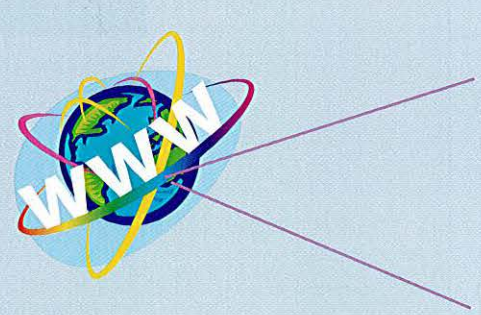

See www.nlwra.gov.au for maps and information on the export rates of sediment and nutrients from hillslope gully and stream bank erosion, and on groundwater status

See www.mdbc.gov.au for finer resolution maps and information on the export rates of sediment and nutrients, and on groundwater status for the catchments of the Murray-Darling Basin (available in early 2003)

Management objectives

D. Water quality

Core practices

Core practices	Rip. plants & animals	Wildlife corridors	In-stream life	Stream stability	Crops & pastures	Livestock	Non-wood products	Wood products
Consult your local expert on water quality (such as a river management authority)	++	++	++	++	+	+	+	+
Check relevant laws and regulations	++	++	++	++	+	+	+	+
Maintain well-established bank vegetation to reduce surface erosion by at least half and protect the waterway from wind blown contaminants	+	+	+	++	+	+	+	+
Limit the disturbance of riparian vegetation on both banks of small streams	++	++	++	++	++	-	-	-
Identify and prioritise the highest sources of sediment and nutrient export in the catchment for repair – particularly active gullies, as they deposit nearly all eroded sediment into the stream	+	+	++	++	+	+	+	+
Maintain groundcover at greater than 70% to prevent soil erosion in the riparian area and on neighbouring land (native groundcover vegetation, good pasture or dense cereal crops achieve 70% cover)	+	+	++	++	+	N	?	?
Prevent future erosion by maintaining good grass or tree cover in areas prone to gully extension – particularly on steep hillslope hollows with catchment areas of 1 hectare or more. Focus attention on any landscape dips and where flow concentrates, and aim to establish a broad well-grassed buffer zone that covers the entire area of flow concentration - make sure that the grass stems are not submerged - sediment trapping efficiency may be reduced to as low as 40% where flow becomes channelised	+	+	++	++	+	+	+	+
Maintain a grass filter strip between paddocks adjoining riparian vegetation of at least 10 m – use grass that is perennial, resistant to flooding and drought, and able to keep growing after partial flooding, and avoid grasses that are highly invasive or are a significant weed problem	+	+	++	+	N	N	N	N
Protect and restore the first metre of the grass filter, as the first 60 cm collects ~90% of the sediment load and around 50% of the total phosphorus load	+	+	++	++	N	N	N	N
Avoid disturbing grass filter strips through grazing, cultivation, or herbicide spraying, particularly when the risk of high intensity rainfall is great	+	+	++	+	N	N	N	N
Sow or maintain dense, relatively short grass (10-15 cm is optimal), as clumpy vegetation prevents deposition	+	+	++	+	N	N	N	N
Minimise the displacement of clay-sized (with attached phosphorus) or fine organic particles (with attached nitrogen), as these move through a vegetation strip virtually unchecked	+	+	++	+	N	N	N	N
Maintain trees in the riparian area where the roots can intercept groundwater and take up dissolved nutrients – particularly where the water-table comes to within 2-3 metres of the root zone – riparian forests are estimated to use 10-15% more nitrogen than dense grass stands	+	+	++	+	+	+	+	+
Maintain young trees in the stand, as their nutrient uptake is thought to be greater (although this can be seasonal)	+	+	++	++	+	+	+	+
Fence off the vegetation patches and strips, and remove or minimise access by livestock, vehicles and equipment	++	++	++	++	++	+	+	+
Minimise the drift of chemical sprays into the riparian vegetation and the waterway	++	++	++	++	++	++	++	++

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CASE STUDY

Jon and Vicki Taylor are full-time managers of a 1,200 ha super-fine wool producing enterprise near Armidale in NSW. 'The Hill' has been in the family for 165 years, and was handed down to Jon and Vicki in 1986. Three kilometres of Terrible Vale Creek passes through the property, fed from two large tributaries. In the early '80s, the stream banks were bare from heavy stocking and the creek waters were muddy. During floods, the creek spreads up to 50 metres across and is 2 metres in depth, moving soil from upstream and eroding the stream banks. About 2-3% of the property was treed, but without any understorey and virtually no trees in the riparian area itself.

The Taylor's revegetation plans started to take shape in the mid-'80s. They wanted to improve the quality of the creek water and provide habitat for native species. Jon explained that 'we wanted to keep our own soil in place, and at the same time trap all the nutrient-rich topsoil that the neighbours are giving away.' By 2002, fencing was erected along 2.4 kilometres of creek line, with 50 metre strips of mixed vegetation on each stream bank about 4 rows deep. Livestock were removed for the first few years to get plants established, and used later to crash graze long grass. Jon cautioned that he 'removes livestock when the grass is short and before teeth marks are evident in the tree bark.' The Taylors use livestock of a certain age, type and gender to safely graze amongst the trees. They have found that even very young trees can be exposed to grazing with careful monitoring.

Woody vegetation now covers 7-8% of the farm, about one fifth of which are local provenance species. Over 300,000 trees have been planted, of which around 30 varieties are exotic – radiata pine, poplars, elms, silver birch, ash, oaks, pears and apples. The Taylors have no intention of harvesting any trees in the riparian area, but will harvest wood products elsewhere on the property. Jon noted that 'little was known about revegetation techniques and local provenance stock was difficult to get at the time we got interested in revegetation.' The local provenance species they have grown suffer from both New England dieback and frost damage along the creek lines. One native species local to an area about 10 kilometres away has performed well and plans are in place to expand these plantings this winter.

The Taylors know that they have been successful in achieving their management objectives of improved water quality and habitat by observing simple indicators of change – the birds flying between trees, the reeds growing in the creek, the clear creek waters, the sheep lounging in the shade and the increased stocking capacity of the farm.

CASE STUDY

'Oonooie' is a cane farm near Sarina in Queensland where the average rainfall is 2,500 mm per year. The soils are poor quality, but can produce good yields with the right management. Previous owners used burning as a primary management tool, and the land had been burnt so often in the past that most of the riparian vegetation had been destroyed. Keith Schmidtke and his family purchased 'Oonooie' in 1980, with the goal of making it sustainable. Faced with erosion, weeds, rats and shrinking riparian areas, the Schmidtke's decided to take a whole farm planning approach. In 1997, Keith was named 'Mackay Environmental Farmer of the Year'.

The Schmidtke family moved all the cane fields back from the stream bank to create a wider riparian area. An extensive tree planting program commenced in 1982, using remnant trees and 4,000 tubestock plants. This was supplemented by natural regeneration, encouraged by the elimination of burning, controlling weeds such as lantana, and using some chemicals to clean up problem areas. By not burning, most grass seeding was eliminated, reducing the supply of feed for rats. Along with green cane harvesting and some chemical spraying, the rat problem is now under control. The farm was also marred by gullies – 60-70 in just 150 hectares, with one gully being 400 metres long by 6 metres deep at one end. Repair of the gullies required a total of 300,000 cubic metres of soil.

The strategies and treatments put in place by the Schmidtke's have had a marked effect. A continuous strip of trees and shrubs now runs throughout the property providing a corridor for birds and animals, as well as acting as a sediment trap and preventing erosion. A good tree canopy cover shades out unwanted introduced plants and keeps grass down. Erosion has become manageable, with the repair of gullies reclaiming 24 hectares of productive cane land. Green cane trash blanketing and good riparian cover now filters and traps sediment from entering the creek. The muddy waters from the days of burning are a thing of the past.

The Schmidtkes argue that their management makes sound economic sense. Keith says that 'the overall cost of restoring the land has been minor compared to the benefits. My family intends to farm this property until retirement and will endeavour to keep the whole farm, especially the riparian land, both functional and picturesque.' These functions include stream bank stability, erosion control, fish habitat and wildlife corridors. In Keith's own words – 'What a great scene to live with. You wake up in the morning with kookaburras laughing in the trees, magpies and butcher birds warbling their song for all to hear, and there are scrub turkeys, flocks of ducks, and mobs of kangaroos and wallabies. Surely this alone is enough reason to take care of our riparian area, but when we add all the other benefits – erosion control of stream banks, no siltation of stream beds, good water quality, fish habitat, aesthetic appeal and rat control, what better picture of a wonderful lifestyle can I paint?'

Riparian zone on a cane farm being used to filter and trap sediment, provide habitat for owls that keep rat populations in control, maintain streambank stability, and make the farm a nicer place to be! (Source Land & Water Australia. ((Photo: Ian Prosser.))

E

Protecting stream stability

Objective

To maintain bank stability that is sufficient for the stream to recover quickly from small flooding events.

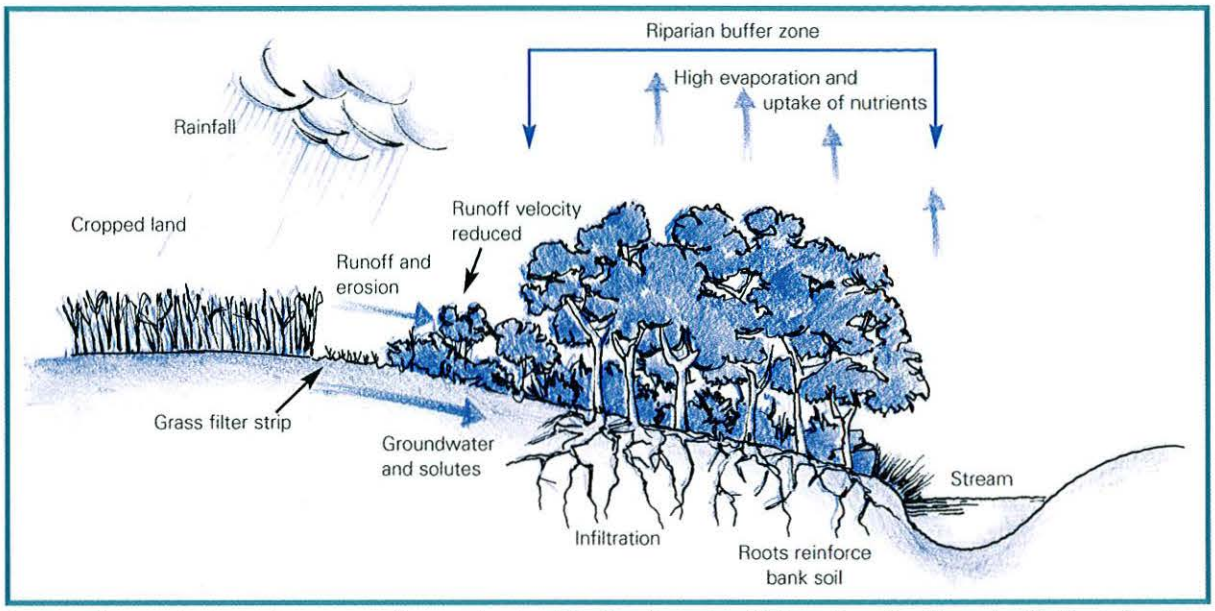
Management principles

In many cases, the erosive forces acting on streams in Australia are too great to be controlled by vegetation alone. Streams have been widening and deepening to carry the extra water running off land cleared for agriculture and towns. Vegetation has little or no influence on the stability of a channel that is much wider than it is deep. When restoring and managing riparian vegetation, you need to know whether the stream flow and channel are in balance. Your channel or bank stability problem may be linked to larger catchment processes. You may need to plan works with upstream landholders, and engineering structures could be required. The advice of a local expert should be sought to work through these issues.

Channel erosion is a natural process. You should aim to restore some stability to your stream so that it is less sensitive to small floods and capable of recovering from them. Channel and stream bank erosion is reduced when vegetation lines the upstream banks. Tree-lined channels tend to be narrower and deeper, and less prone to catastrophic widening and gullying.

Well-established bank vegetation will reduce surface erosion by one to two orders of magnitude. Bare banks are prone to collapse and scour (where sediment is removed bit by bit). Overgrazing can lead to bare patches of soil. Grazed stream banks erode about three to six times faster than ungrazed banks. Stream banks that are dry will be more stable than wet ones. Those with dispersible or weakly bound soils are most prone to erosion because they breakdown into small particles and because their surfaces seal easily when bare.

The removal of riparian vegetation has resulted in streambank erosion and the collapse of large sections of the bank on an adjacent sugar cane property. (Source: Land & Water Australia. (Photo: Ross Digman.))



Processes that occur in the riparian zone to assist streambank stabilisation. (Source Land & Water Australia. (Illustration: The Idea to Here.))

Streams naturally meander and form outside and inside bends. The outside bend is where erosion usually occurs, while material is deposited on the inside bend, forming a 'bar'. Inside bars naturally colonise with vegetation, which then channels stream flow onto the outside bend. Fast currents put the outside meander bend under stress, leading to erosion. You can remove vegetation from the inside bar to reduce this stress. Planting vegetation on the outside bend will provide reinforcement (in most cases it is necessary to first stabilise the base of the bank or 'toe' with rock or some other engineering structure). No protection works are required on the inside bend.

Vegetation in between major meander bends may require removal of some overhanging trees or branches, which could fall in and cause direct erosion problems. You may need to position snags so that flow is directed into the centre of the channel and away from the banks.

Plant roots reinforce the soil close to the surface, where the roots are denser and the soil is weakest. You need to continue vegetation down the face of the bank to stabilise banks of 3 m or more. Choose plants with a dense network of fibrous roots for greater protection from erosion. In Australia, roots don't tend to grow beyond the summer water level. They can also be shallow where the watertable is high or a hard soil layer exists. Woody plants provide the greatest bank stability, while grasses provide groundcover and so reduce scour.

Bank stability can be influenced by strong winds.

Wind loading on trees is significant where wind speed is more than 40 km/hr (fast enough to make branches move). A wide stand of trees is more stable than a single line along the bank top. The weight of trees affecting stability is seldom valid as an argument for not planting them, except when the bank is vertical or near so. Where the bank is sloping, vegetation will generally improve the stability of the bank.

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Management objectives **E. Stream stability** **Core practices**	Rip. plants & animals	Wildlife corridors	In-stream life	Water quality	Crops & pastures	Livestock	Non-wood products	Wood products
Consult your local adviser on stream flow and channel equilibrium (attend to the flow of the channel first), dominant erosion processes and plant selection	++	++	++	++	+	+	+	+
Check relevant laws and regulations – stream bank and in-stream works sometimes require local government approval	+	+	++	++	+	+	+	+
Line stream banks with well-established vegetation, using woody plants for mass stability and grasses to reduce scour – introduced species may be needed for initial stability, while slower growing natives get established	+	+	++	++	+	+	?	?
Retain or plant wide stands of trees (more than one or two rows) to reduce the likelihood of slumping and the impacts of wind loading	+	+	++	++	N	N	++	++
Treat areas of waterlogging caused, for example, by a dam on the neighbouring floodplain or high watertables with drainage works and/or planting of recharge and seepage points beside the stream bank to reduce the chances of slumping	+	+	++	++	+	+	+	+
Control access (livestock, equipment, harvesting operations) to stream banks, particularly when wet (and unstable) and where soils are dispersible or weakly aggregated	++	++	++	++	N	–	?	?
Revegetate and construct fences a minimum of 5 metres away from stream banks, and 10 metres away where active stream bank erosion is evident (and do not harvest the trees), particularly the outside of meander bends - position fences at near-parallel to the direction of flood flows (rather than at right angles)	+	+	++	++	N	N	?	–
Remove vegetation from the inside bar of a meander bend to reduce the stress on the outside bend	+	+	++	++	N	N	N	N
Stabilise the toe of the bank on outside meander bends with rocks or some other engineering structure, or anchored large woody debris, if needed	+	+	++	++	N	N	N	N
Retain or revegetate the toe of the bank down to the low water level, particularly banks higher than 3 m and the outside of meander bends (batter back to an angle of 30°, where possible)	+	+	++	++	N	N	N	N
Use dense plantings (1 m randomly spaced) adapted to flooding, and slow release fertiliser when planting seedling trees in gravel or sand at the toe of a stream bank - adding some silt or sand to coarse gravels for extra reinforcement	+	+	++	++	N	N	?	?
Don't use tree guards or stakes when planting for erosion control in high velocity sections, as it may trap debris and wash out the plants	+	+	++	++	N	N	N	N
Position trees (and associated large woody debris) to direct flow into the centre of the channel and away from the banks – if a snag is lying across the channel, rotate it to an angle of 20-40° to the stream bank, as this will achieve immediate improvement to the capacity of the channel	+	+	++	++	N	N	N	N
Remove overhanging trees or branches which could fall in and cause direct erosion problems – lop branches near the water surface if they have a tendency to trap smaller woody debris, causing log jams	+	+	++	++	N	N	N	N

++	The core practice will always make a positive contribution to the management objective
+	The core practice is most likely to have a positive impact on the management objective
–	The core practice is most likely to have a negative impact on the management objective
N	The core practice is most likely to have no impact on, or is not relevant to, the management objective
?	The effect of the core practice on the management objective unkown

F

Using riparian land to improve the productivity of crops and pastures

Objective

To shelter adjacent crops and pastures from wind and windborne materials, and provide habitat for beneficial animals, especially pollinators.

Management principles

Riparian vegetation can act as a windbreak and provide habitat for beneficial animals. These functions can boost your farm productivity. A windbreak provides shelter to reduce direct damage to the neighbouring crop or pasture from soil erosion, sandblasting, leaf damage and flattening of plants. Microclimate and water availability are improved, resulting in increased plant growth. Greater plant growth means more feed for your livestock and, sometimes, higher crop yields. Production benefits vary from place to place with climate, soil type and wind. In general, agricultural productivity will only improve if some already limiting factor changes at your site.

The National Windbreaks Program showed two broad areas of crop and pasture response – an area of lower yield due to competition for water and nutrients between 1-3 windbreak heights (H), and an area of no change or slight increase in yield a further 10-20 H downwind. These areas vary depending on species of crop, soil type, and root and soil structure.

The area shaded by a windbreak also changes with time of day, time of year, orientation and latitude – a longer shadow is cast in temperate and cool regions than in the tropics. Shelter tends to increase yields in dry years, in general, while wet years show little response. Yield gains from improved microclimate are small in most years, but guard against the possibility of major losses from strong winds.

The minimum wind speed near the ground, where shelter for plants and animals is most important, is typically between 3 H and 8 H. The greatest increase in temperature and humidity occurs at about 5 H, extending to only about 12 H. Windbreaks also reduce the downwind movement of chemical sprays, by trapping it and by slowing wind speed.

You need to consider two primary factors when designing a windbreak. The first is its structure. Height is the main influence on the downwind extent of shelter, while the length of your windbreak should be more than 20 times its height. Width itself has little impact on performance. The ideal windbreak has moderate porosity (spaces) 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

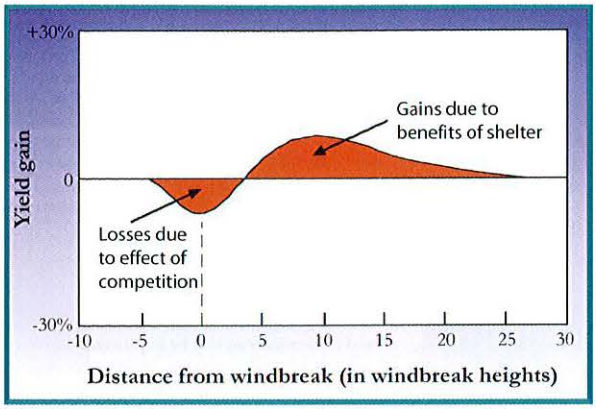
In addition to other benefits of farm forestry, trees can improve farmland by offering protection from wind. (Source: Shaping the Future with Farm Forestry. JVAP Newsletter, Issue 8. Spring 2002.)

the ground to prevent wind funnelling at low levels. A single-row can provide useful shelter but poses a higher risk of forming gaps than a multiple row windbreak.

The second primary design factor is windbreak layout. The best orientation is at right angles to the prevailing wind, although you may have little flexibility in determining this on riparian land. The wind can change direction by up to 30° and result in only small reductions in the distance sheltered if your windbreak is long enough (i.e. more than 20 H). Even when the wind is blowing along the line of trees, a small area is still sheltered because of the 'drag' effect of the trees on the wind. Riparian land in hilly terrain will experience different wind patterns than on flat land. Windbreaks will provide an important risk management tool for intermittent events of high winds which can cause a lot of erosion in a single event.

Healthy, vegetated riparian land not only benefits crops and pastures by acting as a windbreak, but also by providing habitat for pollinators. Much of our food comes from crops that require pollination by insects, birds or other animals. Lucerne, an important pasture in salinity control, is a pollinator-dependent species. Pollination is the process of moving pollen from male flower parts to female flower parts. For some plants, like grasses and cereal crops, the movement of pollen by wind is sufficient to pollinate flowers. For other plants, the male flower parts contact the female flower parts of the same flower. However, the majority of plants need 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. These pollinators are declining due to loss of habitat and pesticide use. Farmers in many parts of the world have to purchase the services of bee-keepers to pollinate their crops.

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 beetles are eaten by cuckoo-shrikes, kingfishers and the larger honeyeaters, while whistlers snatch leaf beetles and caterpillars from eucalypt foliage. Magpies take thousands of scarab larvae per hectare each year. Ibis may consume large numbers of insects, particularly grasshoppers and larvae, but their activity is often local. 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 predatory insects and spiders can take a significant proportion of insects that are not eaten by birds. Predation of crop and pasture insects is likely to be greatest next to forested land.



The effect of a windbreak on crop yields. (Source: Design Principles for Farm Forestry. *Joint Venture Agroforestry Program, Rural Industries Research and Development Corporation.)*

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- The 'optical method' can be used to estimate the porosity of a 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's even more accurate if you use a photograph.
- A ten metre high windbreak will provide protection over an area extending perhaps 300 metres downwind.

See www.rirdc.gov.au

The Joint Venture Agroforestry Program (JVAP) has been responsible for running the National Windbreaks program.

Management objectives

F. Crops and pasture

Core practices

Core practices	Rip. plants & animals	Wildlife corridors	In-stream life	Water quality	Stream stability	Livestock	Non-wood products	Wood products
Consult your local vegetation or farm forestry expert, if you intend to harvest some of the trees (like Greening Australia)	++	++	++	++	++	++	+	+
Use mixed, local native species in multiple rows to maximise beneficial animals, especially native pollinators	++	++	++	++	++	?	?	?
Create a riparian windbreak of at least 20 windbreaks heights in length – the longer the windbreak the greater the area sheltered	+	+	+	+	+	+	+	+
Maintain or establish a riparian windbreak that is more than a single row of trees to maintain uniform porosity (spaces). Use multi-row windbreaks with a range of life spans (there is no benefit in creating a streamlined profile with tree rows of different heights) and ensure replanting or regeneration is timed to prevent tree deaths (or tree harvesting) resulting in gaps or major variations in porosity – this is particularly the case in dry regions where trees generally grow slowly and tree deaths are more likely than in wetter country	+	+	+	+	+	+	+	+
Use low branching and bushy trees where only a single-row windbreak is desirable, as they provide reasonably uniform porosity from the ground to the top	+	+	+	+	N	N	?	?
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	+	+	+	+	N	+	?	?
Replace young trees that die as soon as possible, and control weeds during the establishment phase	+	+	+	+	+	+	+	+
Fence the windbreak to prevent livestock eating foliage and therefore increasing porosity, especially for windbreaks made of just a few tree rows	++	++	++	++	++	–	++	++
Place gates at the end of the windbreak	N	N	N	N	N	N	N	N
Achieve the maximum possible height as soon as possible by choosing a fast-growing tree species – if the trees of this species are short-lived, supplement with outer rows of slower-growing trees	N	N	N	+	+	+	+	+
Select plant species that mainly send their roots downward rather than shallow, spreading roots, if competition for water and nutrients with the neighbouring crop or pasture is a concern – likewise for waterlogging and salinity	N	N	N	+	+	N	?	?
Consider using deciduous trees where substantial protection is needed in the winter months, when the leafless trees will allow the winter sun through and shadowing will be reduced – deciduous trees have the advantage of not competing for water and nutrients, while still providing some wind shelter, when they are leafless	–	–	–	–	+	–	?	?
Prune low branches to reduce shading of pastures and crops, reduce fire risk or maximise log quality, where appropriate – side trimming may be needed in windbreaks containing trees with broad, spreading crowns to prevent both excessive shading and damage to fences from falling branches	–	–	N	N	N	+	?	+

++	The core practice will always make a positive contribution to the management objective
+	The core practice is most likely to have a positive impact on the management objective
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N	The core practice is most likely to have no impact on, or is not relevant to, the management objective
?	The effect of the core practice on the management objective unkown

G

Using riparian land to provide shade, shelter and feed for livestock

Objective

To protect and improve the condition of livestock by using riparian vegetation for shade, shelter and feed.

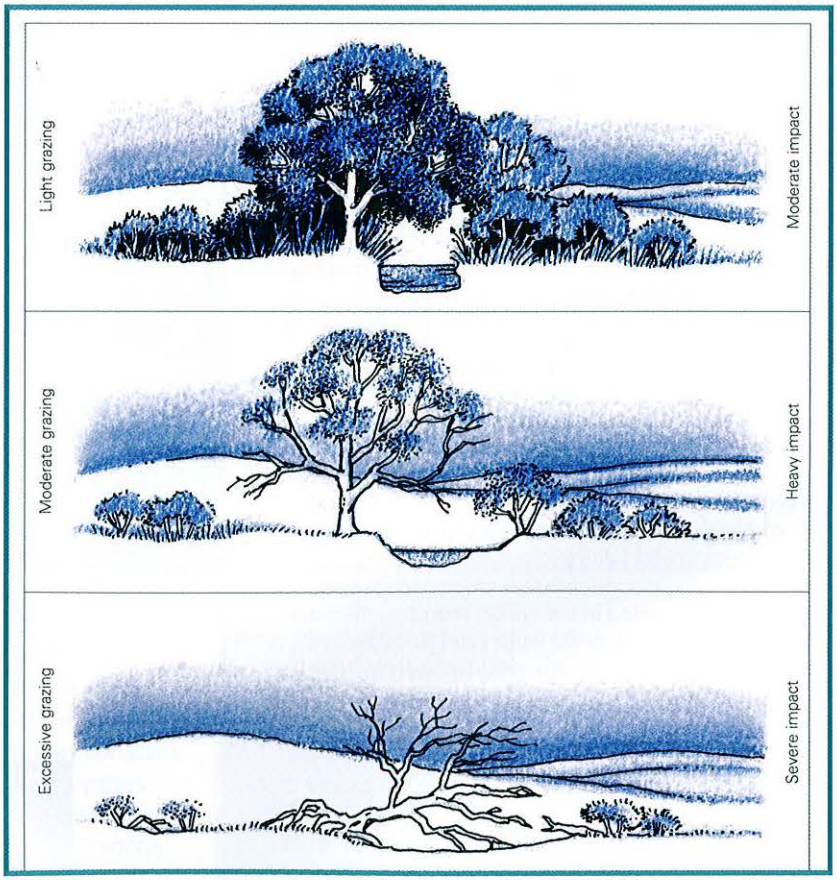
Management principles

Livestock like to graze the understorey grasses and shrubs on riparian land, favouring the microclimate, feed, shelter and moisture there. Shelter can improve livestock production and survival by increasing pasture supply and reducing stress on animals. The long-term aim of grazing on riparian land should be to improve animal health and production, while minimising damage to the vegetation and maintaining ground cover at above 70%. You can achieve this by managing the timing, intensity and duration of grazing, together with providing access to clean water.

Research at Bungendore (NSW) shows that native pastures growing under moderate tree cover have higher productivity. Pasture productivity under trees (across five seasons) was 26% higher on average. Tree cover increased productivity in non-drought seasons and had the largest relative effect in winter.

Heat stress can seriously increase livestock mortality (death) and reduce stock fertility, weight gain and milk production. Heat stress is the main climatic problem affecting the productivity of livestock in tropical Australia. Although sheltering livestock from the weather (sun, heat, drought, wind, cold and frost) improves their condition, especially dairy cattle, lambs and newly shorn sheep, it is better to shelter and feed livestock elsewhere on the property, as riparian land is fragile. However, where this is not possible or desirable, steps can be taken to minimise the impact of grazing on riparian land.

Long periods of grazing riparian land can lead to even-aged trees and/or reduced species diversity (shifting to those plants more tolerant of grazing). Overgrazing can restrict the establishment of many riparian plants, reducing canopy cover and increasing light and temperature. Livestock can compact and disturb the soil, especially during rain. If allowed access to the stream, it can be contaminated with their manure and urine, contributing phosphorus, nitrogen, bacteria and viruses. Weeds may also be carried into the riparian area in their coats, hooves and manure.



Heavy livestock grazing in riparian areas can eventually result in near-total collapse of the native riparian vegetation cover. (Source: Land and Water Australia. Modified from Thomas et al. 1979. (Illustration Carolyn Brooks.))

There are many ways to improve management of riparian areas so that livestock access can be controlled. Off-stream or purpose built in-stream watering points might also be considered to reduce stock impacts on the riparian zone. Animal growth rates and productivity will increase with access to clean water. Livestock tend to drink less water, grow less quickly and contract more bacterial infections when their drinking water is polluted. To avoid soil pugging (footprints), restrict livestock access to when soil moisture is low, and limit their access to steep banks where animal losses may result.

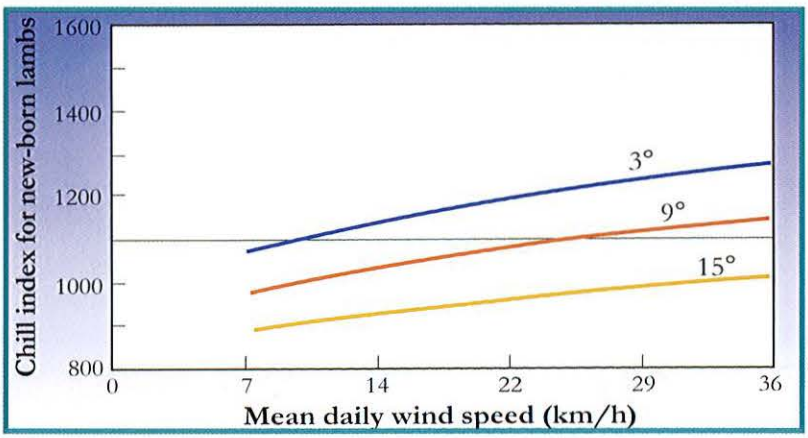
When restoring your riparian land, exclude livestock until the plants are firmly established. Once established, livestock should be excluded when plants are starting their annual growth, and during flowering and seed production. Grazing is best when plants are dormant or, in the case of grazing for weed control, just before they set seed. Trees that lose their leaves may provide feed when leaves fall (or are pruned), especially when pasture quality is at its worst. Although this leaf fall is of lower quality than green leaf, it is still higher quality feed than dry season grass, and has different nutritional properties.

Livestock tracks and pugging provide direct routes for sediment and nutrients to wash into the riparian zone. (Photo: Siwan Lovett.)

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

FAST FACTS

- Understorey birds were most diverse in farm sites that were never grazed (5% increase) and were 9% less diverse in sites that were mostly grazed
- Bird diversity is re-established about 15 years after the removal of stock from a heavily grazed site. This increase in diversity continues, reaching a maximum diversity after about 25 years. (Birds on Farms, p viii)



The effect of wind and temperature on heat losses from new born lambs. (Source: Design Principles for Farm Forestry, Joint Venture Agroforestry Program. *Rural Industries Research and Development Corporation.)*

G. Livestock

Core practices	Rip. plants & animals	Wildlife corridors	In-stream life	Water quality	Stream stability	Crops & pastures	Non-wood products	Wood products
Consult your local agronomist (and farm forestry expert, if grazing beneath trees for later harvesting)	+	+	+	+	+	++	++	++
Exclude livestock from riparian land with rare, threatened or vulnerable species	++	++	++	+	+	+	N	N
Limit or remove livestock access to the riparian area of small streams	++	++	++	++	++	++	N	N
Maintain groundcover at greater than 70% in the riparian area and on neighbouring land to prevent soil erosion	+	+	+	+	+	+	N	N
Control the timing, duration and intensity of livestock grazing to enable healthy riparian vegetation to re-establish	+	+	+	+	+	+	+	+
Move livestock before vegetation degradation or stream bank erosion becomes a problem	+	+	+	+	+	+	+	+
Exclude livestock during plant establishment, and at key times like at the commencement of annual growth and during flowering and seed production	+	+	+	+	+	+	+	+
Access by livestock to riparian areas should be for short periods only, and not when the soil is wet	+	+	+	+	+	+	+	+
Allow livestock to drink from streams at purpose-built access points or install off-stream watering points (pumping to storage tanks or dams or reticulated to troughs; or from gravity fed dams) - Check relevant laws and regulations - local council often requires approval before constructing livestock access points in the stream bed or banks	+	+	+	+	++	+	N	N
Use livestock grazing to control weeds or use a non-persistent herbicide – where weeds are shallow-rooted and small in number, pull by hand or grub out with a hoe - Care should be taken when spraying near or over water	+	+	+	+	+	+	+	+

++	The core practice will always make a positive contribution to the management objective
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?	The effect of the core practice on the management objective unkown

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Harvesting non-wood products from riparian land

Objective

To supplement farm income through harvesting non-wood products from riparian land for sale or on-farm use.

Management principles

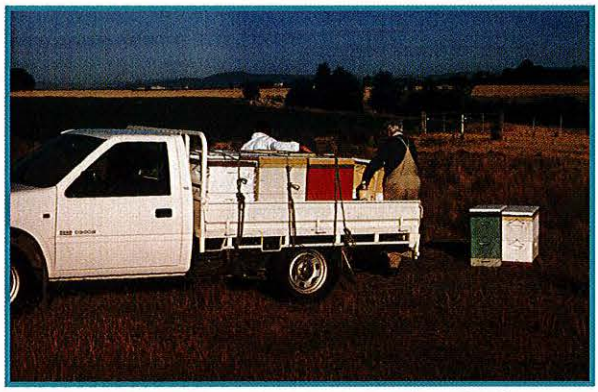
Harvesting non-wood products (such as seed, honey, foliage, bushfoods, essential oils, nuts or pharmaceuticals or other bio-based products) from your riparian land may have little impact on the other values you wish to protect. These non-wood products may be harvested from native trees (old growth, regrowth, planted) or exotics like carob, jojoba, olives, cork oak and nut-bearing trees. Alternatively, there may in future be potential for chemicals including preservatives, adhesives, herbicides or degreasing agents to be extracted from trees. However, the impact would depend on the specific product and nature of harvest. You should see whether there are any regulations or laws that govern the use of riparian land before getting started. Local and State laws sometimes prevent or limit productive activities on riparian land.

Using trees to harvest non-wood products certainly provides a more diverse habitat than agricultural crops and introduced pastures – both above and below the ground. Retaining remnant vegetation and planting local natives provide the highest biodiversity values, followed by planting non-local natives and lastly exotic species. A single species planting has less biodiversity value than a mixed species planting but greater biodiversity than an agricultural landscape.

Harvesting non-wood products from riparian land should avoid affecting plant and animal species abundance, distribution, frequency, fertility and mortality (death) – not just in the riparian area itself but also on neighbouring land and the in-stream environment. As a general rule, harvesting should not take place in riparian habitat that is important for rare, threatened or endangered species. Activities that cause significant disturbance, like foliage cutting, should be restricted to times that least affect wildlife. Disturbance of small streams is more likely to lead to off-site problems, like degradation of water quality, than in lower parts of the catchment. Harvesting that alters shading is likely to affect the distribution and abundance of in-stream life and in-stream plant growth, particularly if nutrient inputs are increased.

The productivity of a stand of trees and their growth (together with their protection from fire, disease and pests) can be improved by using silvicultural techniques like selective thinning (tree removal), pruning or other management methods. Influencing the extent to which individual plants compete for light, nutrients and space through forest thinning is a primary way of manipulating the growing stock. The aim of thinning might be to accelerate the growth and value of the remaining trees and to provide shelter and feed for livestock.

There are many potential non-wood products, and they have varying management and harvesting methods. This is an area of active research so specific advice cannot be given at this stage.



There are many potential non-wood products, and they have varying management and harvesting methods. (Photos: Keith Macilvride.)

Management objectives

H. Non-wood products

Core practices	Rip. plants & animals	Wildlife corridors	In-stream life	Water quality	Stream stability	Crops & pastures	Livestock	Wood products
Consult your local farm forestry expert (like Greening Australia)	+	+	+	+	+	+	+	+
Investigate the availability of biodiversity incentive schemes to support the maintenance or restoration of riparian land before deciding to harvest non-wood products	++	++	++	++	++	+	+	N
Check relevant laws and regulations	+	+	+	+	+	+	+	+
Limit the disturbance of small streams	+	+	+	+	+	N	?	?
Ensure that harvesting practices minimise the impact on light and shade	+	+	+	+	+	N	?	?
Retain dead standing trees and those with hollows - where the number of hollows is insufficient for birds and tree-dwelling mammals, install artificial hollows in the form of nest boxes	++	++	+	N	N	+	?	?
Avoid harvesting when the soil is wet, particularly as stream banks are more unstable	+	+	+	+	+	+	?	?
Apply silvicultural practices in the riparian area that maintain habitat value and an uneven age forest structure	+	+	+	+	+	+	?	?
Time thinning, pruning and harvesting activities during periods that least interrupt wildlife, avoiding breeding or nesting seasons	+	+	+	N	N	N	?	?
Avoid excessive soil disturbance, as any soil disturbance associated with thinning can encourage the germination of weeds	+	+	+	+	+	N	+	+
Maintain a closed canopy to suppress (certain) weeds	+	+	+	+	+	+	+	+
Leave fallen trees to break down naturally, including thinnings and prunings	+	+	+	+	N	N	?	?
Fence off the riparian area, particularly to manage access by livestock	+	+	+	+	+	+	+	+
Consider using fire to encourage the germination of certain plant species and to reduce fuel loads– however, fires also burn the forest litter and fallen limbs that provide habitat for some animal species, so leave some to accumulate - use a patch burning approach, leaving unburnt areas as a refuge for plants and animals	+	+	+	+	+	N	?	?
Keep a well-maintained road and firebreak network - water supplies and fire fighting equipment is necessary in fire-prone forests	+	+	+	+	+	++	++	++
Consider using strategic grazing to control weeds or alternative methods such as herbicides, hand removal, mulching, etc. - care should be taken not to damage desirable species, or interfere with long-term regeneration when using herbicides	+	+	+	+	+	+	++	++
Apply hygiene protocols to vehicles and machinery to stop the spread of weeds	+	+	+	+	+	+	++	++
Remove exotic wildlings that escape into neighbouring bush	++	+	+	N	N	N	N	N

++	The core practice will always make a positive contribution to the management objective
+	The core practice is most likely to have a positive impact on the management objective
-	The core practice is most likely to have a negative impact on the management objective
N	The core practice is most likely to have no impact on, or is not relevant to, the management objective
?	The effect of the core practice on the management objective unkown

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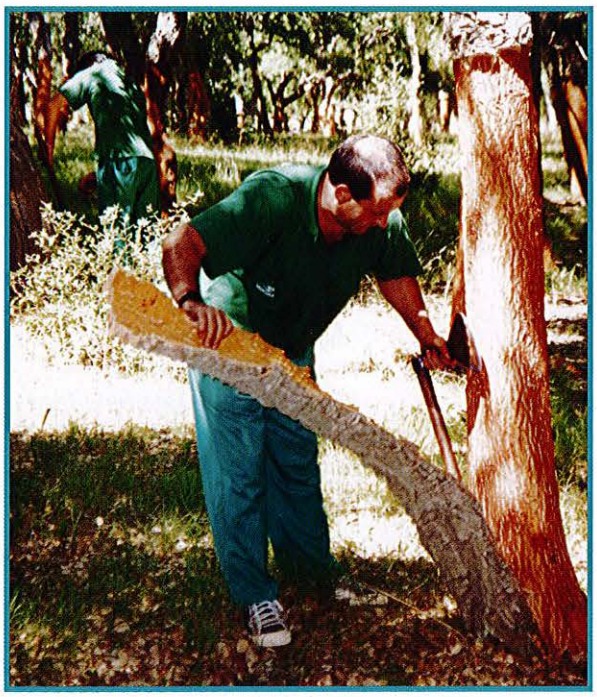
Blue mallee being harvested for leaf oil at GR Davis's property, West Wyalong, NSW (Source: Breeding Trees for the low rainfall regions of southern Australia, *RIRDC Pub. No. 02/031.)*

See

www.rirdc.gov.au

The Joint Venture Agroforestry Program is actively researching a wide range of potential non-wood products. New reports will be regularly posted on the website. It is also worth viewing the *Research in Progress* reports to see what may be on the horizon.



Harvesting cork. (Photo: Lisa Robins)

Harvesting wood products from riparian land

Objective

To supplement farm income through harvesting wood products from riparian land for sale or on-farm use.

Management principles

Harvesting wood products (such as timber, poles, posts, charcoal, firewood or broombush) from your riparian land may range from low, through to high on-site impacts, depending on harvesting intensity and method. The extent of the off-site impacts will be highly dependent upon your management practices. Adopting this management objective will require you to make trade offs against other objectives, like stream stability, biodiversity conservation and water quality. However, if you are revegetating bare riparian land for carefully managed wood production, you are likely to create more benefits than leaving it barren. You should read this section in conjunction with 'non-wood products', as the principles and core practices generally apply to wood production. The issues discussed there are not repeated here, even though they are relevant.

You will generally require a planning permit from local government before establishing a farm forest and harvesting the trees. Some planning codes prohibit the harvesting of wood on riparian land altogether, while others enforce certain conditions, for example, relating to road access and fire control. Most States have in place a code of practice for private tree growers. You may even need to comply with a code in order to get a planning permit and the right to harvest trees. Non-compliance with such a code, whether compulsory or not, may limit your future opportunities.

It is difficult to harvest timber and other wood products from riparian land of small streams without causing significant disturbance, especially where remnant habitat is concerned. The risks to water quality from catchment contaminants and erosion of the streambed are significant. Stream bank collapse is unlikely as the low banks of small streams preclude this regardless of vegetation cover. You can minimise off-site impacts by careful harvesting during dry periods, especially if the stream stops flowing.

If you are thinking about harvesting large woody debris (for firewood or posts), you should consider the potential impact on in-stream plant growth. Large woody debris is the main driver of in-stream plant growth, with the riparian land of small streams feeding the lower parts of the catchment. Historically, most large streams contained much greater volumes of wood than they do today. When streams stop flowing, the natural dips and the pools associated with large woody debris provide the only available habitat for in-stream life. For these reasons, you may need to restrict the harvesting of firewood or posts to riparian areas not immediately beside the stream.

Riparian land that is lower in the catchment is better suited to the harvesting of wood products. In this environment, the role of trees as a filter is generally less important (as described earlier in 'water quality'). This is not to understate the value of riparian vegetation in protecting the stream from neighbouring agricultural land uses, especially where it is intensive. The high, dry banks of floodplains are susceptible to collapse from instability caused by tree removal, particularly on the outside banks of meander bends. The weakening and collapse of the banks of these streams can have worse consequences in some places than the disturbance of smaller streams. In some environments, intensive forestry with trees which use lots of water may have a negative effect on water quality of streams, for example, the relationship between intensive forestry and water yields in various environments is an area of active research. Eucalypts which use lots of water have had to be removed from streambanks in South Africa.

When growing trees on riparian land for timber, choosing the 'selective thinning' method will achieve the most benefits across the management objectives outlined in this Guide. The removal of individual trees will lead to a mixed age forest that can be selectively logged. The alternative thinning methods provide fewer benefits – 'strip thinning' where trees are removed in a continuous strip, and 'gap thinning' where several trees are removed in patches.

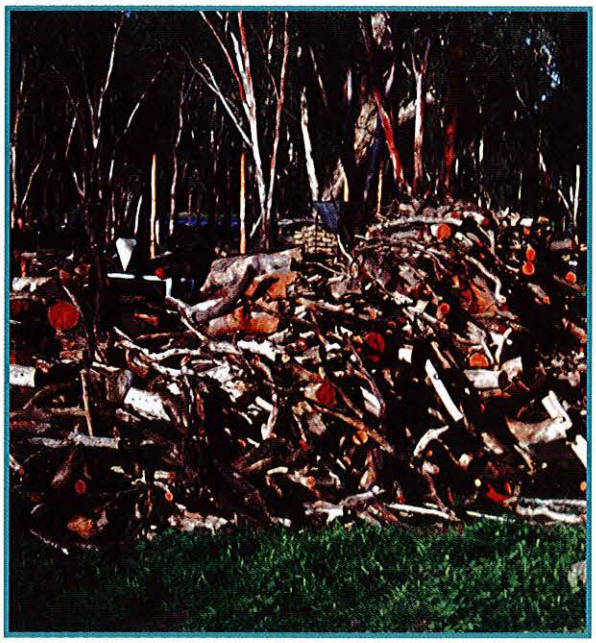
Selective thinning is especially suited to uneven aged stands of native forest. It can create conditions for growth and regeneration that improves the yield of a range of forest products. It maintains natural

patterns of species and communities, resulting in improved biodiversity (especially where specific trees are retained) while allowing trees of good timber quality to be maintained. You can also adjust cutting to fit market conditions. You can achieve good site protection for livestock and neighbouring crops and pasture, as well as minimise wind damage and fire hazard. Chemical thinning (compared to traditional mechanical means of spacing using chainsaws or brush cutters) may be a cost-effective option for you – leaving dead trees standing for habitat or future firewood use.

Pruning is uncommon because eucalypts naturally self-prune in native forests. You may benefit from pruning native trees in the riparian area where tree stocking is low and self-pruning is delayed or fails to occur. Pruning is usually only economic where a species has a high sawlog value. If your stand has been heavily thinned it may be beneficial to prune selected trees. On-site processing of wood products removed from the riparian area is preferable. Not only does on-site processing add value to your timber (by capturing more margin), but it reduces site disturbance from large-scale machinery and vehicles, together with returning residues such as bark, sawdust and edgings to the riparian land.

FAST FACTS

- In a farm site, the diversity of ground-foraging birds increased by 30% and bark-foraging birds by 70%. (Birds on farms, p. XII).



Harvested wood products (Photo: MDBC)

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I. Wood products

Core practices

Management objectives	Rip. plants & animals	Wildlife corridors	In-stream life	Water quality	Stream stability	Crops & pastures	Livestock	Non-wood products
Consult your local farm forestry expert (like Greening Australia)	+	+	+	+	+	+	+	+
Investigate the availability of biodiversity incentive schemes to support the maintenance or restoration of riparian land before deciding to harvest wood products	++	++	++	++	++	+	+	N
Check relevant laws and regulations, and comply with the applicable code of practice	+	+	+	+	+	+	+	+
Avoid harvesting wood products from the riparian land of small streams – if harvesting takes place then do it in the dry season	+	+	+	+	+	+	-	N
Minimise the removal of large woody debris for firewood, posts or access	+	+	+	+	+	+	N	N
Don't remove the vegetation closest to the bank of the stream, including overhanging trees and fibrous root mats - plant and maintain (do not harvest) closely spaced trees down the face and toe of the bank for stability	+	+	++	++	++	+	N	?
Don't fell trees within at least 10 m of the outside of meander bends	+	+	++	++	++	+	+	?
Avoid timber harvesting when the soil is wet, particularly as stream banks are more unstable	+	+	+	+	+	+	N	?
Avoid wood harvesting in important lines of sight (such as near roadways and bridges or from look-outs) and popular locations (such as fishing holes or near camping sites)	N	N	N	N	N	N	N	?
Apply selective logging practices in the riparian area that maintain (a) habitat value, (b) an uneven age forest structure, (c) more than 50% retention of trees greater than 40 cm diameter at breast height (DBH) on a broad area basis in each logging cycle, and (d) the forest in a state from which it can recover to a similar structure before the next logging cycle	+	+	+	?	+	+	+	N
Thin a stand so that the average distance between trees after thinning is 15-20 times the diameter of the trees - a good rule of thumb for enhancing the productivity of certain regrowth areas while maintaining or enhancing habitat and conservation benefits	+	+	+	?	+	+	N	N
Avoid excessive soil disturbance, as any soil disturbance associated with thinning can encourage the germination of weeds	+	+	+	+	+	+	N	+
Use close tree spacing to achieve early canopy closure and to allow for greater selection during thinning (to compensate for the generally poorer tree form found as a consequence of using unimproved seed), when revegetating riparian land with the aim of producing some high value trees	+	+	+	?	+	+	+	N
Prune early and frequently to ensure knots are confined to the smallest possible size and do not develop to a size likely to affect timber quality - begin when the trees are about 2 m tall	N	N	N	N	N	N	N	N
Consider using on-site processing of farm-grown timber – single circular sawmills are good value for money and able to handle difficult timbers, with a relatively low amount of sawlog handling required	-	-	-	N	N	N	N	N

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CASE STUDY

Patrick and Anne Francis farm 'Moffitts', a 50 ha cattle property in southern Victoria just 30 mins from Melbourne at Romsey. This old settler's block in the headwaters of the Maribyrnong River catchment was stripped of trees and converted to pasture land in the 1880s. In 1988, Patrick purchased the block from his parents, who'd farmed 220 ha since WW2 and sold it on to family members.

On purchase, there were only 4 local acacia trees (*A. melanoxylon*), 3 manna gums (*E. viminalis*) and some introduced pines (*P. radiata*) and hawthorn bushes abutting riparian land, and not much more elsewhere on the farm. About one kilometre of stream frontage dissected three of the four paddocks, and all were eroded from livestock access.

In 1994, Patrick and Anne started a revegetation program with both production forestry and conservation in mind. 'Moffitts' is in a 700 mm rainfall zone, which is adequate for production forestry; however, the average rainfall since 1996 has only been 530 mm. They have a whole farm plan, together with an environmental management plan, with the long-term aim of integrating forestry and conservation into the landscape.

Patrick and Anne have defined their specific environmental management objectives as:

- √ To improve biodiversity above and below the soil surface
- √ To ensure water quality is not degraded by management on the property
- √ To ensure air quality is not degraded by management on the property
- √ To enhance carbon sequestration above and below the soil surface
- √ To minimise emissions of greenhouse gases
- √ To minimise the use of pesticides and fertilisers
- √ To avoid pollution of soil, water, and air
- √ To minimise water 'leakage' below the root zone of plant
- √ To ensure only enough water is retained in farm dams to meet requirements of livestock and domestic purposes

The Francis' used direct seeding (using Greening Australia's planter) and tubestock plantings to rehabilitate all but 100 m of stream frontage, fencing and revegetating both banks to between 10 and 50 m. Patrick describes their approach in this way - 'We direct seed a row or two of local provenance species, both trees and understorey species, closest to the stream for habitat, with at least two more rows of forestry plantings. We use improved tubestock with good stem form for the forestry plantings.' Today, there's no bare soil in the riparian area, and it's a very stable environment.

Livestock haven't been allowed access to any plantings yet because Patrick suspects that they might damage young vegetation. He uses phase grazing over 16 paddocks for 7-day periods at 150 dse/ha, with an average rest period of 16 weeks. He is considering letting livestock access the riparian area for a shorter period of 2-3 days once or twice a year. While the grass is long, weeds, pest animals and fire have not been a problem. Spot spraying is used to control blackberries, hemlock and hawthorn. Foxes are shot and there are few rabbits on the property. Patrick explains that 'we don't bait (for foxes) because it's too difficult in this sort of area, with so many neighbours'. As for fire control, the last fire that came close to the property was the Ash Wednesday fire in 1983, but even it didn't come too close. Patrick is a strong believer in groundcover for improving soil, plant and biodiversity health. If growth needs to be controlled for fire breaks he uses grazing pressure rather than slashing, except around the house and sheds. High pruning of trees also reduces the risks of a fire damaging the trees.

Patrick high prunes the forestry plantings to 6.5 metres using a cherry picker. In 2000, he began to high prune Black wattle (*A mearnsii*) and suitable eucalypts in conservation plantings. He clarified by saying 'if it has a good stem, then why not prune it and see what happens! If I can get some good logs out of the conservation plantings, then I'll be able to grow more local provenance species, which will be a better result for conservation.'

'Moffitts' now comprises 20% tree cover in forestry blocks and belts surrounding paddocks, as well as in riparian areas. Over 8000 forestry trees have been planted and 4 km of direct seeding undertaken so far. Thinnings from the plantations are providing fire wood plus rails for yards and fences. More forestry plantings are planned, but no more than one hectare every three years so appropriate silviculture can be undertaken on time across all plantings.

'Moffits' now comprises 20% tree cover in forestry blocks and belts surrounding paddocks as well as in riparian areas. (Photos: Patrick Francis.)

Ecosystem services

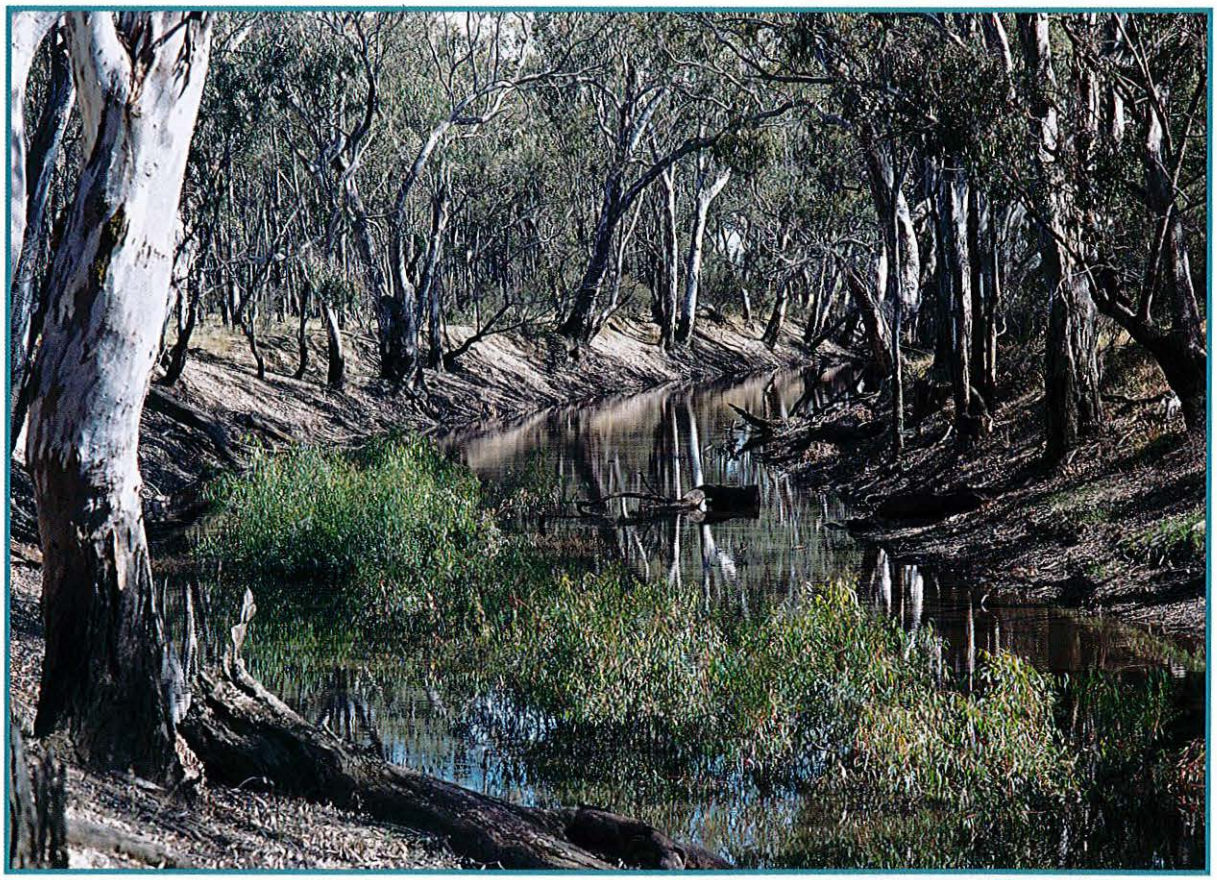
Objective

To maximise the ecosystem services provided by the riparian environment.

Management principles

Ecosystems are the suite of living things (plants, animals, fungi, bacteria, viruses) interacting with one another and their surrounds. In doing so, they perform functions which benefit themselves and each other. Ecosystems exist from the small scale of under a rock, to the grand scale of the globe. These ecosystems, of which people are a part, provide us with critical services – the air we breathe, the fresh water we drink and the food we eat. The growth of human populations, together with our management practices, has had negative impacts on the ecosystems that support our very existence. The free market economy (as practised at present) has been instrumental in the exploitation of these 'free' resources provided by nature.

There is increasing attention now being paid to developing systems that can factor the value of these 'ecosystem services' into the market economy - people's buying and selling processes – so that the services that nature provides are not taken for granted and degraded by individuals, to the detriment of the community as a whole. The idea of identifying and trading ecosystem services aims to protect natural values like pollination, soil fertility and carbon storage. In creating a market, there are difficult questions that need to be answered, like who benefits and who pays, and how to share this fairly? Australia has some experience in this area, with salinity credit trading between NSW, Victoria and SA in operation since 1989, under the Murray-Darling Basin Salinity and Drainage Strategy. There are several pilot scale trading systems for carbon and biodiversity underway.



Through careful management riparian lands can be used for both economic and environmental gains. (Source Land & Water Australia. (Photo: CSIRO Ecosystem Services Project.))

The riparian area provides a diversity of ecosystem services, which may provide financial benefits to farmers through incentive schemes for ecosystem services at some time in the future. Salinity mitigation, biodiversity conservation and water purification probably provide the highest benefits, while carbon storage (see 'The Carbon Farmer' workbook to estimate your potential returns from carbon credits associated with tree plantations) could also be significant for large tracts of riparian land. Ideally, incentive schemes will be devised that can account for the diversity of benefits, and credit the landholder for the total value of ecosystem services provided by well-managed riparian land. One day a farmer may be paid not just for seed production, but also for storing carbon to control the greenhouse effect, conserving biodiversity and controlling salinity.

Core practices

Core practices for 'ecosystem services' have not been presented in a matrix like the other nine management objectives. This is because ecosystem services are diverse, and therefore not meaningful to represent in this way. However, the core practices outlined in the earlier sections can be used as a guide for some ecosystem services. If you are interested in the existing or potential ecosystem services provided by your riparian land, it is best to discuss the options available with a local adviser.

If you wish to protect the ecosystem service of 'biodiversity', then the core practices described in the sections on 'riparian plants and animals', 'wildlife corridors' and 'in-stream life' are applicable. Similarly, the sections on 'water quality' and 'stream stability' provide advice on protecting ecosystem services relating to water filtration.

An ecosystem service like 'salinity control' is more complicated. The sections in Chapter 2 on 'groundwater flow systems' and 'salinity and salt stores' are very relevant. There are core practices referring to salinity control in most of the sections in Chapter 3.

'Carbon storage' is an ecosystem service that is also covered to some extent in the core practices of several sections. Importantly, you need to take into account the end use of the vegetation (e.g. conserved, harvested for firewood, harvested for furniture), and how quickly the wood breaks down and releases its stored carbon back into the atmosphere. This is particularly relevant when considering the core practices outlined in 'wood products'.

Increasingly, market-based incentive schemes for ecosystem services will be available, and you should consider factoring this into your riparian use and management practices.

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What are ecosystem services?

Production of goods

- Food – terrestrial animal and plant products, forage, seafood, spice
- Pharmaceuticals – medicines, precursors to synthetic drugs
- Durable materials – natural fibre, timber
- Energy – biomass fuels, low-sediment water for hydropower
- Industrial products – waxes, oils, fragrances, dyes, latex, rubber, precursors to many synthetic products
- Genetic resources – the basis for the production of other goods

Regeneration processes

- Cycling and filtration processes – detoxification and decomposition of wastes, renewal of soil fertility, purification of air and water
- Translocation processes – dispersal of seeds necessary for revegetation, pollination of crops and native vegetation

Stabilising processes

- Coastal and river channel stability, compensation and substitution of one species for another when environments vary, control of the majority of potential pest species, moderation of weather extremes (such as temperature and wind), partial stabilisation of climate, regulation of the hydrological cycle (mitigation of floods, droughts, salinity)

Life-fulfilling functions

- Aesthetic beauty, cultural, intellectual, and spiritual inspiration, existence value, scientific discovery, serenity

Preservation options

- Maintenance of ecological components and systems needed for the future, supply of goods and services awaiting discovery

(Source: Rip Rap p.5 by Gretchen Daily, Stanford University)

Summary

This Guide outlines principles and core practices according to ten management objectives for riparian land. There may be other management objectives that you also wish to consider – the ten presented are common management objectives, but not the only ones. It is hoped that the matrices that outline the core practices will provide a practical tool for helping you to set and achieve your multiple objectives for riparian land. Importantly, the core practices described need to be considered in the light of the catchment context discussed in chapter 2. This could save you both time and money, and make sure that you get the outcomes you were expecting.

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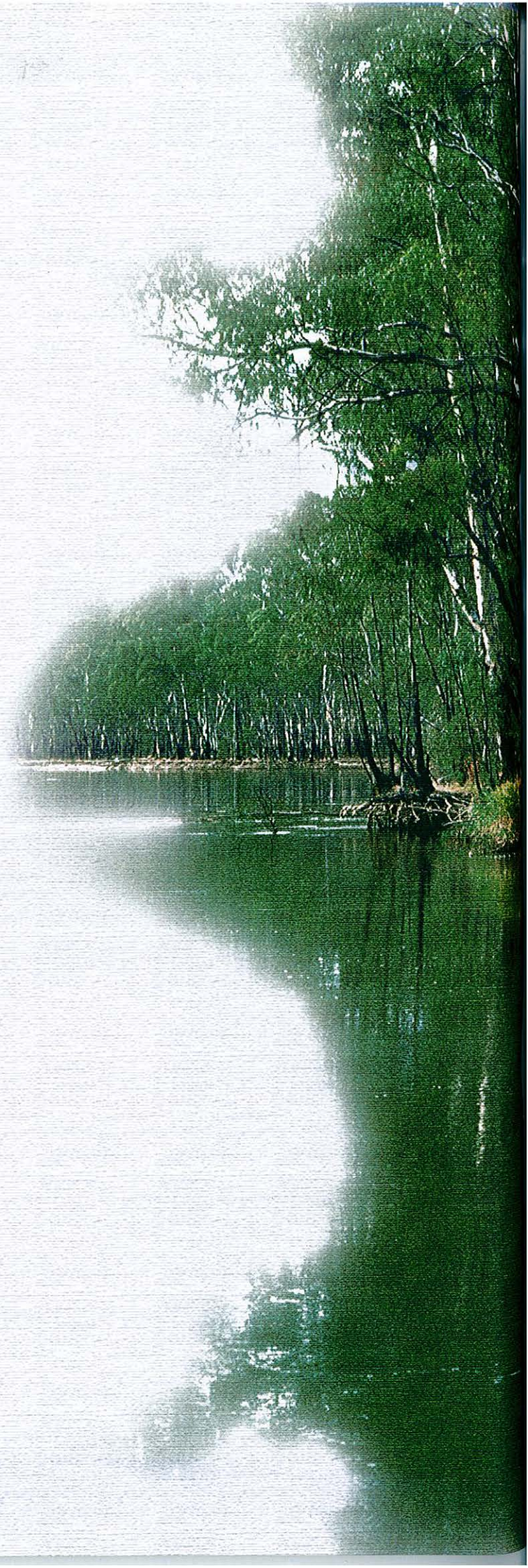
Managing Riparian Land for Multiple Uses

By
Lisa Robins

RIRDC Publication No.: 02/103

This Guide provides information to farm managers, advisers and catchment/landcare facilitators on how to gain both economic and environmental outcomes from riparian land. The potential uses of riparian land are outlined, together with management principles and practices. A summary of the research underpinning these principles and practices is provided to support on-farm decision-making with the best available information. It mainly draws on information about southern Australia, but can be adapted for use more broadly.

This report is a collaborative venture between Land & Water Australia, The Joint Venture Agroforestry Program of Rural Industries R&D Corporation and the Murray-Darling Basin Commission. It is the first in a new Integration Series that brings together and collates recent findings from different research and development (R&D) programs, and suggests how they can be used to improve on-ground management.



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