



RIVER AND RIPARIAN LANDS MANAGEMENT NEWSLETTER

**MANAGING
RIPARIAN
LAND
to achieve
multiple objectives**



Most people have a view about how riparian land should be used and managed. 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. Whatever the view, when people decide to manage their riparian lands differently it is often to address a single management issue. By considering the full range of functions performed by riparian lands, however, managing for a single issue can be the starting point from which further environmental and productive benefits can be gained.

continued page 3



Land & Water
AUSTRALIA
research • development • innovation

EDITION 23, 2003

CONTents



This publication is managed by Land & Water Australia, GPO Box 2182, Canberra ACT 2601

Land & Water Australia's mission is to provide national leadership in utilising R&D to improve the long-term productive capacity, sustainable use, management and conservation of Australia's land, water and vegetation resources. The Corporation will establish directed, integrated and focused programs where there is clear justification for additional public funding to expand or enhance the contribution of R&D to sustainable management of natural resources.

Land & Water Australia's Home Page is: www.lwa.gov.au

Edition 23, February 2003
RipRap is published throughout the year. Contributions and comments are welcomed and should be addressed to the Editor.

Editor: Dr Siwan Lovett

Feedback and comments to:
Dr Siwan Lovett
Program Coordinator
Riparian Lands R&D Program
Land & Water Australia
GPO Box 2182
Canberra ACT 2601
Tel: 02 6257 3379
Fax: 02 6257 3420
Email: public@lwa.gov.au
Website: www.rivers.gov.au

Designed by: Angel Ink
Printed by: Goanna Print

ISSN 1324-6941

Theme: Managing riparian lands to achieve multiple objectives	1 and 3
Using riparian land to improve the productivity of crops and pastures	5
Using riparian land as wildlife corridors	7
~ Case study: The Hill	9
Harvesting non-wood products from riparian land	10
Harvesting wood products from riparian land	11
~ Case study: Moffitts	12
Rapt in rivers: Rivers Arena update	14
Oral history	
~ Learning through listening: Dairy Farmers CD	31
~ Mapping the journey: Your opportunity to contribute	34
It's a Wrap: news from around Australia's States and Territories	18
Kids River Health Conference	31

RIParian lands:

WHERE LAND AND WATER MEET



From the Editor

Trade-offs and compromises between environmental and productive objectives are characteristic of decision making in natural resources management. This edition of *RipRap* aims to show you how win-win situations for the environment and financial bottom line can be gained by managing your riparian zone to achieve multiple objectives. We have integrated the research findings from four R&D programs to provide different perspectives and management approaches for riparian areas, and we hope that you find this information useful and relevant for your decision making. This edition also provides updates on Land & Water Australia's Rivers Programs and the research being undertaken through these initiatives. A new oral history CD — *Dairy Farmers Going with the Flow* — is now available (page 16) and marks the first in what we hope to be a series in which different industries talk about what they are doing to make their farms sustainable. We also give you the opportunity to contribute stories about your rivers and riparian environments along the Bicentennial National Trail (page 17). I hope you enjoy this edition of *RipRap*, and encourage you to follow-up any of the articles you find interesting with the contact details provided.

MANAGING RIPARIAN LAND

to achieve multiple objectives

Riparian lands perform many different functions. Riparian vegetation protects streams by slowing surface runoff, using nutrients and trapping sediment and other contaminants. As well as protecting streams, 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.

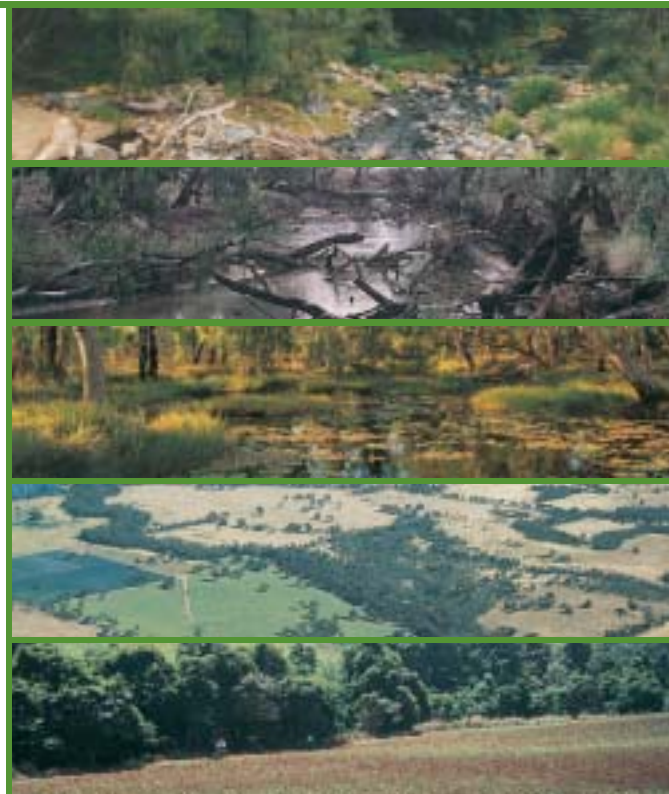
In the future, some of the natural functions of riparian vegetation, like carbon storage, water filtration and salinity control may form part of the farm's production system, and be valued and traded as part of an ecosystem services market.

In recognition of the diversity of environmental and economic benefits provided by riparian lands, a new guideline has been published that draws together information from four research and development programs, each with a different 'view' about riparian land management. The National Riparian Lands R&D Program and Native Vegetation Program have worked with the Joint Venture Agro-Forestry Program and the Dryland Landscapes and Industries Program to bring together recent findings, and show how they can be used to improve on-ground management. It is an initiative that recognises the importance of research programs working together, rather than in isolation.

The idea behind developing the guideline, was that each of the research programs involved have information that can assist people to manage their riparian lands so that a range of objectives can be achieved. Sometimes these objectives are complementary, whilst others are not, and the guideline discusses the trade offs that have to be made when attempting to gain both environmental and productive benefits.

CHECKLIST of functions performed by riparian lands

- ~ 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.

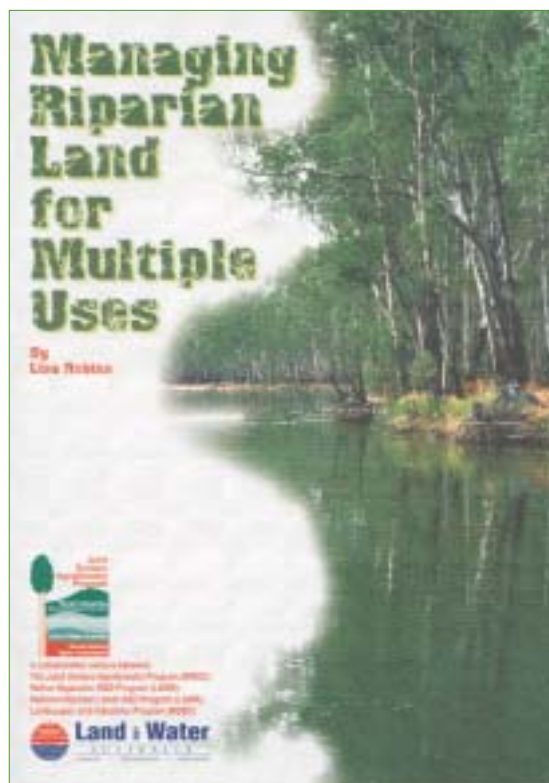


MANAGING RIPARIAN LAND to achieve multiple objectives

The guide has ten sections, with each focusing on a particular management objective:

- A. Conserving riparian plants and animals
- B. Using riparian land as wildlife corridors**
- C. Maximising the health and diversity of in-stream life
- D. Using riparian land to improve water quality
- E. Protecting stream stability
- F. Using riparian land to improve the productivity of crops and pastures**
- G. Using riparian land to provide shade, shelter and feed for livestock
- H. Harvesting non-wood products from riparian land**
- I. Harvesting wood products from riparian land**
- J. Ecosystem services

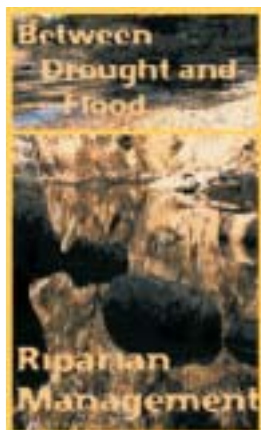
This edition of *RipRap* covers four of these sections (highlighted above), with the information chosen because it comes from programs other than the National Riparian Lands R&D Program. Previous editions of *RipRap* and our fact sheet series cover the remaining six topics.



Lisa Robins is the author of the guideline and worked with the following people to integrate the research findings of their respective programs in this report:

- ~ **Siwan Lovett** Program Coordinator, National Riparian Lands R&D Program, Land & Water Australia
- ~ **Jann Williams** Program Coordinator, Native Vegetation R&D Program, Land & Water Australia
- ~ **Deborah O'Connell** Research Manager, Joint Venture Agroforestry Program, Rural Industries R&D Program/Land & Water Australia
- ~ **Sharon Davis** Manager, Dryland Landscapes and Industries Program, Murray-Darling Basin Commission

If you would like the complete guideline, copies are available for free from CanPrint Communications on 1800 776 616.



Between Drought and Flood — Riparian Management

Merriwa farmers in the Upper Hunter have been undertaking methods to protect their rivers and waterways with a very positive effect.

This video highlights their achievements and looks at the benefits of controlled grazing on rivers and fencing their riparian zones to enable quick recovery. The effect is far reaching; as protected areas benefit riparian zones further downstream.

This 15 minute video is available for \$29.95 + \$5 postage & packaging from:

Merriwa Landcare Inc. PO Box 19, Merriwa NSW 2329 Email: landcare@merriwa.com

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 which, in turn, can boost your farm's productivity. A windbreak provides shelter that reduces direct damage to the neighbouring crop or pasture from soil erosion, sandblasting, leaf damage and flattening of plants. Microclimate and water availability are also improved, resulting in increased plant growth. Greater plant growth results in more feed for livestock and, sometimes, higher crop yields. These production benefits vary from place to place with climate, soil type and wind.

Studies funded by the National Windbreaks Program examined crop and pasture response to windbreaks. The areas studied varied depending

on species of crop, soil type, and root and soil structure. Overall, it was found that the area shaded by a windbreak changes with time of day, time of year, orientation and latitude, with a longer shadow cast in temperate and cool regions than in the tropics. Shelter increased yields in dry years, whilst in wet years there was little response. Yield gains from improved microclimate were small in most years, but guarded 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 5 H and extending to 12 H. Windbreaks also reduced the downwind movement of chemical sprays, by trapping it and slowing wind speed.

When designing a windbreak there are two primary factors to consider. The first is its structure. Height is the main influence on the downwind extent of shelter, and 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 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 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

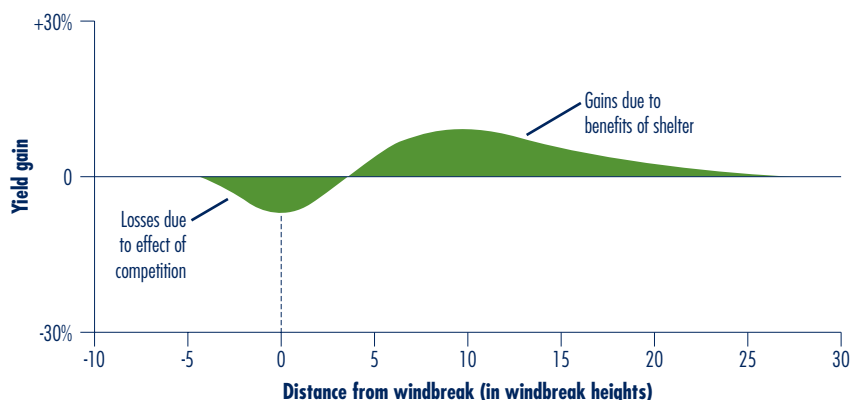
H = windbreak heights



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

USING RIPARIAN LAND to improve the productivity of crops and pastures

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



Contact for RIRDC publications
www.rirdc.gov.au

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. For example, 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. 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.



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.

These pollinators are declining due to loss of habitat and pesticide use. Farmers in many parts of the world now have to purchase the services of bee-keepers to pollinate their crops.

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, 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, and ibis may consume large numbers of insects, particularly grasshoppers and larvae. Having forested land next to crops provides habitat for natural predators that can assist the control of pest species. In the cotton industry, recent research has shown that habitat for bats next to cotton crops reduces the numbers of heliothis moth, whilst in the sugar industry habitat for owls next to cane fields reduces the numbers of rats. Viewing forested riparian areas as habitat for natural pest controllers is another way of achieving environmental and economic benefits on-farm.

Key references

- The effect of a windbreak on crop yields*, in *Design Principles for Farm Forestry*, Joint Venture Agroforestry Program and Rural Industries Research & Development Corporation, Canberra.
- Snell, A. & Brooks, S., *Windbreaks – Increasing crop growth on the Atherton Tablelands*, Short Report no. 67, Rural Industries Research & Development Corporation, Canberra.
- Cleugh, H., *Trees for Shelter – A guide to using windbreaks on Australian farms*, in press, Research Publication 02/059, Rural Industries Research & Development Corporation.
- Prinsley, R., Cleugh, H., Carberry, P., Sudmeyer, R. & Anderson, C. eds, 2002, 'National Windbreaks Program – current research on farm trees' in *Australian Journal of Experimental Agriculture*, vol. 42, no. 6, pp. 649–900.

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 1000 metres or more.

The width of natural riparian vegetation needed for habitat or movement depends on the wildlife species, habitat type and landscape setting. Research can provide 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. When planning your riparian corridor it is a good idea to consult with local experts about the requirements of particular animal and plant species so that you can revegetate accordingly.

Corridors can also aid the movement of feral animals and plants. 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.

In most cases, however, the risk of genetic pollution to eucalypts is small. This is because there are strong barriers to hybridisation (cross-breeding) between distantly related species, for example, differences in flowering time, or differences in other characteristics of the flowers. 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 these will depend on factors like the movement of 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).

The value of your riparian land as a corridor for wildlife is an important consideration in deciding how to manage it.

USING RIPARIAN LAND as wildlife corridors

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.

Key references

- Lindenmayer, D. 2000, *Islands of bush in a sea of pines*. Research Report 6/00, National Research and Development Program on Rehabilitation, Management and Conservation of Remnant Vegetation, Land & Water Resources Research & Development Corporation, Canberra.
- Potts, B., Barbour, R. & Hingston, A. 2001, *Genetic pollution from farm forestry using eucalypt species and hybrids*, Rural Industries Research & Development Corporation, Publication no. 01/114, Canberra.
- Williams, J. 2000, *Managing the bush*, National Research and Development Program on Rehabilitation, Management and Conservation of Remnant Vegetation, Research Report 4/00, Canberra.



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



MANAGING FOR BIODIVERSITY

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.

Photo shows a riparian corridor running through a primarily cleared landscape and providing a vital habitat for wildlife. Photo CSIRO Ecosystems Services Project.



Jon and Vicki Taylor's story

Jon and Vicki Taylor are full-time managers of a 1200 hectare 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 four 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 Taylor's 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 Taylor's 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.



'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.'

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, pharmaceuticals or other bio-based products from riparian lands provides an additional source of on-farm income. 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. There is also the potential for chemicals including preservatives, adhesives, herbicides or degreasing agents to be extracted from trees. Using trees to harvest non-wood products provides a more diverse habitat than agricultural crops and introduced pastures — both above and below the ground. The highest biodiversity values are gained when remnant vegetation is retained and local natives planted, with a single species planting having less biodiversity value than a mixed species planting.

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, as well as to provide shelter and feed for livestock.

When harvesting non-wood products from riparian land it is important to protect plant and animal species living in the area. 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. 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. Care needs to be taken when harvesting so that both the environmental and economic benefits being provided by riparian land are protected.

There are many potential non-wood products, and this is an area of active research. To keep up to date with developments visit the www.rirdc.gov.au website as the Joint Venture Agroforestry Program provides regular updates about new developments. It is also worth viewing the Research in Progress reports to see what may be on the horizon.

Key references

- Colton, B., Murtagh, J., Drinnan, J. & Clarke, D. 2000, *Tea tree oil*, Rural Industries Research & Development Corporation, Publication no. 00/192, Canberra.
- Guijt, I. & Race, D. 1998, *Growing successfully — Australian experiences with farm forestry*, Greening Australia, Canberra. Rural Industries Research & Development Corporation, 1997.
- Simpson, S. & Chudleigh, P. 2001, *Wattle seed production in low rainfall areas*, Rural Industries Research & Development Corporation, Publication no. 01/08, Canberra.



Harvesting cork. Photo Lisa Robins.

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.



HARVESTING WOOD products from riparian land

Objective

To supplement farm income through harvesting wood products from riparian land.

Management principles

Harvesting wood products such as timber, poles, posts, charcoal, firewood or broombush from your riparian land offers further opportunities to increase farm income. 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 edition of *RipRap*. The removal of individual trees will lead to a mixed age forest that can be selectively logged. Strip thinning, where trees are removed in a continuous strip, and 'gap thinning' where several trees are removed in patches, are other harvesting methods that can be used. 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)

Harvested wood products,
photo MDBC.



whilst also allowing trees of good timber quality to be maintained. Chemical thinning is another option to be considered (compared to traditional mechanical means of spacing using chainsaws or brush cutters) as this leaves dead trees standing for habitat or future firewood use. You can minimise off-site impacts by careful harvesting during dry periods, especially if the stream stops flowing.

The extent of both on and off-site impacts from harvesting will depend upon the management practices used, and the trade offs made against other objectives, like stream stability, biodiversity conservation and water quality.

Other maintenance activities such as pruning, vary depending on the tree species. Eucalypts naturally self-prune in native forests, however, native timbers may benefit from pruning where tree stocking is low and self-pruning is delayed or fails to occur. Pruning is usually only cost effective where a species has a high sawlog value. On-site processing of wood products from the riparian area is ideal, as this adds value to your timber (by capturing more margin), and reduces site disturbance from large-scale machinery and vehicles. In addition, the returning residues such as bark, sawdust and edgings stay in the riparian area providing further habitat.

A riparian zone that is wooded can also provide good site protection for livestock and neighbouring crops and pasture, as well as minimising wind damage.

Some planning codes prohibit the harvesting of wood on riparian land altogether, while others enforce certain conditions relating to road access and fire control. Most States have in place a code of practice for private tree growers and it may be necessary to comply with a code in order to get a planning permit to harvest trees.

Key references

- Campbell White & Associates Pty Ltd & Black, A. 1999, *Practical farm forestry — Whole farm case studies*, Rural Industries Research & Development Corporation, Publication no. 99/99, Canberra.
- Dames & Moore NRM/Fortech, 1999, *Integrating farm forestry and biodiversity*, Rural Industries Research & Development Corporation, Publication no. 99/166, Canberra.
- Lamb, D. & Borschmann, G. 1998, *Agroforestry with high value trees*, Rural Industries Research & Development Corporation, Publication no. 98/142, Canberra.
- Lindenmayer, D. 2000, *Guidelines for biodiversity conservation in new and existing softwood plantations*, Rural Industries Research & Development Corporation, Short Report no. 77, Canberra.
- Murray, J. 2000, *Native regrowth — A farmer's guide to maintaining biodiversity when thinning regrowth forest*, Rural Industries Research & Development Corporation, Publication no. 00/12, Canberra.
- Parsons, M. 1999, *Native forests on farms*, Rural Industries Research & Development Corporation, Publication no. 99/21, Canberra.
- Stirzaker, R. & Lefroy, E. 1997, *Alley farming in Australia — Current research and future directions*, Rural Industries Research & Development Corporation, Publication no. 97/29, Canberra.

In one farm forestry site, the diversity of ground-foraging birds increased by 30% and bark-foraging birds by 70%.

MOFFITTS Patrick and Anne Francis' story

Patrick and Anne Francis farm 'Moffitts', a 50 hectare cattle property in southern Victoria just 30 minutes 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 had farmed 220 hectares since World War II and sold it on to family members. On purchase, there were only four local acacia trees (*A. melanoxylon*), three manna gums (*E. viminalis*) and some introduced pines (*P. radiata*) and hawthorn bushes abutting riparian land. 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. The Francis' developed 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 defined their specific environmental management objectives to:

- ~ improve biodiversity above and below the soil surface;
- ~ ensure water quality is not degraded by management on the property;

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

The Francis' used direct seeding and tubestock plantings to rehabilitate stream frontage, fencing and revegetating both banks to between 10 and 50 metres. They direct seeded a row or two of local provenance species, both trees and understorey species, closest to the stream to provide habitat, then at least two rows of forestry plantings were put in using improved tubestock with good stem form. This approach has resulted in a riparian area with no bare soil and a stable streambank environment. 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. Livestock have not been allowed access to any plantings yet because the Francis' suspect that they might damage young vegetation. However, they are considering letting livestock access the riparian area for a shorter period of 2–3 days



once or twice a year as this would fit in with the phase grazing method used on the property. Phase grazing is used over 16 paddocks for 7-day periods at 150 dse/hectare, with an average rest period of 16 weeks.

The Francis' believe in the importance of maintaining groundcover for improving soil, plant and biodiversity health. If growth needs to be controlled for fire breaks they use grazing pressure rather than slashing, except around the house and sheds. High pruning of trees to 6.5 metres also reduces the risks of fire damaging the trees. In 2000, Patrick began to high prune Black wattle (*A. mearnsii*) and suitable eucalypts in conservation plantings. The rationale behind this was '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 (see photos). Over 8000 forestry trees have been planted and 4 kilometres of direct seeding undertaken so far. Thinnings from the plantations provide 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.

Photos: Patrick Francis.



RAPt in rivers

A new page that keeps you up to date with Land & Water Australia's Rivers Arena

National Rivers Consortium

The National Rivers Consortium is a consortium of policy makers, river managers and scientists. Its vision is to achieve continuous improvement in the management of Australia's rivers. Partners making a significant financial contribution to the National Rivers Consortium and represented on the Board of Management are:

- ~ Land & Water Australia
- ~ Murray-Darling Basin Commission
- ~ CSIRO Land and Water
- ~ Water and Rivers Commission (WA)
- ~ Department of Land and Water Conservation (NSW)
- ~ Catchment and Water Management Boards (SA)

The National Rivers Consortium is funding major research projects in the Torbay Catchment of south-western Australia, the Murrumbidgee Catchment of NSW, and in South Australian catchments focussing on ephemeral streams.

In 2003 the National Rivers Consortium will also be implementing a new National Training Program in River Management. While course providers are yet to be determined, the training will include a Graduate Certificate course in river management that will be available nationally, as well as vocational education and training courses in river management and restoration in Western Australia, South Australia and the Riverina districts of NSW/Victoria.

For further information

Brendan Edgar, Program Coordinator
Tel: 02 6257 3198 Email: brendan.edgar@lwa.gov.au

National River Contaminants Program

The National River Contaminants Program is a new four year program funded through a partnership between LWA and the Murray-Darling Basin Commission. The program addresses issues of declining water quality in Australia's river systems, with salinity, nutrients and sediments being identified as the highest priority river contaminants for research.

A number of projects were recently approved for funding and will commence in 2003. These include:

Title	Principal investigator	Institution
In-stream and riparian zone nitrogen dynamics	Dr Christine Fellows	Griffith University
Catchments nutrients and sediment budgets: identification of knowledge gaps	Dr Myriam Bormans	CSIRO Land and Water
Integrated impacts of contaminants and flow on riverine ecosystem production	Dr Darren Ryder	University of New England
Predicting salinity induced loss of biodiversity	Mr Ben Kefford	RMIT University
Development of risk based approaches for managing contaminants in catchments	Professor Barry Hart	Monash University
Development of a catchment contaminant cycle model for stakeholder use	Dr Rob Vertessy	CSIRO Land and Water
Innovative techniques for managing multiple threats to high value aquatic systems	Dr Paul Boon and Dr Paul Bailey	Monash University and Victoria University of Technology
Alternative stable states: a potential paradigm for managing salinised ecosystems	Dr Jenny Davis	Murdoch University
Characterisation and dynamics of colloidal material in a turbid tropical river	Dr George Lukacs	James Cook University

For further information about these projects check the www.rivers.gov.au website under Research Activities.

For further information

Brendan Edgar, Program Coordinator
Tel: 02 6257 3198 Email: brendan.edgar@lwa.gov.au

REVISED AND *new* River and Riparian Management Fact Sheets

These Fact Sheets are grouped according to whether they deal with riparian land, in-stream issues, river contaminants or other matters. They aim to set out the general principles and practices for sound management. We have revised and updated the original 1-7 Riparian Management Fact Sheet Series, as well as writing some new Fact Sheets to cover *Planning for river restoration, River flows and blue-green algae* and more!

Available for free from CanPrint Communications on 02 6295 4444 or Freecall 1800 776 616. Also available in pdf at www.rivers.gov.au

River Landscapes

NEW PROGRAM

National Program for Sustainable Irrigation

The National Program for Sustainable Irrigation started in late 2002. Its purpose is to provide Australia with research and innovation to achieve sustainable irrigation — reducing impact, increasing productivity, and maximising community benefits. Program partners include policy makers and irrigators; research agencies and water service providers. An important goal of the program is to make emerging information rapidly useable. Science and practice will work together to link ecology, community and productivity.

Research proposals which lead to improvements in the sustainability of irrigation have been called for and more information can be found at the sustainable irrigation website www.lwa.gov.au/irrigation

For further information

Liz and Murray Chapman
Program Coordinators
Tel: 03 5763 3214
Email:
rplan@mcmedia.com.au



NATIONAL PROGRAM FOR
Sustainable Irrigation

NEW MANAGER

Colin Creighton — Water Manager, Land & Water Australia

Colin is a natural resource manager working at scales from Australia-wide through his job as Water Manager for Land & Water Australia to very local, through his forestry and grazing property in north Queensland. Colin is always on the lookout for productive, smart, sustainable solutions to better use Australia's natural resources.

Colin's day job is coordinating research across a range of water issues — irrigation, river and estuary management, riparian lands, contaminants and linking this downstream to fisheries and marine management with groups such as the National Oceans Office and the Cooperative Research Centre for Coastal Zone, Estuary and Waterway Management.

Colin has graduate and post graduate qualifications — metallurgical engineering, natural resources and management and has worked in most of Australia's natural resource sectors — including heavy engineering, mining, fishing, farming, consultancy and all tiers of government — local, State and Commonwealth.

In his spare time Colin is developing a plantation forestry/dairy farm in North Queensland, practicing what he preaches in terms of productive land use, irrigation and river management.



Contact details

GPO Box 2182
Canberra ACT 2601
Tel: 0418 225 894
and 02 6263 6038
Email:
colin.creighton@lwa.gov.au

W E L C O M E



THEME

RESEARCH

GETTING A GRIP

IT'S A WRAP

INFORMATION

15

LEARNING through listening

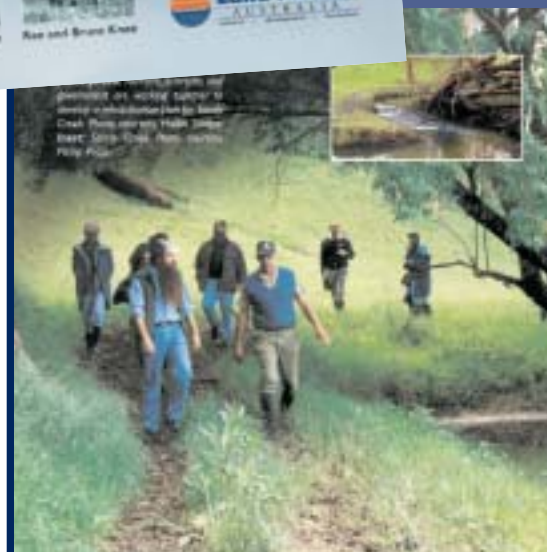
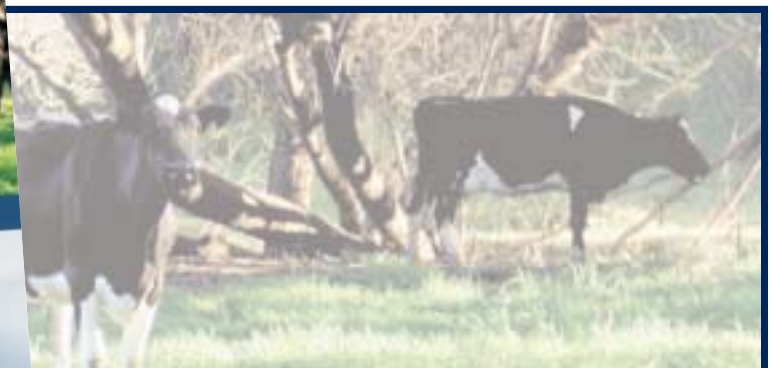
Dairy Farmers — Going with the Flow

by Siwan Lovett

The most important source from which we gain understanding is first-hand experience. In general, however, western culture, has come to favour the indirect knowledge gained from secondary experience, in which information is selected, modified, packaged and presented to us by others. Gathering and learning from the stories of people who have lived and worked in communities where we are undertaking science, or attempting to demonstrate the relevance of science, allows us to link science with experience. This linking of science and experience has been shown to lead to understanding, and a building of confidence in people to act on the information provided.

Dairy Farmers — Going with the Flow is a new product from the National Riparian Lands R&D Program that captures the stories and experience from two dairy farming families. The dairy farmers on this compact disk, Peter and Helen Snape and Bruce and Rae Knee, tell us how they are managing their rivers and land in a way that adds value to their properties and dairy herds. The Snape's story features the life and times of Sandy Creek and the Knee's story is about the Franklin River. Both dairy farming families live in the Gippsland region of south-east Victoria. These farmers say that they are on a winner — increasing the productivity of their land as well as making healthier rivers for their kids...

...they are dairy farmers going with the flow.



The CD is attractively presented with historical photographs and other details about the rivers provided in the insert cover. It is entertaining to listen to, and could be used as the lead in to a discussion about the ways in which production and conservation can be achieved on farms. The CD is free and is available from CanPrint Communications on 1800 776 616. Product number EC 020442.

MAPPING the journey — an environmental travelogue

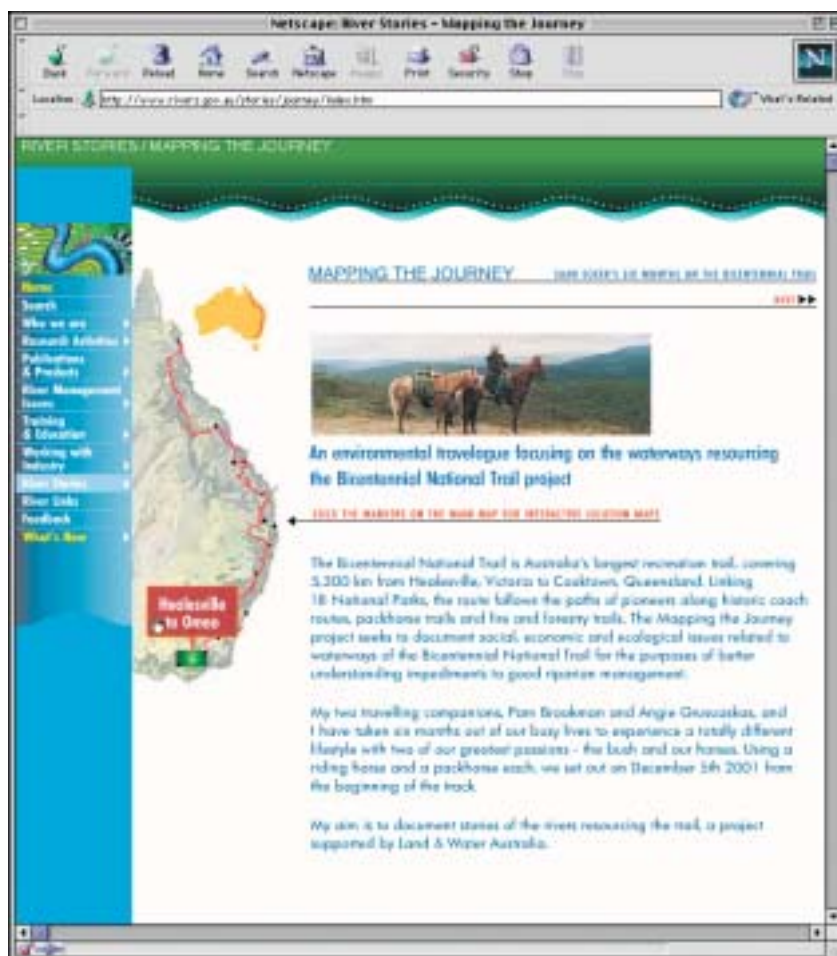
focusing on the waterways resourcing the Bicentennial National Trail

by Siwan Lovett

The Bicentennial National Trail is Australia's longest recreation trail, following the Great Dividing Range from Healesville (Vic) to Cooktown (Qld), and linking 18 National Parks. The trail is designed for self-reliant non-motorised trekking, with the route following the paths of pioneers along historic coach routes, packhorse trails, and fire and forestry trails. When Saan Ecker talked to us about her plans to ride the Bicentennial National Trail from Healesville (Vic) to Oberon (NSW), we were keen to be involved. In return for a financial contribution from the National Riparian Lands R&D Program, Saan provided us with an environmental travelogue of her experiences as she rode the trail. You can read about Saan's journey on our website at <http://www.rivers.gov.au/stories/journey/index.htm>.



We crossed the Howqua River 30 times in one day and we encountered all kinds of weather, snow at Lovicks Hut, Victorian Alps. Photos Saan Ecker.



Your opportunity to contribute...

Saan's stories have only taken us a quarter of the way along the Trail. We thought it would be great to have the whole of the Bicentennial National Trail covered, and are now giving you the opportunity to contribute a story about part of the Trail you are familiar with. Your story needs to be about the waterways along the Trail as we want to link the scientific information being undertaken through our Program, to the experiences that people have in living and working with their rivers and riparian environments.

If you have a story you would like to contribute, please send it to us at the address below. Your story needs to be no more than 800 words, and any photographs or diagrams need to be sent on a disk. Sending pictures via email does not provide us with good enough quality to go on to the website. Your contribution will then go up on our website as we fill in the whole trail and build up a valuable store of oral histories.

Send your contributions to

Dr Siwan Lovett
Land & Water Australia
GPO Box 2182, Canberra ACT 2601



Rivercare on the Dasher River — using multi-purpose rehabilitation techniques to achieve multiple benefits

The Dasher River, a major tributary of the Mersey River in north-west Tasmania, has recently been the subject of *Natural Heritage Trust* funded Rivercare activities. The Mt Roland Catchment Rivercare Group undertook this work after a considerable planning period, with their vision being to restore and protect the riparian zones within the catchment. The group has taken a 'whole of catchment' and 'whole of community' approach to river management and rehabilitation. This means they have been able to prioritise works to achieve maximum environmental gains and draw on the diverse range of skills found within their community to maximise their capacity to undertake the works.

The majority of the works undertaken aimed to reduce the impact of agricultural practices on the river system, whilst protecting and enhancing existing native riparian vegetation. A combination of activities was used to achieve this aim, including riparian fencing, installation of alternative stock watering systems, revegetation and some weed control. Structural works were also used in two middle catchment reaches (called D8 and D9) as they exhibited a high degree of accelerated river instability. The river at these points has a gravel bed and is alluvial, with minimal bedrock control and a history of channel instability as a result of past channel straightening activities and the removal of protective riparian vegetation.

Structural works

The structural works implemented by the Mt Roland Catchment Rivercare Group aimed to reduce the supply and throughput of sediment from reach D9, in order to maintain the largely 'good' geomorphic condition of the downstream reach D8. A number of rock riffles and timber structures were installed to achieve this, with the work undertaken along reach D9 during May 2001. The riffles were designed to:



1. Reduce immediate upstream flow velocities thereby minimising erosion potential.
2. Decrease overall bed gradient in order to reduce within channel flow velocities, thereby reducing sediment transport.
3. Arrest current headcutting/bed degradation and limit the extent of any future bed instability.

Some pertinent design aspects of the riffles included the use of a range of rock sizes for structural integrity, and a gentle downstream ramp grade of around 1 in 20 to allow for fish passage and to reduce scour potential at their lower end. The riffles also increase aeration of water as it flows over the downstream ramp and create pool habitat upstream.

The main purposes of the timber structures are to:

1. Reduce bank erosion by directly protecting the bank from erosive flows and by deflecting flow away from the bank.
2. Trap and store sediment.
3. Reduce flow velocities by increasing within channel flow resistance.
4. Increase flow variability within the back-up pools created by the riffles.

For further information

Guy Lampert
Department of
Primary Industries,
Water & Environment
Tel: 03 6336 5221
Email:
Guy.Lampert@dpiwe.tas.gov.au



One of the challenges in using timber as a river rehabilitation tool is keeping it in place. The Mt Roland Catchment Rivercare Group overcame this by anchoring pieces to ‘piles’ driven into the bed and/or bank and, by creating an interlocking framework of a number of wood pieces. Timber was also incorporated into rock bank protection works, so that it protruded from the lower bank and provided further in-stream habitat.

Since these works were installed the river has experienced a number of near bank-full flow events. Field observations confirm that the structures are operating with their desired outcomes. Bank erosion rates have reduced immediately upstream of the rock riffles and sediment is being deposited within the voids of the timber structures. Bars downstream of D9 show little evidence of fresh sedimentation, and this suggests that sediment movement has reduced. It has also been reported that the timber structures have become a favoured spot for local fishing enthusiasts, with both the native Blackfish and the introduced Brown Trout being caught in these locations.

Stock control, revegetation and other works

Other works implemented throughout the Dasher River catchment include stock fencing of riparian areas and the installation of alternative stock watering systems. Stock control in riparian areas has improved animal health and management, while protecting existing native vegetation and assisting revegetation efforts. The Mt Roland Group Catchment Rivercare Group has developed special fencing for use in low lying flood prone areas — a lift up electric fence that can be quickly raised entirely above flood levels. For most of the time the fence is left in the raised position, with the dropped position only used when stock are in the riparian paddock.

Revegetation has also been undertaken and the group have now planted over 40,000 seedlings within their riparian zones. By establishing riparian zones with a diverse range of species the group hope to achieve the following benefits:

- ~ Greater bank stability through differing root assemblages and depths of different species.
- ~ Reduced channel marginal flow velocities by maximising flow resistance.
- ~ Trapping of sediments and nutrients sourced from agricultural practices thereby improving water quality.

- ~ Providing a source of organic material for a range aquatic fauna (food source, cover and spawning habitat).
- ~ Regulating temperature through shading and improving conditions for aquatic fauna and reducing evaporation rates.
- ~ Providing shelter for stock.

Ti-tree brushing has also been laid in bundles on bar surfaces to capture fine sediments and to provide a seed source for native vegetation regeneration. By capturing fine sediments, the ti-tree bundles help to reduce stream turbidity while creating a more hospitable environment for native vegetation to colonise than the previous coarse gravel surfaces of the bars.

It is hoped that through this use of a combination of multi-purpose river rehabilitation techniques, the Dasher River and its tributaries will develop a more naturally functioning and healthier riparian zone within a productive agricultural setting.



Middle catchment reach D8 at low flow (top) and near bank full.

Living successfully with your landscape — balancing production and conservation

Have you ever tried to understand your local farm landscape? I don't mean just how it looks, but what's going on, how healthy it is, what you can really do with it. You are probably like many others we know who are concerned that their local landscapes, especially around watercourses, have been under some severe pressure and may be deteriorating under current management. We also know that a lot of people are looking for new ways to use their landscapes, and this includes finding multiple uses to get more benefits from the same areas. This is highlighted as the central theme of this issue of *RipRap* — achieving multiple objectives from riparian resources.

Until now, it has been a pretty daunting task to think at this broad landscape scale and to get the right balance of different activities that can be safely accommodated. It has also been hard to pull together all the advice that is around on managing landscape resources and then apply it in your own area. Well, now you can do it! This edition of *RipRap* coincides with the release of an exciting new book about managing production landscapes that provides vital clues. Quite simply, *Managing & Conserving Grassy Woodlands* contains information about how to understand these landscapes and decide where to focus your management attention. The book is the result of some recent research on local farms, looking to find ways to balance landholders' needs for production and conservation. The research was supported as a joint initiative of Land & Water Australia and Environment Australia under the Native Vegetation R&D Program.

Because riparian zones and watercourses are such a vital component of the broader landscape, their protection and rehabilitation feature in a chapter of the book and are identified as keystone ecosystems. Riparian areas usually have the richest resources, being more fertile and better-watered at the bottom of the slope in the drainage lines. This makes them favoured sites for wildlife habitat and refuges. The same attributes make them attractive to livestock as well as providing aesthetic experiences for farmers and urbanites alike. This diversity clearly offers landholders considerable scope for multiple uses of riparian resources, but, at the same time, creates a good deal of potential for conflicts to

arise between production, conservation and lifestyle pursuits — especially when different interests are seeking different values from the same set of resources.

We looked at the health of the whole landscape and its ability to continue to provide useful ecological services for both production and enjoyment of future generations.

Many of the landholders that we spoke to were trying to manage their land in a sustainable way, but felt that things were getting out of balance and their country was being “pushed a bit”. We decided to take a close look at some local properties and how their production systems were actually impacting on the health of those landscapes. We took a broad view and included impacts on soils and pastures, as well as the general health of trees, shrubs, wildlife habitat, riparian zones and watercourses. That is, the health of the whole landscape and its ability to continue to provide useful ecological services for both production and enjoyment of future generations.

What we actually found on the properties was a mixed bag of positives and negatives. Some parts of the landscape were generally healthy, such as soils and pastures, while other parts were not, such as the state of farm trees and riparian vegetation. This balance was not sustainable and we set about working with groups of landholders to find ways to improve on this situation. From the outset, landholders

Watercourse flowing through a broad alluvial valley in south-east Qld. There is cropping and improved pasture on the flats, and grazing down to the water's edge — a typical land use pattern. The original vegetation was grassy woodland with mature Eucalyptus tereticornis and shrubbier species on the bank. Photo S. McIntyre





were keen to know what sorts of things were going to cause problems for them and how these might be better managed. They were also concerned that the technical information available to support conservation was often hard to access, fragmented, confused with jargon, or simply did not fit into the large scheme of things that they were trying to achieve.

In developing some answers to these issues, we asked ourselves what are the key requirements for managing a landscape in a sustainable fashion, and how can these be expressed in a way that anyone can understand and use to guide their thinking? How do people make informed choices about how they manage their landscapes for the future? What does it take to successfully include multiple uses in a landscape?

First and foremost, our research into these questions showed that multiple uses can be accommodated within various parts of production landscapes, but that tradeoffs are invariably involved. For example, some uses are naturally complementary, such as using trees and shrubs to stabilise banks and filter overland flows of sediments. This same use would also promote diversity in wildlife and provide useful shade for

fish habitat and picnic sites. Further, if you can pick the right tree species it might also support some limited agro-forestry activities or contribute to species biodiversity. However, these multiple uses have to be carefully thought through. Some other activities may well be in direct conflict with these uses, such as uncontrolled livestock access leading to severe erosion and lost habitat from trampling, tracking and damage to shrubs.

Managing & Conserving Grassy Woodlands provides six fundamental principles to guide peoples' thinking on the different elements of the landscape that they are working with and how they might negotiate the trade-offs that need to be made between production and conservation. These principles provide a planning framework that relates to soils, pastures, trees, riparian zones and watercourses, and wildlife and habitat needs. They allow you to understand and think about your landscape and the key issues to focus on when looking for that balance between conservation and production in your management. Like the keel on a boat we see these principles as a way to stay true to your course, something you can come back to, time and again, to understand your heading on a journey to sustainability.

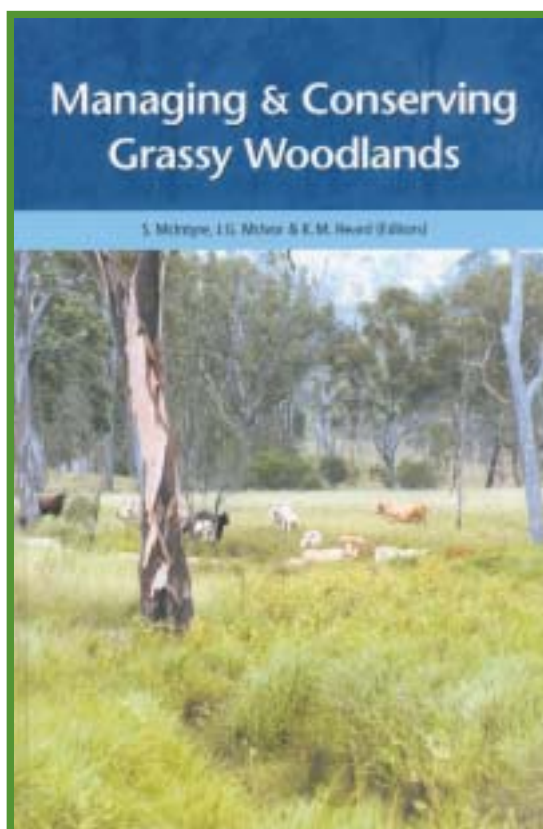
For further information

Neil MacLeod
CSIRO Sustainable Ecosystems
Tel: 07 3214 2270
Email: Neil.MacLeod@csiro.au

6 principles for land and water management

1. Property planning and management should include a long-term vision which considers the whole of the property and its place in the catchment.
2. Manage soils to prevent erosion and to maintain productive capacity and water quality.
3. Manage pastures for production and to maintain the variety of plants and animals.
4. Maintain local native trees for the long-term ecological health of the property and catchment.
5. All properties require core conservation areas for species that are sensitive to agricultural land uses.
6. Watercourses are particularly important to the ecosystem and grazing enterprise, and require special management.

NB: it should be noted that under these principles are a number of sub-principles that provide a further level of detail.



Managing & Conserving Grassy Woodlands is the result of some recent research on local farms, looking to find ways to balance landholders' needs for production and conservation.

Copies are available through CSIRO Publishing 1800 645 051 or via the web www.publish.csiro.au for \$59.95 plus postage and handling charges.

Case studies on managing the riparian zone to achieve multiple objectives...

Despite the vast differences in the river systems around Western Australia, our rivers can, and are being managed to achieve multiple objectives. The following case studies illustrate this.

Dalyup River, 35 kilometres west of Esperance, south coast of Western Australia

The lower section of the Dalyup River has an extensive floodplain, which is used intensively for cropping and stock grazing. In 1999 and 2000, two major flood events caused considerable damage to the river and its floodplain with a consequent loss of valuable farmland. The Water and Rivers Commission is now working closely with land managers to protect the Dalyup and West Dalyup River, and Lake Gore — a RAMSAR wetland at the end of the catchment. This is because an Action Plan completed in 2002 highlighted minimising flood risk as critical to help ensure the long-term protection of the river and its floodplain.

A demonstration site established on Lawrie Shaw's property (part funded by the Natural Heritage Trust and the Water and Rivers Commission), has undertaken several measures to protect his floodplain from future damage, and to promote the concept of 'flood paddock management', as an alternative to traditional farming on the floodplain. Recent trials on Lawrie's property have shown that planting perennial fodder crops on the floodplain creates a win-win situation where land can still be used productively whilst at the same time protecting the area from further erosion. Lawrie planted *Acacia saligna* on the floodplain and found it to be a good fodder crop that also provides stock with protection from the wind. It is planted very close together so that the extensive root systems bind the soil together, with the plant also slowing the velocity of the water as it flows onto the floodplain, the combined effect is a reduction in erosion.

Lawrie also fenced the riverbanks so that he can manage grazing pressure. The fences are designed to withstand flooding and are made from four single wire electric fencing with polypipe fence posts that lie down during high flows, as well as 'sacrificial' boundary fencing across the river (two strainer posts). The floodplain is now being managed differently to the



Above: Dalyup River — post 2000 flood event. Note the extensive erosion and sedimentation of the main channel. Photograph WA Department of Agriculture. Below: *Acacia saligna* plantings on the floodplain of the Dalyup River. Photo Kaylene Parker.



adjacent paddocks and it is hoped that more farmers in the lower catchment uptake the concept of this new practice to help protect the floodplains of the Dalyup and West Dalyup River. Landholder Lawrie Shaw is ecstatic with the success of the project:

"I have ordered another 10,000 Acacia seedlings for next year. The cows have never looked so good, and the river seems to be benefiting from being fenced off. Hopefully, when the next flood comes, the work we have done will pay off".

For more information

Dalyup River

Kaylene Parker
Tel: 08 9841 0106

Email:

kaylene.parker@wrc.wa.gov.au

or visit our web page:

[www.wrc.wa.gov.au/
region/southcoast/infodata/
esperancec/dalyupr/dalyup.
html](http://www.wrc.wa.gov.au/region/southcoast/infodata/esperancec/dalyupr/dalyup.html)



The Ord River, East Kimberley, north west Western Australia

The primary use of water from the Ord River storage facilities is irrigation. However, since the construction of the dams, other industries have also developed. They include the hydro-electricity scheme, tourism operations, pastoral stations, commercial fisheries and aquaculture. The river is also the focus of a range of recreational activities including fishing, swimming and boating. Ecologically, the Ord is a precious resource with Lake Argyle, Lake Kununurra and the lower Ord River all Ramsar listed wetlands.

The Ord River also has high cultural significance, with almost 50% of the East Kimberley population Aboriginal. Traditional beliefs and customs are strong, and waterways remain an important source of food and water, as well as being culturally significant. Living areas and recreational access areas for Aboriginal people are important considerations in planning for the Ord and, in recognition of this, several projects are currently underway to obtain input from Aboriginal people on their values and aspirations for the river.

A large portion of the Ord River foreshore is Unallocated Crown Land (UCL). In the past, *ad hoc* developments such as riverside camps, tour boat lunch shelters and toilets, pumps, pipes and jetty structures have been established without relevant planning approvals. Within the irrigation areas, riparian buffer zones were included in the original issue of freehold land. Land managers use the riparian areas to access water pumps and reticulation pipes for servicing and maintenance, as well as for recreation activities. In some parts of the irrigation districts, access to riparian areas is resulting in degradation. A new strategy has recently been developed to address this problem and to facilitate ecologically sustainable development so that the ecological values of the Ord UCL can be protected.

The strategy is being developed by the Ord River Waterways Management Group and the Department of Land Administration. It will assess current developments and plan for future use of riparian areas. It is envisaged that in the development of the UCL Strategy, individuals, agencies and groups will have responsibility for managing different areas of the riparian zone. These areas will remain as public land, but be



Ord River, East Kimberley. Photos Jane Rapkins.



vested in and managed by an interested body. The vesting body will also be responsible for weed and feral animal control, as well as environmental monitoring. The community will be involved in the identification of compatible uses in riparian areas and have a part in developing management strategies and actions.

Although it sometimes felt that the East Kimberley is behind the rest of the country, in many ways it is fortunate that planning can take place to protect riparian areas before they become degraded. The range of people with knowledge about how the rivers and riparian systems of the Ord function, will be involved in the planning process to ensure their experience and understanding is an integral part of the UCL Strategy.

For more information

Ord River

Jane Rapkins

Tel: 08 9168 1082

Email:

jane.rapkins@wrc.wa.gov.au

Onkaparinga Catchment Water Management Board's 'Watercourse Management Assistance Program' — Aiming for Multiple Outcomes



The Onkaparinga Catchment Water Management Board (the Board) covers an area in the Southern Mount Lofty Ranges of more than 92,000 ha, comprising the Onkaparinga River Catchment, and nine relatively small neighbouring catchments (see map). The watershed of the Mount Lofty Ranges contributes to a combined capacity of 200,000 ML to Adelaide Metropolitan reservoirs, which provides an average of 60% of Adelaide's water supply. Of this, approximately half is derived from reservoirs in the Onkaparinga Catchment. Around 90% of this area is classed as open space, or rural land use, with a little over 45% being devoted to dairying, or other pasture production.

Since late 1999, the Board has run a Watercourse Management Assistance Program (WMAP). The broad aim of this program has been to improve and protect water quality and biodiversity through promoting and assisting good land and watercourse management practice.

Initially, priorities for the program were determined on a sub-catchment by sub-catchment basis, with significant input from the local catchment community. This process was essentially a ranking exercise, yielding a long list of properties to be approached in rank order, and offered assistance. Unfortunately, most properties identified as high priority under this arrangement were those in poorest condition (and therefore perceived as needing attention most urgently!). More recently, the program has come to rank priorities for investment following an assessment of the relative threats, assets and recovery potential of the reach of watercourse in question.

The program is now structured to offer two lines of assistance to landholders within the Board's area who have a watercourse on their property. Firstly, financial assistance may be offered to landholders who's reach of watercourse represents a high or moderate recovery potential reach, or if their reach represents a significant natural asset, or immediate threat to a significant natural asset. Technical assistance, in the form of property management planning and watercourse rehabilitation planning is available to any landholders seeking such support.



The program seeks to achieve co-operative rehabilitation projects with landholders, and as such, the landholder must be prepared to commit their own resources to working in partnership with the Board to rehabilitate their watercourse. Landholder resources may take the form of in-kind labour, or capital commitment. Early experiences demonstrated that unless there was a high degree of landholder involvement and ownership of the rehabilitation project, the project would suffer.

The extent of the financial assistance offered to a landholder by the Board is dependant on both an assessment of the relative threats, assets and recovery potential of their reach of watercourse, and the landholders own commitment to the project. Financial assistance offered through the WMAP includes:

- ~ Subsidies for the erection of fences to exclude stock from watercourses. This includes subsidies for stock watering facilities necessitated by fencing off watercourses.
- ~ Removal of exotic trees from riparian areas.
- ~ Control of woody weeds, and other invasive weeds in riparian areas.
- ~ Revegetation of riparian areas to create suitable buffers to watercourses.
- ~ Construction of erosion control structures.

The anticipated outcomes of the program are:

- ~ Improved water quality through reduced soil, nutrient, pesticide and pathogen input into watercourses.
- ~ Reduced soil erosion.
- ~ Improved (riparian) biodiversity and habitat conservation.
- ~ Improved property values, profitability and sustainability.

The principle strategy to achieve these outcomes is to create, or protect, stock-free vegetative buffers along watercourses to intercept nutrients, pathogens, sediments and pesticides moving from the paddock into the watercourse. These buffers will also improve bank stabilisation.

Many reaches with high recovery potential have good remnant riparian vegetation persisting, and are often threatened by stock activity and/or

weed invasion. In these cases, stock exclusion and sensitive weed control are undertaken to maximise natural regeneration of riparian vegetation. On project sites that have more pronounced exotic tree or weed problems and, therefore, a diminished capacity to regenerate naturally, weed control is followed by active revegetation. This takes the form of tubestock and direct seeding techniques where appropriate.

Seed for revegetation is collected from the nearest appropriate remnant vegetation, and grown by contract growers. There is a heavy emphasis on Primary Successional species in the revegetation activities for their weed suppression effect. In following years, less robust species are integrated into the revegetation to enhance biodiversity values.

The program has evolved steadily in the three years it has been operating, with significant changes in the prioritisation of project sites, and expectations placed on landholders receiving assistance. While it is very early to be trying to gauge the extent to which the program is achieving the desired outcomes at a catchment scale, it has achieved some success over this time at the individual property scale, and in terms of raising the profile of good watercourse management throughout the catchment. Refinements to the program will encourage even greater success. Changes that are currently in train or planned include:

- ~ Prioritisation of watercourses for rehabilitation works using a more formalised risk assessment framework. This will identify the value of watercourse assets at a reach level, threats to that asset, the likelihood of asset loss and the consequences of losing it.
- ~ Development of an incentive-based program along the lines of the Bush Tender process used in Victoria.
- ~ Developing a river health rapid assessment method that works for SA hydrological regimes (in partnership with Land & Water Australia). This will allow us to monitor the effectiveness of rehabilitation works and through this to refine our work practices.

For further information

Michael Garrod
Onkaparinga Catchment
Water Management Board
Tel: 08 8374 6016
Email:
mgarrod@onk.cwmb.sa.gov.au
Web: www.onkaparinga.net

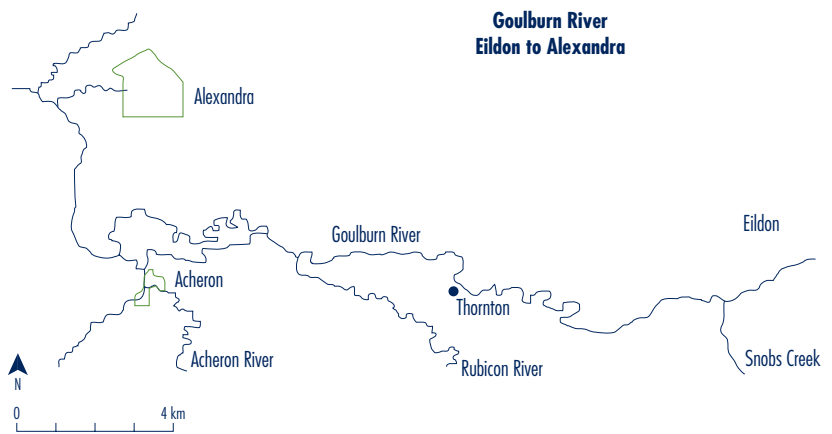
Early experiences demonstrated that unless there was a high degree of landholder involvement and ownership of the rehabilitation project, the project would suffer.

Recreation and waterway management go hand in hand

The Goulburn River in north-east Victoria, between Eildon and Alexandra, has a history of intensive agricultural and recreational use. This reach of stream is unique in that it is proclaimed a “Heritage River” under the *Heritage Rivers Act 1992*, and over 90% is boarded by some form of crown land. The stream is regulated for irrigation purposes downstream and has been subjected to significant modifications as a result of past land and river management practices. Recreational use is largely based around angling and the river supports the most popular trout fishery in Victoria. Camping and other water-based activities are also popular, and associated tourism contributes significantly to the economies of local towns.

As a result of localised recreational pressure, stock access and exotic vegetation infestations, stream health had declined in this reach, and over recent decades the riparian zone had become particularly degraded. In planning a program to restore the ecological functions of the riparian zone, the Goulburn Broken Catchment Management Authority (GBCMA) sought ways to incorporate multiple uses of the stream and riparian zone. The outcome has been to allow recreational activities, adjacent agricultural land use and environmental values to co-exist, as well as creating opportunities for community education about waterways and fisheries issues.

Desktop (aerial photography and GIS) and on-ground surveys were used to benchmark the condition of the stream. The environmental values and the potential threats to those values were identified. A major threat to stream health was exotic vegetation infestations, predominantly willows (*Salix* sp.). The ecological functions normally provided by natural riparian vegetation were lacking or absent as a result of



this infestation, with willows having seasonal shade and leaf fall patterns in contrast to native vegetation that provides inputs to the stream all year round. In addition, the tree roots of willows are matted rather than large and coarse, and the wood breaks down very quickly leaving little in the way of habitat for in-stream plants and animals.

In addition to willow infestation, stock access to the river was causing increased bank erosion, soil compaction, a reduction of riparian vegetation and increased nutrient inputs. Recreational impacts were also identified, with anglers having localised impacts (vehicle parking, entry and exit points, vegetation trampling and rubbish) in the areas they were allowed access to.

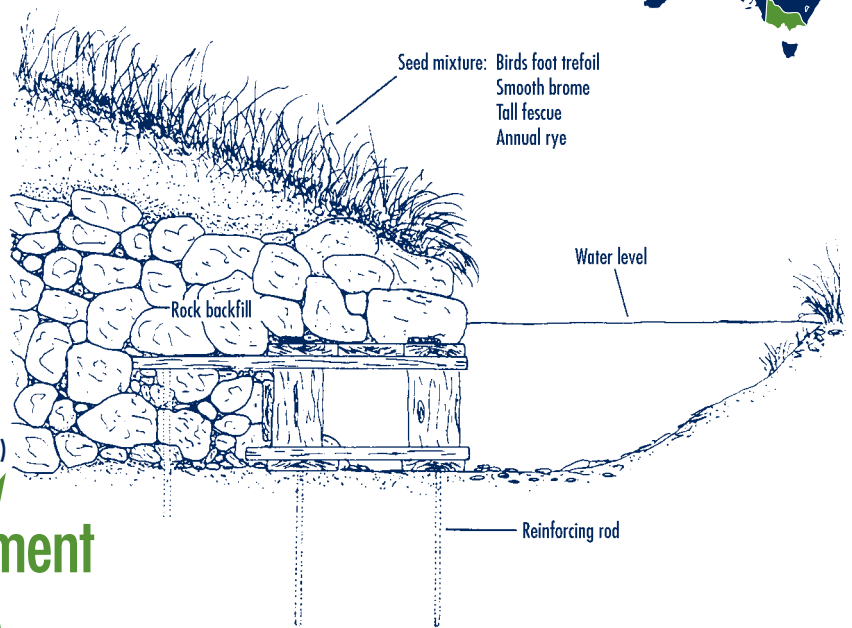
A number of strategies were put in place to address these problems. To reduce localised recreational impacts, a greater number of access areas were developed over the whole reach. This involved a substantial exotic vegetation control program, followed by revegetation with indigenous riparian species. Mosaic planting was used to allow for strategic access points. There was recognition that in the short term, the removal

The outcome has been to allow recreational activities, adjacent agricultural land use and environmental values to co-exist, as well as creating opportunities for community education about waterways and fisheries issues.



Revegetation (stream health)

Restoration (improving habitat)



Waterway management

Recreational users



Recreational users



of exotic vegetation may have some impact on available habitat for trout. To address this issue, in stream artificial habitat structures were constructed to provide habitat until the riparian zone begins to function more naturally.

All works were undertaken on Crown Frontage Reserves with defined legal access points. Existing remnants of riparian vegetation were protected with fencing, which had barrier free access gates and canoe launch ramps. Directional and interpretive signage was installed to provide information to recreational users about the values of the river, fish habitat and how to minimise the impact of their activities.

Licences that allow for grazing on Crown Frontages were reviewed, with conditions that promoted protection of the riparian zone and public access and use of the waterway. Fencing was constructed by adjacent landholders with the assistance of a Waterway Grant. Where

necessary, an alternative water source was partially funded by a grant. This has reduced the impacts of constant stock access and it is hoped will facilitate natural regeneration and protection of revegetation sites.

While this project focused on trout fisheries, future projects are focusing on native fisheries, and these will benefit from the experiences of implementing a habitat restoration project. Another outcome of the project has been the development of some principles for multiple benefits/use on public land.

For further information

Tony Kubeil & Rebecca Nicoll
Waterway Vegetation Officers
Goulburn Broken Catchment Management Authority
Tel: 03 5761 1557 or 0408 597 213 (Tony Kubeil)
Email: tonyk@gbcm.vic.gov.au



Restoring Tarpaulin Creek

In January 2002, Tony and Helen Griffin, owners of Uriarra Station, a 1200 hectare grazing property about 20 kilometres from Canberra, began protecting and enhancing the riverine ecosystem of Tarpaulin Creek. This creek winds about three kilometres through the eastern portion of Uriarra Station from just above the old Uriarra forestry settlement, prior to its confluence with the Murrumbidgee River. To help fund the Tarpaulin Creek rehabilitation work, the Griffins made enquiries with Greening Australia ACT & SE NSW, who steered them towards the ACT Rural Conservation Fund (RCF).

Background

Close scrutiny of the angle of the vegetating banks along Tarpaulin Creek indicated that most erosion occurred centuries ago, well before European settlement. Current damage was primarily limited to livestock tracking and some recent gullying due to uphill mainroad drainage. Another notable concern was that of water quality. Tarpaulin Creek doubles as an effluent and stormwater overflow from the Uriarra settlement, and although there are two settlement ponds in place immediately below the settlement, during times of excess flow, the quality of water being released may be questionable. Certainly, a healthy, well vegetated and stable riparian zone below these ponds would assist in delivering cleaner water into the Murrumbidgee.

Work in progress

The Griffins got started with three main goals in mind:

1. Fencing and removing livestock access to Tarpaulin Creek.
2. Protecting and enhancing the included remnant.
3. Increasing diversity with planting within the riparian zone.

Although still a work in progress, the Griffins aim to have the total length of the creek as it runs

between the settlement and the Murrumbidgee excluded from stock, with a high quality and permanent fence above both banks. The resulting riparian corridor will vary in width depending on topography and remnant inclusion, but will average around 40 metres. The corridor will then be revegetated using direct seeding and tubestock plantings in the areas not accessible to the direct seeding equipment. Only locally occurring native species will be planted, and these will include a mix of grasses, mid storey shrubs and acacias, with the upperstorey species including a eucalyptus and casuarina species.

To facilitate total stock exclusion from the creek, funding assistance is also being provided by the RCF for stock watering points. These will be dams made in newly fenced paddocks that prevent stock from accessing the creek.

ACT Rural Conservation Fund Snapshot

The RCF is an ACT Government initiative, supported by the National Heritage Trust. The RCF provides funding assistance and technical advice to ACT rural landholders keen to undertake biodiversity conservation activities on their properties. It helps with funding for fencing, revegetation — either by tubestock planting or direct seeding — and provision of alternate stock water supply in event of riparian-related work. Funding assistance is drawn up on roughly a dollar for dollar agreement with the landholder, whose contribution can either be cash or ‘inkind’.

The RCF is managed in partnership with Greening Australia ACT & SE NSW. After a couple of site visits by a Greening Australia field services officer and considerable discussion and planning, an application for assistance is lodged with the RCF Committee. In the case of the Griffin’s proposal for Tarpaulin Creek, the committee did not hesitate in recommending it to the ACT Environment Minister. With his approval, the hard work on the ground commenced.

For more information

Simon Katz
Greening Australia ACT
Tel: 02 6253 3035
Email: skatz@act.
greeningaustralia.org.au

Overall, the Griffin’s work through the Rural Conservation Fund signals a new lease of life for Tarpaulin Creek.



Mangrove regeneration and estuarine river bank stability: The easy way

In 1999 the Manning Catchment Management Committee received \$30,000 through the Environment Protection Authority's Environmental Trust funding program to undertake a mangrove rehabilitation project. The project was located on the south side of Dumaresq Island, which is about 5 kilometres downstream of Taree on the Manning estuary. This is a high energy area, frequently attacked by large wind generated waves. The primary aim of this project was to develop and implement methods of riverbank protection that would both simultaneously reduce riverbank erosion rates to natural levels, and encourage the regrowth of mangroves and associated riparian vegetation.

Over the years numerous bank protection techniques have been trialed in the Manning, including:

- ~ dumped builder's rubbish;
- ~ car tyres secured on timber posts;
- ~ timber revetment walls;
- ~ rock gabions; and
- ~ rock revetment.

The preferred method in the past has been a form of rock revetment with revegetation of the upper bank. The major drawback to this method is that it does little to regenerate mangroves, and while it represents a significant improvement on a sheer eroding bank, it still falls short of providing the biodiversity values of the original vegetation community.

There is ample historical and anecdotal evidence to suggest that the banks of the Manning estuary were originally protected by a thick mangrove fringe set against dense forest. This formed a self-sustaining ecosystem that provided both physical protection to the banks and valuable marine and terrestrial habitat. This project aimed to recreate this ecosystem, however, previous attempts at re-establishing mangroves have met with mixed results. In low energy areas, stock exclusion is usually sufficient to allow prolific regrowth, but in high energy areas (i.e. areas with strong wave action) mangroves do not regenerate well, even when stock are kept away. In these instances it has been commonly observed that while seedlings may initially establish in good numbers, they are soon undercut and wash out.

In designing the mangrove rehabilitation project the following background assumptions were made:

1. Before the forests were cleared from the surrounding area the wind generated wave energy was considerably less than it is today because the forests acted as a windbreak.
2. Wave energy has been further increased as the banks have eroded because the channel is now wider and thus provides greater 'fetch' for wind generated waves.
3. Boat wash provides further erosive wave action.

The overall result has been a great increase in erosive wave action. Meanwhile, the riverbank's ability to withstand this increase in energy has been reduced by:

1. The removal of the riparian forest has tended to make the banks wetter than they were before and, as such, more prone to saturation induced slumping.
2. The removal of the riparian forest has reduced bank strength as the reinforcing effect of the roots has been lost.
3. The loss of mangroves (through clearing or stock access) has left the alluvial banks open to erosion.
4. The practice of 'de-snagging' and the loss of riparian forest have dramatically reduced large woody debris input. This has removed physical barriers that would have formerly both protected the bank and mangrove seedlings.

The net result is the eroding landscape shown in the photograph below.

Project site October 1999. The bank had been eroding at the rate of approximately 500mm/year for many years. Wind generated wave action was cutting a 'wave notch' at the base of the bank which led to bank failure by sloughing. The talus (deposited bank material) was then removed by subsequent wave action and the process started over again.



The design

This project was inspired by works carried out by Brian Fletcher, a landowner at Johns River north of Taree. Brian's property has frontage on to Watson Taylor's Lake at the mouth of the Stewarts River. Prior to European settlement the area in front of the riverbank was a mass of fallen timber which provided physical protection, trapped sediment and acted as a nursery for mangroves. By the time the timber rotted away (and remember, there were some very big trees around in those days!) the mangroves were either big enough to fend for themselves, or more large timber had fallen out of the forest to provide continued protection. This project replaced the role formerly played by large woody debris with a rock barrier.

The rock wave barriers installed at Dumaresq Island are made up of a series of five 50-metre walls laid parallel to the bank and overlapping each other at the downstream end (figure 1). This design was used to allow easy fish passage to and from the area behind the walls at high tide. The upstream end of each wall is curved through 90° and taken to the top of the bank. This creates a rock deflection structure which protects the bank from high velocity flows along the bank face during floods.

Two wall types were installed at the site. Firstly, two walls were constructed to the height of the mean high water mark. This represents the highest tides expected at the site, not allowing for storm surges or floods. Secondly, three walls were constructed to about the mean high water level. These walls will be overtopped by most tides near the full moon (figure 2). The two wall heights are being used to assess the relative degree of protection required for successful mangrove establishment. Results to date indicate that the lower walls, built to the mean high water mark, are sufficient to encourage good natural regeneration of mangroves and thus stabilise the bank.

The upper bank was planted with more than 1000 endemic riparian trees. Rows of Swamp Oaks (*Casuarina glauca*) were planted near the top of the bank to provide a wind break, while a mix of other rainforest pioneer species were planted in a strip about 10 metres wide all along the top of the bank. After two years upwards of 95% of the trees have survived, with growth rates up to 3 metres tall. The eventual aim is to reproduce a species mix that reflects in part the original forest at the site.

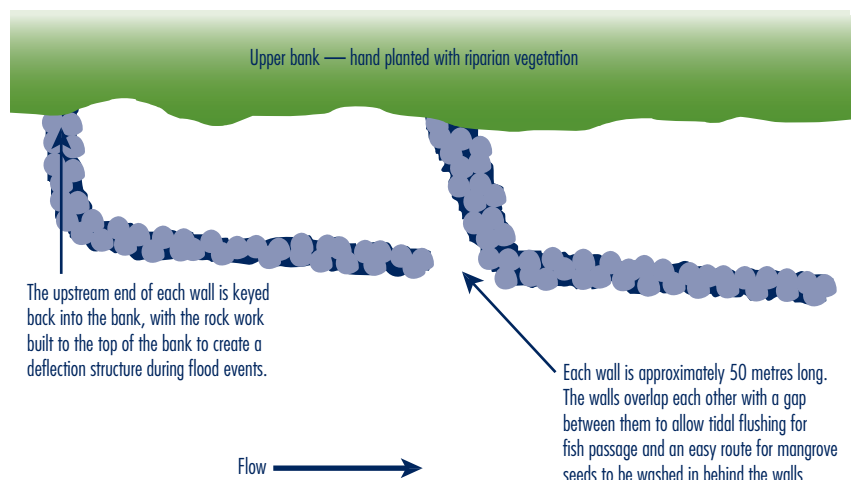


Figure 1. Plan view sketch of typical wall arrangement.

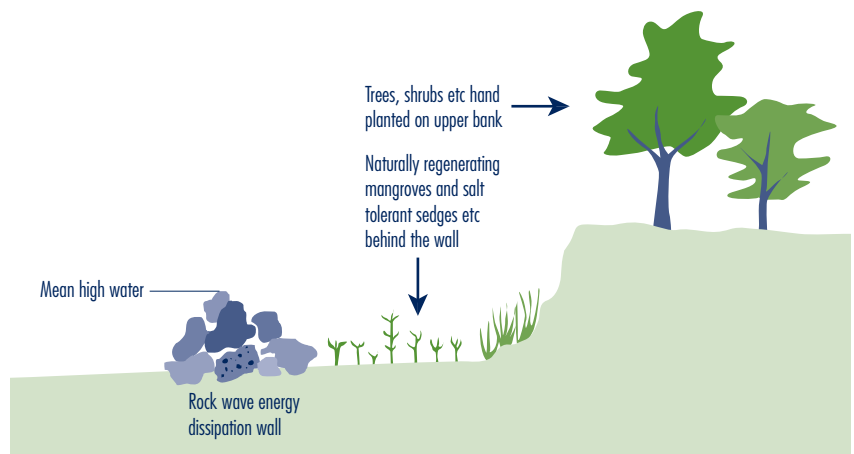


Figure 2. Cross section showing the simplicity of the design. Rock wave energy dissipation walls are constructed parallel to the eroding bank. The distance from the bank depends on the slope and extent of the bench in front of the bank, and the reach of the machine used to place the rock. The wall is built to a height that corresponds with the range between mean high water and mean high water springs. Mangroves and other salt tolerant shrubs and sedges will establish by natural regeneration where a seed source exists. The job is completed by hand planting an upper bank buffer of riparian trees and shrubs.



COSTS

The cost of constructing a project of this design is heavily dependent upon the local quarry rock prices, as this, and the machine hire to place the rock, accounts for most of the cost. As the cost of rock is very variable the prices quoted here can only be used as a guide. With rock delivered to site at the rate of \$27.20/m³ (\$17/tonne) the price of the project was \$87/metre of bank treated. This price includes the walls themselves and all the materials for the upper bank revegetation works (trees, fertiliser, mulch, fencing etc.) but not the labour component. When these rates are compared to the cost of installing the traditional rock revetment method, wave energy dissipation walls are 8–10% cheaper.

This technique is a new solution to the problem of accelerated estuarine river bank erosion in high energy areas, i.e. those areas that are exposed to high levels of wind generated wave action and/or boat wash. It has significant advantages over traditional bank protection methods such as rock revetment. These include:

- ~ It is cheaper.
- ~ It has significant environmental benefits as the whole design is focused upon establishing a wide band of mangroves in front of the eroding bank.
- ~ Mangrove establishment is achieved through natural regeneration via habitat creation — this is far easier than hand planting!

Note: To gain the full environmental benefit, the upper bank revegetation should **not** be considered an 'optional extra'!

Same location as page 21, August 2002. The installation of wave energy dissipation walls has led to the natural regeneration of mangroves by the thousand. As the formerly vertical bank stabilises, the talus material is consolidated by salt tolerant shrubs and sedges (self seeded). The area behind the walls is now a zone of net deposition. Sediment now accumulates where only recently accelerated erosion was taking place.

For further information

Rick James
NSW Department
of Land & Water
Conservation
Tel: 02 6552 2788
Email:
rmjames@dlw.nsw.com.au

KIDS RIVER HEALTH Conference in its sixth year

It's on again! The highly successful Murray-Darling Basin Commission (MDBC) International River Health Conference will run for a third time in October 2003.

This year's Conference kicks off on Friday 17 October with an Aboriginal Corroboree, runs from Sunday 19th and concludes, at night, with rock acts, laser shows and celebrities on Tuesday 21st.

The last three-day event in 2001 saw 600 Year 5 to 11 students and their teachers from across Australia and around the world converge on the banks of the Murray River in Mildura, Victoria. The event launched National Water Week 2001 and saw the announcement of the national winners for Heywire (a competition run by ABC Radio to get the voices of young people from regional Australia onto the radio, talking about important life issues).

2001 Young Australian of the Year (Environment), stresses that it is an event by kids for kids. "The real unique aspect of the Conference is that the students develop the workshops, work with mentors in the lead up to the event and then present to their peers in October."

The 2003 MDBC International River Health Conference's principal sponsor is the MDBC; with major sponsors: the NSW Department of Land and Water Conservation, the Myer Foundation, the SA Government through its Department of Water, Land and Biodiversity Conservation and Land & Water Australia. It has also teamed up with Landcare Australia to manage funding for the event.

The Conference will result in eight smaller regional conferences throughout five MDB States and up to 50 one-day ICM Workshops.

2003 MDBC International River Health Conference details

When: 17–21 October 2003

Where: Mildura, Victoria, Australia

Cost: \$143 (inc GST) per person. Includes three nights motel accommodation, all meals, hat, mug, backpack, t-shirt, CD, video and entrance to the entire Conference program

Registrations close 30 July 2003 (register early as over 250 people missed out in 2001!)

For further information

Arron Wood, Fire Starter Communications

PO Box 692, North Melbourne Vic 3051 Tel: 03 9329 3736 Fax: 03 9329 3550

Email: arron@fire-starter.com.au Website: www.riverhealth.com





RIVER AND RIPARIAN LANDS MANAGEMENT NEWSLETTER

All editions of RipRap are available at www.rivers.gov.au

- Edition 10, 1998: Streambank stability.
- Edition 11, 1998: Riparian zones: what are they?
- Edition 12, 1999: Managing the riparian zone within a total farm system
- Edition 13, 1999: Benefiting from overseas knowledge and experience
- Edition 14, 1999: Managing and rehabilitating riparian vegetation
- Edition 15, 1999: Seeing is believing: the value of demonstration sites
- Edition 16, 2000: Managing snags and Large Woody Debris ★
- Edition 17, 2000: Monitoring and evaluation ★
- Edition 18, 2001: Inland rivers and riparian zones ★
- Edition 19, 2001: River and riparian habitat for fish ★
- Edition 20, 2001: River contaminants ★
- Edition 21, 2002: What are ecosystem services? ★
- Edition 22, 2002: Riparian research: A second phase of the National Riparian Lands R&D Program ★

★ Hard copies of this edition are available.

Clip or copy this coupon and return to

Jennifer Bruce
Publications Officer
Land & Water Australia
GPO Box 2182
Canberra ACT 2601
Tel: 02 6257 3379
Fax: 02 6257 3420
Email: subscribe@lwa.gov.au

Disclaimer

The information in this publication has been published by Land & Water Australia to assist public knowledge and discussion and help improve the sustainable management of land, water and vegetation. Where technical information has been provided by or contributed by authors external to the Corporation, readers should contact the author(s) and make their own enquiries before making use of that information.

Print Post Approved Number
PP 299436/00235

Would you or a colleague like to be on our mailing list for RipRap or other Land & Water Australia newsletters?

Your name: Mr, Mrs, Ms, Dr (please circle) First name:

Surname

Position:

Organisation:

Postal address:

..... State Postcode

Tel: Fax:

Email:

Suggest a theme for future issues:

.....

Riparian Management Fact Sheets

New series available
Also available in pdf format at www.rivers.gov.au

Yes! Please put me on the mailing list for the following Land & Water Australia R&D newsletters:

- RipRap* — River and Riparian Lands Management
- Thinking Bush* — Native Vegetation R&D Program
- Focus* — Dryland salinity

