Proof

Understanding, managing and rehabilitating riparian areas

by Amy Jansen and Michael Askey-Doran

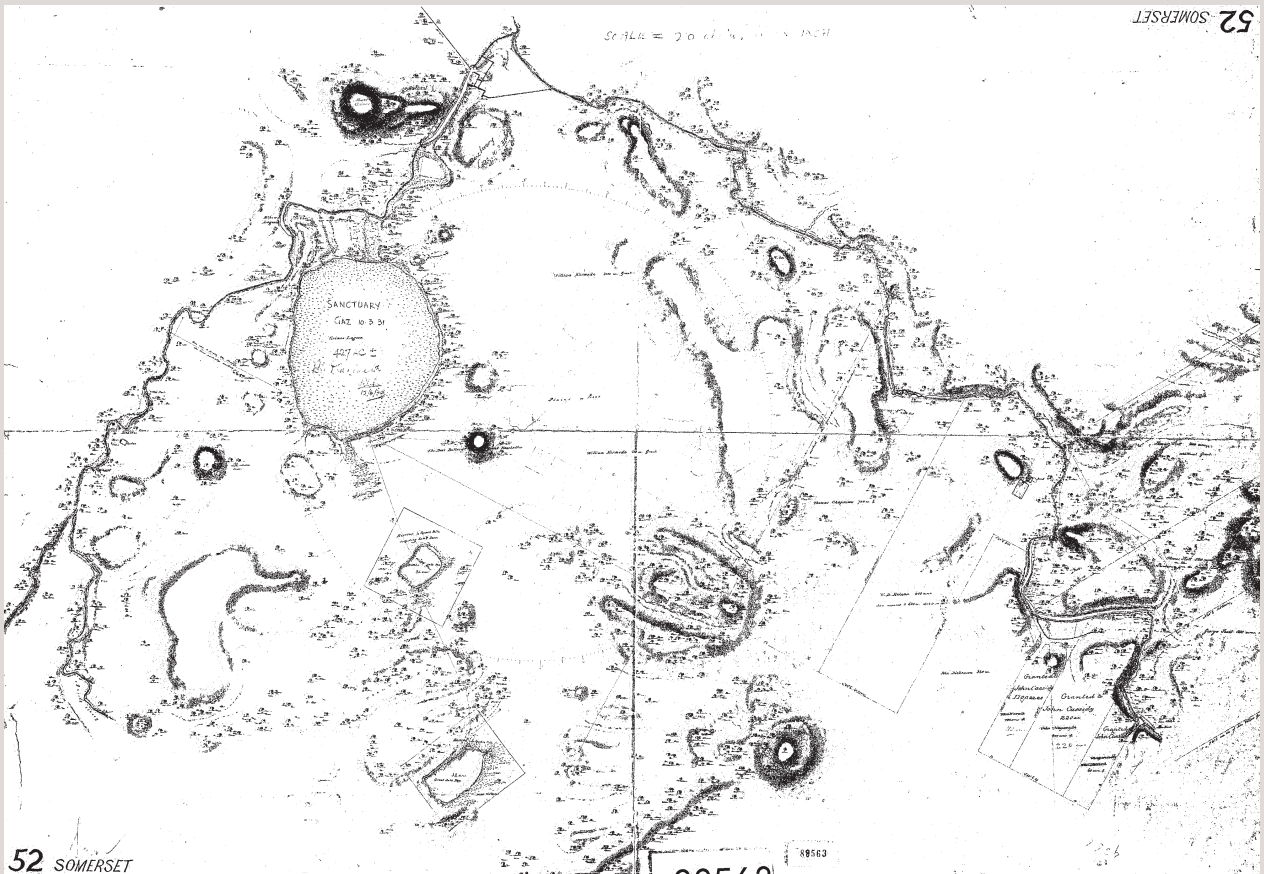
Photo Michael Askey-Doran collection.

proof ***n***. 1. Evidence sufficing or helping to establish a fact; proving, demonstration. 2. Test, trial. 3. Compare old maps with present day maps. 4. Photographic evidence change over time. 5. Ability to implement management based on sound scientific principles. 6. Indicators to provide proof of positive or negative management. 7. Evidence of participation, ownership of issues. 8. Proof of understanding, past, present, future.

Proof of environmental change can be gauged by remembering the past and how things were — the look, feel, sound and movement of the bush or animals. Proof can also be measured by comparing old maps and diaries with knowledge and memories of today.

Lachlan Macquarie described his travels through the Midlands. He notes many interesting things about the landscape:

Map from the 1830s of the Blackman River and surrounding Salt Pans Plains. Map courtesy DPIW.



Wednesday 4th December 1811.

I have named this 'High Hill' or mountain on account of the fine view it commands, *Prospect Hill.* — After descending from this Hill, we pursued our Journey to *Jerico Plains*, where we halted at 1/2 past 10 a.m. close to the *River Jordan*, a small stream running through an extensive meadow; this being 8 miles distant from our last Ground. — We travelled over a succession of very fine Hills and fertile Vallies for 10 miles to a Jungle with fine Springs of fresh Water —.

Thursday 5th December 1811.

Having left *Salt Pans [sic] Plains*, and passed Grimes's Lagoon, a very fine one a quarter of a mile long, on our left, we entered *Argyle Plains* — and Encamped on the Banks of "*Macquarie River*" (so named now) which flows out of Grimes's Lagoon and runs by many windings all the way to Port Dalrymple.

This figure shows an overlay of one of the original surveyor's maps on a current aerial photograph of the Macquarie River south of Ross. Map courtesy DPIW.

Friday 6th December 1811.

At 6 a.m. Set out from *Macquarie River* — travel for 3 miles through *Argyle Plains* — which contains good Pasturage; thence through Hills & Vallies for 3 miles more — poor Soil — to "*Mount Campbell*" leaving it on our left; then enter "*Maclaine Plains*" and travel through them for 2 miles to a rising Ground covered with wood, which separate them from the next Plains. Thence travel 2 miles over "*Antill Plains*", which are beautifully interspersed with Trees and contain good Pasturage for Cattle. — At 10 a.m. halted on the Left Bank of *Elizabeth River* in Antill Plains.— At 1/2 past 3 p.m. Pursued our Journey from *Elizabeth River*, which we forded close to where we Encamped, and travelled for 7 miles across "*Macquarie Plains*" (— now so named and commencing from Elizabeth River, and which is *40 miles* from the settlement at Port Dalrymple); these Plains are very extensive and beautifully interspersed with Trees and small Eminences and skirted by fine ranges of Hills, well calculated for grazing of Horned Cattle & Sheep, the Plains also being in most Places a good Soil for Tillage & Pasturage.

Saturday 7th December 1811.

— travelling for 10 miles through *Epping Forest*, which is all very poor bad soil, to the open Plains; which I have named *Henrietta Plains*; — These Plains are by far the richest and most beautiful we have yet seen in Van Diemen's Land; forming a grand, and interesting fine Landscape, and having a fine noble view of *Ben-Lomond*, *the Butt*, and a long lofty Range of smaller Mountains on the East and West of our Track, extending all the way to Port Dalrymple; the New River, or *South Esk*, meandering in a beautiful manner through the Plains, making the Landscape complete. — The Soil and Herbage of Henrietta Plains far excel anything of the kind we have yet seen. —

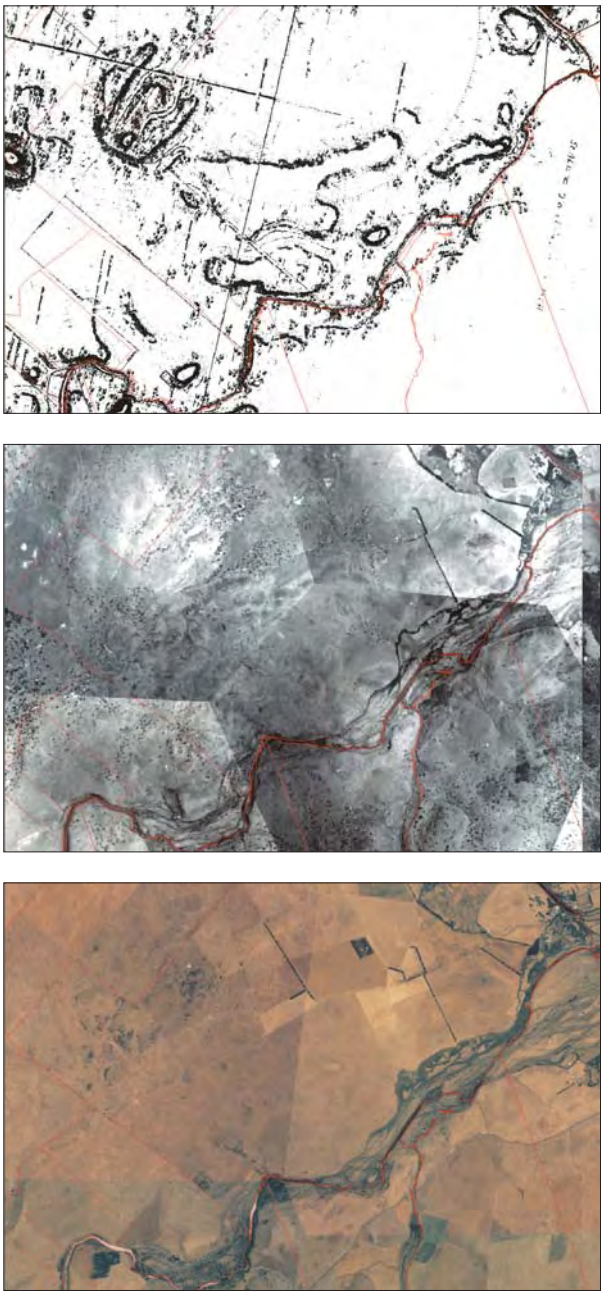
Macquarie, Lachlan, *Journal to and from Van Diemen's Land to Sydney in New South Wales*. 4 November 1811 – 6 January 1812. Original held in the Mitchell Library, Sydney. ML Ref: A777, pp. 1–34. [Microfilm Reel CY302 Frames #347–380.]

The black arrow indicates channel change on the Macquarie River. Map courtesy DPIW.

By the 1830s surveyors were marking blocks of land along the Macquarie River for settlers in the region. The figure on the opposite page shows an overlay of one of the original surveyor's maps on a current aerial photograph of the Macquarie River south of Ross. These original maps are accurate as well as artistic: the surveyors spent time drawing the hills as well as the essentials of property boundaries and the location of the river.

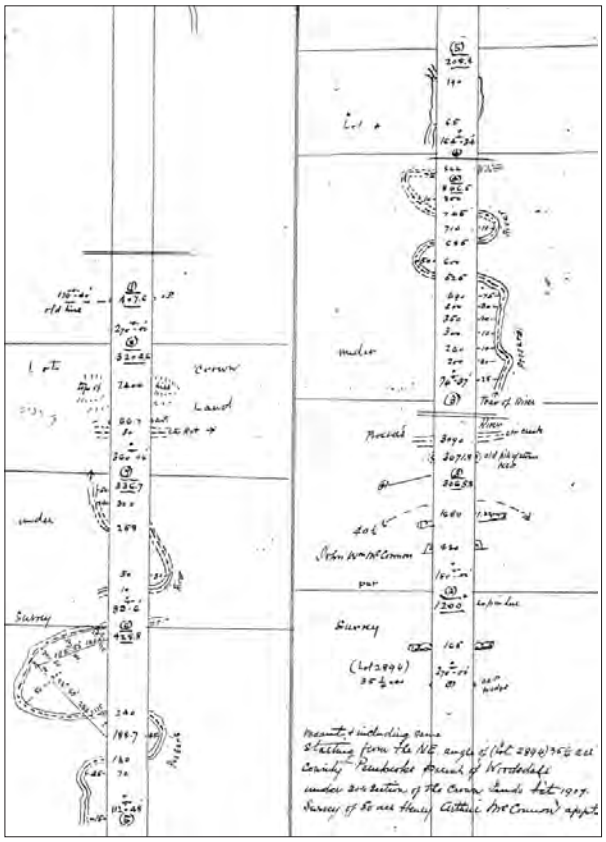
Today, we can use these maps to see if there have been changes to the river. The figure above shows the original survey map (in black) overlain on the current aerial photograph, and overlaid with the current cadastral boundaries (in red). The arrow indicates where it looks like the channel has been straightened.

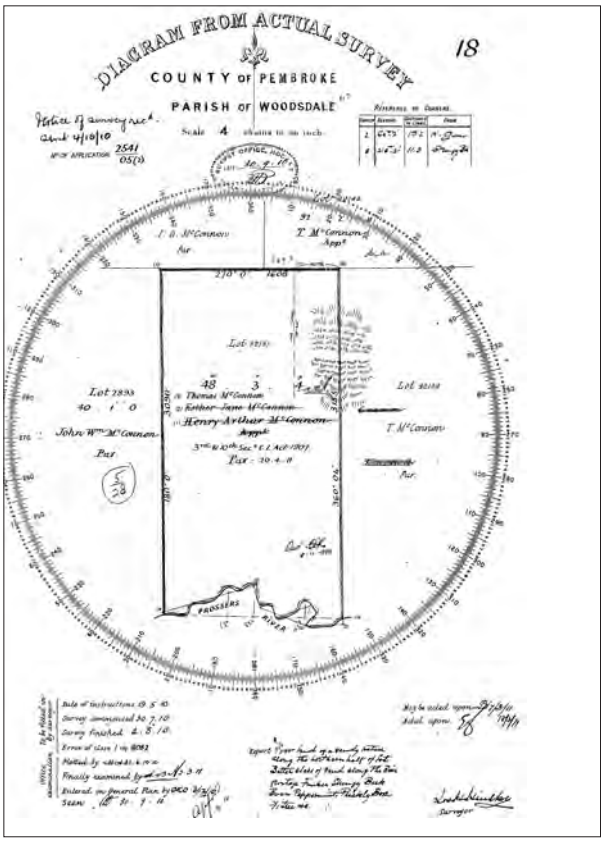
Often we think that the river is very unstable and we need to spend a lot of money repairing it. However, a time series of maps and photos shows the river has actually been relatively stable for a long time and that erosion is localised. Most changes to the river and the surrounding landscape probably occurred in the 1800s. The photos at the right show that, since the 1940s there have been no obvious changes to the position of the river channel.



These figures are of the same location on the Macquarie River showing an early surveyors map from the 1830s, an aerial photograph from the late 1940s and an aerial photograph from 1997. Maps courtesy DPIW.

The most evident changes have been an increase in the amount of vegetation along the river (mainly willows and gorse) and a decrease in the number of trees on the hillslopes. These changes in the vegetation have led to significant changes to the riverine environment.





Above: The surveyor's notes. Right: The original survey. Images courtesy DPIW.

WOOLGROWER PERSPECTIVES

Lindsay Young, Lewisham

"I was talking to an older fellow in Ross the other day and he said that a late friend of his could remember when the bottom of the river around our area was covered in tea-tree and it was clear enough to see the bottom in his young day which was about 90 years ago. I think there has been a steady decline because stocking rates have gone up over the last 50 years and stock have had access to the river, grazing there and tracking down for drinks. Now stock water is pumped all over the farm anyway so it is no problem just to put a trough in the paddocks that are fenced off."

Photo Laura Eves.

A similar assessment of the Prosser River in Tasmania's south-east was also completed. An early surveyor carefully mapped all the bends in a section of the Prosser River in drawing a plan of a property which was sold to Henry Arthur McConnon in 1911.

Since then there have been major changes to this section of the river. It became infested with Crack willow and in 1992 the willows were removed and the channel altered (Prosser Landcare Survey 1995). These changes are evident in the time series shown in Figure 1 on the opposite page. Both the original survey and the photograph from 1984 show the channel in a similar position to that shown by the cadastral layer (with some minor changes that may be due to errors in the surveys, or to small changes in the channel). However, the photograph from 2003 shows that the channel in this section has been completely straightened (and significantly shortened).

Figure 1. The original survey map completed in 1910, an aerial photograph from 1984, and an aerial photograph from 2003 of the same section of the Prosser River, with the cadastral layer overlain in red for reference. Source Prosser Landcare Survey 1995.

Proof can also be assessed scientifically in terms of current condition and trajectory of change. As part of the Rivercare planning process, the entire length of the upper catchment of the Macquarie River was assessed. Figure 2 summarises the condition based on this assessment.

- 'Intact' reaches are in very good condition, with good coverage of native vegetation both in the riparian areas and on adjacent hillslopes.
- Reaches with 'Some impact' have been cleared to some extent but retain native vegetation in patches and are often under threat from overgrazing by livestock, weed infestations and further clearing.
- 'Impacted' reaches contain some remaining native vegetation but have been extensively cleared and are subject to stock access and weed invasion.
- 'Heavily impacted' reaches have been almost entirely cleared of native vegetation and the channels have been altered by straightening or construction of weirs.

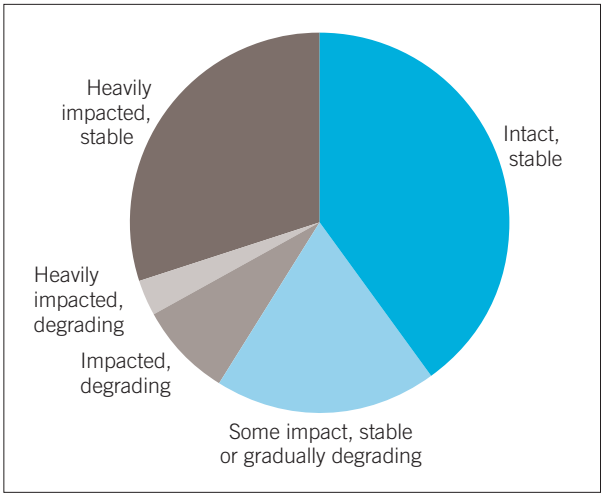


Figure 2. Proportional lengths of the upper Macquarie River and main tributaries classified according to condition and trajectory of change. Data from Rivercare Plan, Hamlet 2002.

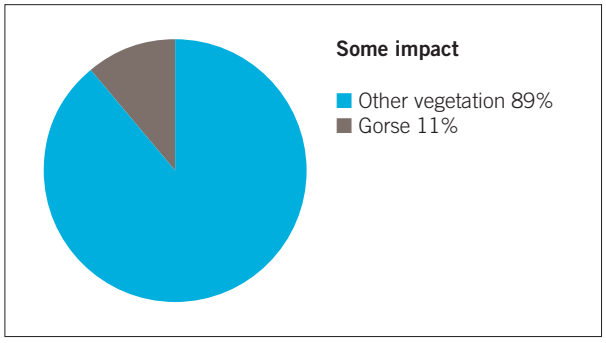
Figure 2 shows that 40% of the length of the river and its main tributaries is in 'Intact' and stable condition (all in the higher parts of the catchment). However, 60% of the river shows some signs of impact, and is either degrading or so heavily impacted that it can get little worse (including all of the lowland floodplain areas of the river).

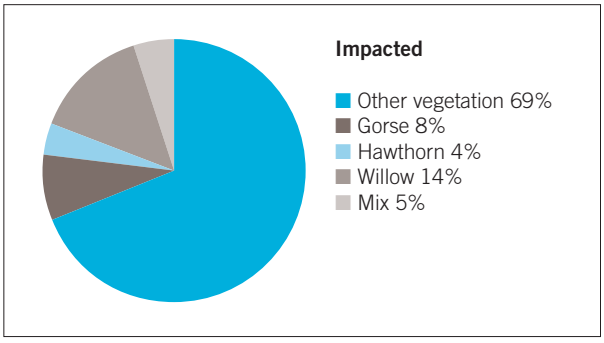
This reach shown in the photo below would be classified as having 'some impact', whilst the photo below right shows a stretch of river that has been heavily impacted by stock and vegetation clearing. Photos Michael Askey-Doran collection.

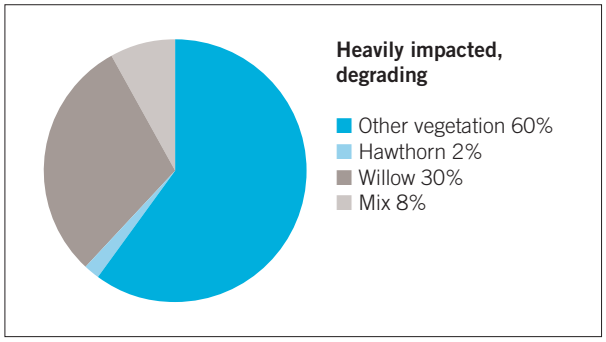
As an indication of the impact of agricultural activities, 63% of the riparian area in the reaches not classified as 'intact', was agricultural land, i.e. either improved pasture and cropland or land cleared for agriculture. One of the major problems in these areas is weed infestation. Figure 3 shows the total lengths of serious weed infestations along reaches of the upper Macquarie River in the different condition categories (there were virtually no serious weeds found in the 'Intact' reaches).

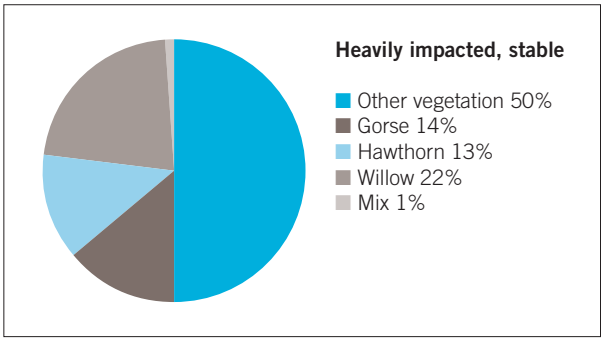
In total, of 188.5 kilometres of river length assessed for vegetation, 12.9 kilometres were dominated by gorse, 8.1 kilometres by hawthorn, 16 kilometres by willow and 1.7 kilometres by a mix of these weeds as well as briar rose. This compares to 74.7 kilometres that was classified as 'intact'.

Figure 3. Proportional lengths of serious weed infestations along the upper Macquarie River and main tributaries in reaches classified according to condition (see previous figure — data from Rivercare Plan). 'Mix' is a mixture of the serious weed species, 'Other vegetation' is dominated by improved pasture but can also include native riparian vegetation. Reference Hamlet 2002.









Willows, gorse and hawthorn dominate this riparian area. Photo Michael Askey-Doran collection.

It is clear that agricultural land use and invasion by exotic weeds have had major impacts on the Macquarie River and its tributaries. The majority of these impacts probably happened 100–150 years ago, although weed invasion is an on-going process, as is localised degradation due to uncontrolled stock access. These problems are not unique to the Macquarie River, but are fairly typical of many rivers in agricultural landscapes. The Macquarie landowners have undertaken Rivercare planning and a series of rehabilitation projects so that they can rectify these problems in an effective and strategic way.

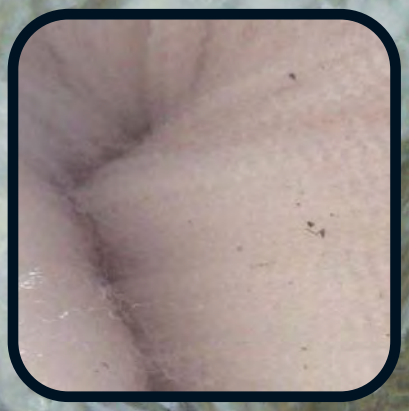
WOOLGROWER PERSPECTIVES

Tim and Jane Parsons, Curringa

"It is my view that anything that we do and touch, if you are going to plant a tree somewhere or divert a bit of water to prevent erosion, or pull out some weeds it is a universal thing. It is doing good and fitting in. What we are doing on this farm and the farm next door and the farms right through, it is generational contracts. It is lifetime stuff. So I think if somebody wants to plant some trees somewhere, be it on that hill or down in that gully or whatever there is a benefit. Even if it is just a benefit for bees or butterflies or insects and ants or birds. It is just a little toe hold."

Photo Laura Eves.

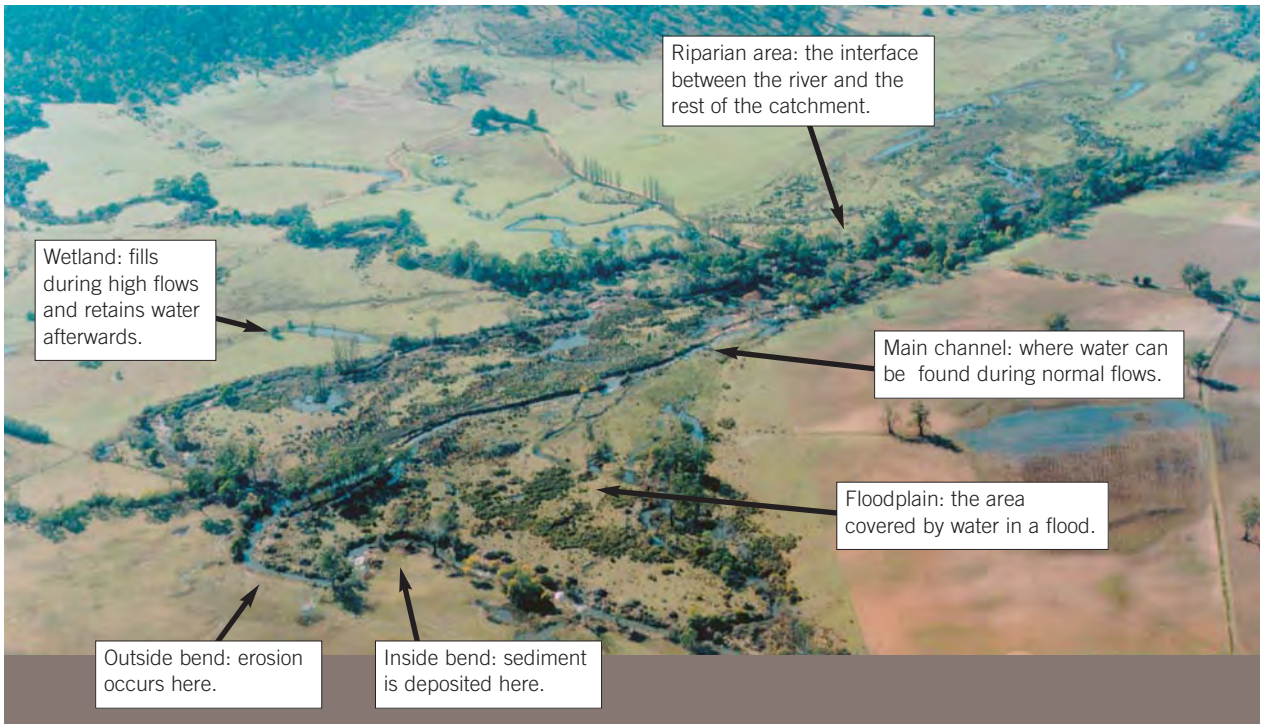
Photo at left Michael Askey-Doran collection. Other photos this page Laura Eves.

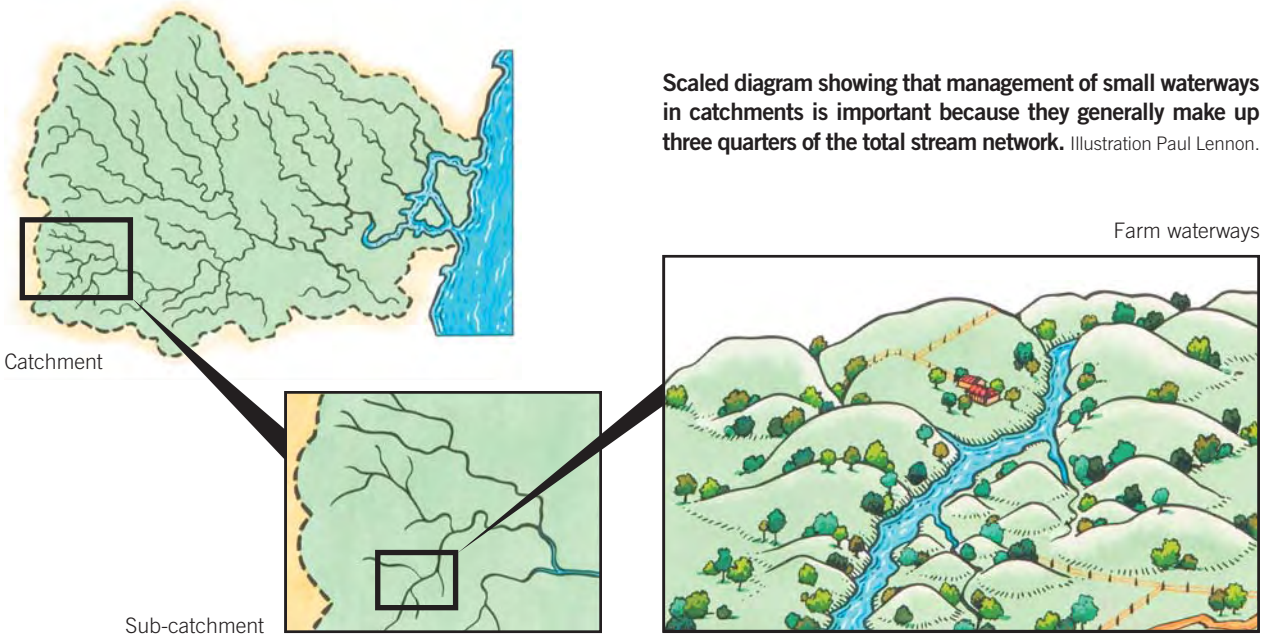


What makes up river systems?

The flow of water through the landscape, down gullies, depressions, drainage lines into creeks and streams and further into the main rivers helps define catchments. The ridges, hills and mountains that act as catchment boundaries are also the sources or headwaters for a catchment's river system. Catchments occur at different scales in the landscape. For example, the Macquarie River is a sub-catchment of the South Esk River and the Blackman River is a sub-catchment of the Macquarie River. A range of smaller tributaries flow into these rivers making up a complex network of drainage lines that can greatly exceed the length of the main part of the river.

River systems are made up of a number of components as shown in the photograph below. Photo Michael Askey-Doran collection.





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

As well as the main channel, there are a number of types of wetlands which can be a part of the river, or off to the side:

Marsh.

Lagoon.

In-stream wetlands are a feature of rivers in the Midlands.

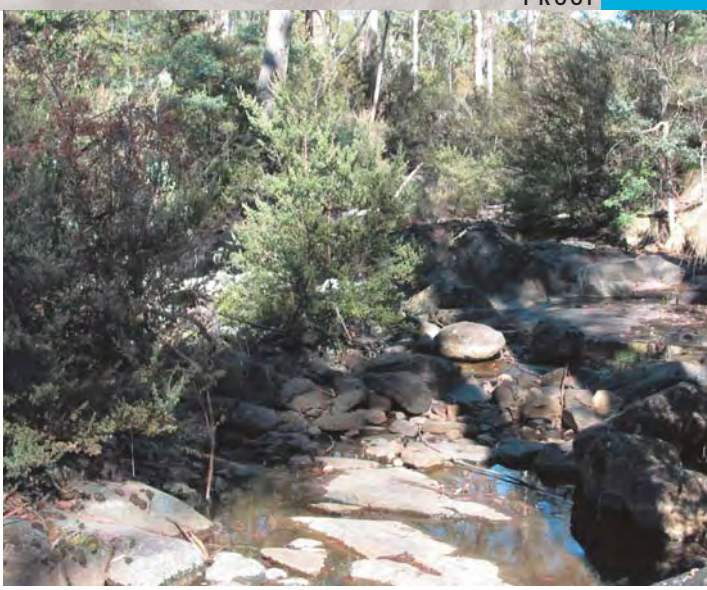
The riparian area is a highly productive but vulnerable, part of the landscape. This is where management can make a difference: what we do in riparian areas has implications for the entire catchment. Understanding the importance of these riparian areas, and learning how to better manage them, are the focus of this Guide.

What are riparian areas and why are they important?

Riparian areas are at the boundary between land and water, so they are important buffers between what happens on land and what occurs in the water. Because of their position in the landscape, they are also moister and more fertile than surrounding areas, making them important resources both for humans and native plants and animals. They are often small in area (commonly only 2–5% of the landscape), yet they are critical parts of the catchment, performing many important functions and providing many benefits to human users.

Riparian vegetation is distinct from the drier vegetation up-slope. Photos this page Michael Askey-Doran collection.

Healthy vegetation traps sediment. Photo Jenny O'Sullivan.



Healthy vegetation stabilises banks.

A channel that has filled with sediment.

Unstable banks and woody weeds.

Key functions

Riparian areas perform many important functions within the landscape:

1. **Trap and store sediment**
   - sediment from land adjacent to the riparian area is prevented from entering the water
   - sediment builds soil and banks in the riparian area.

2. **Stabilise banks**
   - stable banks resist erosion, preventing movement and widening of the channel.

Photos on pages 27–29 Michael Askey-Doran collection unless credited otherwise.

Healthy vegetation slows down and takes up water.

Flood waters have stripped this floodplain.

3. Store water and energy

- flood waters are slowed down, reducing erosion and flood damage
- high flows over the floodplain are trapped to recharge underground aquifers.

4. Filter and buffer water

- riparian plants absorb and trap nutrients, preventing them entering the water
- sediment and contaminants such as nutrients, pathogens are trapped and prevented from entering the water
- overhanging vegetation shades the water, reducing high temperatures which may kill in-stream animals and allow unwanted algae to grow.

5. Provide food and habitat for *in-stream* plants and animals

- in-stream animals rely on inputs of organic matter (dead leaves and wood from the riparian area) for their food
- many animals living in the river also require dead wood or litter on the bottom to hide from predators or shelter from fast-flowing water.

Overhanging and in-stream vegetation provides habitat for animals.

6. **Provide habitat for *riparian* plants and animals**
   - many plants and animals can only live in riparian areas, where there is abundant water, rich soils, and cool, moist conditions
   - many other animals which aren't dependent on riparian zones year round may use them during certain times of the year or in certain parts of their life-cycle.

7. **Provide corridors for movement of animals and seeds across the catchment**
   - plants, via their seeds, and animals move about the landscape along corridors between patches of native vegetation.

Left: Standing dead trees provide hollows and perching sites for a variety of animals.

Riparian corridor of vegetation.

What shapes rivers?

Rivers aren't as simple as they look; there are many different processes at work which control how they function. Understanding these processes is important in order to manage rivers effectively. Rivers are dynamic environments and water is a powerful agent of change. The processes operating in healthy river systems can be seen to be in balance. The natural balance is reflected in the relationship between discharge (the amount of water conveyed) and sediment load (gravels, sands, debris etc.) that move through the system. Rivers become unstable when this relationship slips out of balance and there is either too much or too little of either water or sediment available to the river. Too little sediment and the river may start to erode its bed and banks; too much and the river can't shift it and the channel begins to fill in. Similarly if there is an unnatural increase in the amount of water in the river, streambanks will begin to erode; too little water, and the river won't be able to maintain its channel shape. Geology, climate, vegetation and land-use all influence condition and the way that rivers function.

Geology determines:

- the slope and topography (shape) of the drainage system
- controls channel form and position
- the nature of bed and bank material and sediment that moves through the channel
- soil types and characteristics
- vegetation communities across the catchment.

Climate influences:

- the volume and timing of rainfall, run-off and flooding
- seasonal changes and temperature extremes, such as freeze and thaw
- vegetation communities across the catchment.

Vegetation helps:

- control the energy of the river
- stabilise the streambanks
- filter sediments and nutrients from the surface and sub-surface water.

Patterns of land-use affect:

- the catchment water and sediment yield by altering vegetation, topography, drainage and soils
- the physical condition of channels and banks.

Plants return organic matter to the soil which increases the soil's water holding capacity. Organic material can hold nine times its own weight in water. Sediments build more quickly on well-vegetated riparian areas. The cycle of flooding, sediment deposition and soil building increases the capability for water absorption and storage. Where vegetation is lacking sediment capture is less as is the capability for water absorption and storage.

Erosion processes

There are two main types of erosion that landowners usually have to manage for — streambank erosion and streambed erosion.

Streambank erosion

Even healthy rivers erode their streambanks, it's a normal process that shapes the river. However, a problem begins to occur when changes along the river affect the rate at which streambank erosion occurs. Such changes include clearing of native riparian vegetation and the introduction of stock along the river. The loss of vegetation reduces the stability of the banks, whilst the mechanical action of stock on the streambank causes the bank to break away and start to erode. This can also lead to erosion downstream, as the riparian vegetation hanging over the river helped to slow the river, reducing its erosive impact on the river channel.

Collapsing streambank. Photo Michael Askey-Doran collection.

Streambank erosion can be caused by many different factors, and often they act in combination. By observing the river in its many different stages and monitoring changes that have occurred along its length, it may be possible to identify the likely causes of the erosion. The rate and extent of bank erosion is influenced by:

- the erosive or abrasive effect flowing water and sediment can have on streambanks
- the type of bank material and its susceptibility to erosion
- the presence and condition of riparian vegetation
- the presence of obstructions within the channel that constrict or redirect flow
- irregular bank alignment
- streambed erosion increasing the relative height of banks, making them vulnerable to collapse
- increased channel capacity enabling greater flood volumes
- poorly managed stock access resulting in stock tracks, loss of soil structure, soil compaction, *pugging* of the wetted edge of the stream and damage to protective riparian vegetation
- rapid fall (or *draw down*) in stream water level, particularly in highly regulated stream systems, leaves saturated soil banks without the buoyant support of water
- the entry of water into the channel from off-stream sources, such as dams, road works, contour banks and floodplain channels
- wave action due to wind
- the wash from boats.

Streambed erosion

Streambed erosion occurs when the bed of the river starts to erode away and the channel deepens. Streambed erosion is a sign that the channel gradient has become steeper, and the river is adjusting itself to a more stable gradient. Bed erosion is commonly caused by straightening of the channel or through removal of bed materials such as gravel. An obvious sign of bed erosion is a headcut, which appears as a sharp change in gradient, like a small waterfall, in the bed of the river. The headcut makes its way upstream until the river establishes a new gradient.

An example of a gully with several active head cuts moving up the slope. Photo Samantha Burt.

There are four main processes leading to bed erosion:

- *sediment starvation* when weirs, dams and blockages obstruct the downstream movement of sediment
- *increased channel slope* arising from channel straightening, gravel extraction and de-snagging activities within the channel
- *channel constrictions* that narrow the channel and increase the energy (velocity) of flow sufficiently to erode the streambed
- *increasing flow (energy)* due to an increase in the amount of water that enters the drainage system through catchment clearance, releases from dams, de-snagging and riparian vegetation clearance.

Some cases of bed erosion are quite obvious, whilst others are much more subtle and require a trained eye and some technical experience to identify. There are a number of observable indicators to suggest that bed erosion is affecting, or has affected, a stream:

- a steepening in the bed, often a very steep *riffle* (shallow, turbulent section) that is moving upstream
- bank erosion on both sides of the channel
- a lowering of pool levels
- hanging streamside vegetation or a perched line of lichen on rocks
- exposed bridge footings
- significant alteration to channel shape and behaviour downstream, including sedimentation
- exposure of bedrock, old bed logs or clays in the channel base.

Potential impacts include:

- loss of channel stability and normal stream behaviour
- bank erosion and downstream sedimentation
- streambank collapse as the height of banks increases
- collapse of streamside vegetation into the channel
- lowering of water levels in pools leading to lower ground water levels
- smothering of aquatic habitat by sediment
- reduced water quality due to sedimentation
- reduced natural flooding regimes due to the enlarged channel capacity
- undermining of stream-related infrastructure such as bridges.

Dead wood in rivers

Fallen logs in rivers, called 'Large Woody Debris' (LWD) are important for many reasons, but are often blamed for problems such as erosion and flooding and hence removed. We now know that LWD is extremely important in rivers and that fallen logs in the channel and on the banks help protect the banks from erosion by slowing down the flow. Fallen logs also provide very important food and habitat for a variety of animals. The logs provide a surface for algae to grow on, and this in turn provides food for bugs and fish. This is particularly true in rivers which lack rocky areas in the bed, such as many parts of the floodplain reaches of the larger rivers. Many animals also shelter from the fast flowing water amongst logs.

While it is true that local erosion can occur around fallen logs in rivers, this is actually beneficial, in creating pools and riffles in the stream, which are favoured habitats for particular kinds of fish and invertebrates. Removing a log to prevent this erosion from occurring may be detrimental to the river, and may also just move the problem further downstream. Fallen logs in some circumstances can increase local flooding, but it takes a *lot* of wood to do so. At any point

In-stream woody debris aligned with the flow. Photo Michael Askey-Doran collection.

along the river, the cross-sectional area of wood must be at least 10% of the channel capacity to have any significant influence on flooding. Single fallen logs are very unlikely to influence flooding. Wood should only be re-positioned or removed from streams if it can be shown to be causing problems.

The solution may simply be a matter a moving the wood so that it is aligned with the flow. Removing logs from your section of the river is likely to just move any flooding problems downstream.

Linkages upstream and downstream along the river

It is important to understand that processes occurring in one part of the river affect other parts of the river. While it may be obvious how some events influence downstream areas, there can also be upstream influences. For example, gravel extraction which causes bed lowering will increase the energy and flow of the water upstream, since the gradient of the channel will increase. This can result in increased erosion *upstream*. Downstream effects may also not be very obvious. For example, straightening the channel in one section will increase water flow, possibly leading to increased erosion downstream. Planting a section of bank on a small stream may have effects both up and downstream, once the plants get to a reasonable size. The planting can slow down the water flow and reduce its energy, possibly leading to increased flooding upstream, and a lower risk of flooding as well as less erosion downstream.

Linkages are particularly important to consider when it comes to trying to deal with water quality issues. Revegetation and control of stock access along rivers are only likely to have visible, on-site effects on very small channels. If a large river flows through your property, there is unlikely to be anything you personally can do to improve the water quality of your section of it. However, whatever you do will influence the water quality for your neighbours downstream. The effects are cumulative, so the more people who address the issue, the greater the benefits will be.

The bottom line is that you need to consider your neighbours up- and down-stream when planning any works on rivers.

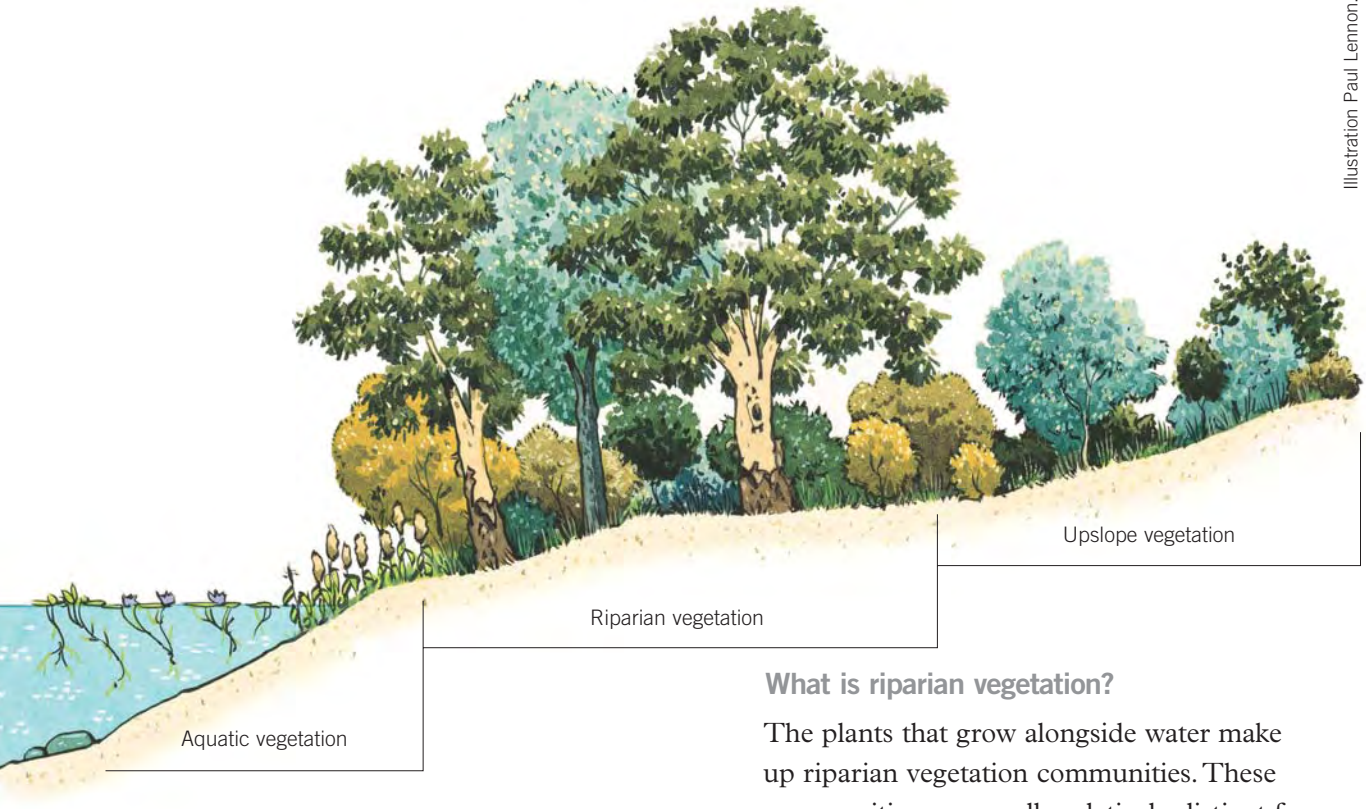


Illustration Paul Lennon.

Riparian vegetation

The question is often asked: What was the vegetation here like before Europeans arrived? This is an important question because we assume that riparian vegetation in its original state (before 1750) performed all of the essential functions of riparian areas. Thus, if we wish to restore riparian functions, it makes sense to try to restore the vegetation to what it was like before we changed it. Many headwater streams still have riparian vegetation in a state similar to its original condition, so we know what to aim for in restoring these types of sites.

However, vegetation in lowland areas has been significantly altered by clearing and grazing, and we can often only guess what the original vegetation was like. We can get some clues from early explorer's descriptions, and from surveys of existing remnant patches of vegetation. Here we will summarise what we *do* know about riparian vegetation in Tasmania's wool growing areas, and how it has been altered since European settlement.

What is riparian vegetation?

The plants that grow alongside water make up riparian vegetation communities. These communities are usually relatively distinct from the communities which grow in drier parts of the landscape upslope, although many species may be common to both areas. It is often the *set* of species, and the abundances of particular species, which make riparian plant communities distinctive. The extent to which they differ is influenced by the surrounding vegetation. In wetter areas, riparian vegetation might be denser but not very different otherwise to the surrounding vegetation. However, in drier areas, the riparian vegetation might be quite distinctive, containing trees, shrubs and other types of plants which are virtually absent in the surrounding landscape.

How does riparian vegetation vary?

Riparian vegetation varies both along the length and with distance away from the river. Whilst there will be plants that are common throughout the length of the river, there will also be a range of plants that only occur in the headwaters or on particular rock or soil types. Variation away from the river's edge is a function of the plant species' preferences and/or tolerance of moisture and

disturbance. Plants that are happy to grow in perennially wet areas occur along the river margins, whilst plants that prefer better drained sites will be further away from the stream on higher ground. Tolerance of flooding also influences where plants grow. There are plants that rely on the disturbance that floods create to release seed and establish new generations, however, if flooding occurs too frequently these new generations cannot establish. Conversely, if flood frequency is reduced the triggers for germination may be removed. Some plants can also tolerate being under water for extended periods of time, while others cannot. This will determine the types of plants, and hence the plant communities, that can grow in areas which are inundated frequently or for long periods of time (for example, on floodplains of large rivers). If flood frequency is reduced, for example by damming upstream, then plants less tolerant of flooding may invade and out-compete the flood-tolerant species, changing the plant community.

Typical vegetation communities and plants

The riparian plant communities growing along Tasmania's rivers and their condition vary depending on location and land use. The healthiest and most diverse vegetation communities are usually found in the upland or headwater areas of catchments. In contrast, native riparian vegetation is usually fragmented and in poor condition on the floodplains, where much of the land has been developed for agriculture.

Riparian areas are special places for plants. Nearly half of Tasmania's native plant species have been recorded in riparian areas. Although only two species of plants in Tasmania are considered to only occur in riparian areas, 76 species mainly occur there. Of these species, nearly 30% are listed as threatened in Tasmania, indicating that riparian areas have been extensively impacted by human activities.

A number of riparian species have seeds which germinate in response to flooding. Photo Laura Eves.

In wetter upland areas riparian vegetation usually consists of a canopy of eucalypts over a tall layer of shrubs and small trees such as blackwood, musk, dogwood and tea-tree. In drier areas the riparian vegetation may consist of scattered eucalypts over a dense shrub layer of tea-tree and wattles, but may also be a more open woodland community with a sparse understorey and a grassy/sedgey ground layer. Remnant riparian vegetation on the floodplain is usually dominated by a mixture of tea-tree, dogwood, wattles and occasional eucalypts (swamp gum, white gum, snow gum).

Surveys of relatively intact riparian vegetation in the Midlands have shown that most riparian areas have a relatively open canopy of *Eucalyptus* species (mainly white gum, snow gum and black gum) a variable shrub layer (often with wattles, dogwood and tea-tree) and usually a grassy and/or sedgey ground layer (dominated by sagg, tussock grass and *Carex* species).

More detailed information on the species of plants and where they are found is in Appendix 1, page 79.

Weeds of riparian areas

Riparian vegetation in the wool growing areas of Tasmania has been greatly altered by clearing and grazing. This has coincided with the introduction of many non-native (exotic) plants. There are a large number of weed species on Tasmanian rivers (e.g. 22 species of declared weeds are listed in the Macquarie Rivercare Plan, Hamlet, 2002). Generally we think of the highly visible species such as willows, hawthorn and gorse, which are nuisance species and affect river flows. However, there are many other weeds, including aquatic and terrestrial herbs, grasses, sedges, shrubs and trees. Some of these could become noxious weeds in the future. Possible future problem species, which are locally common in certain areas, include sycamore, erica, Elisha's tears, creeping jenny, elderberry and fuschia. The most dominant exotic species in riparian areas are pasture grasses.

Teasel is a locally common weed in riparian areas.

Areas dominated by native tussocks can have many exotic species in the bare spaces between them. Photos on this page Michael-Askey-Doran collection.

Tasmanian scrubwren. Photo Vin Lam.

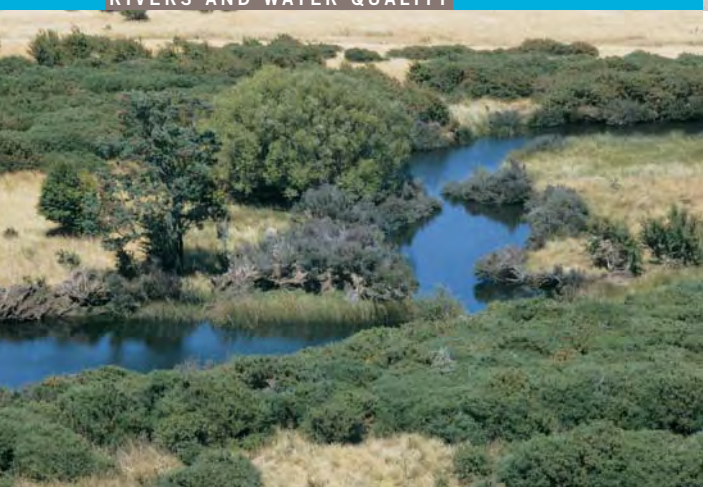
Riparian animals

Many animals are found in riparian areas. Typical animals that come to mind are frogs, dragonflies, platypus and water-rats, which all depend on rivers and riparian areas. However, many other animals also use riparian areas. Some, such as the Azure kingfisher, are only found there. Others, such as the Tasmanian scrubwren, preferentially use riparian areas, although they can also be found in other wet forests. The structural complexity and diversity of riparian habitats makes them suitable for a wide range of animals. However, due to the extensive alterations to riparian habitats in Tasmania, the numbers and kinds of animals found in them can be greatly reduced. Here we will discuss some typical riparian vegetation communities (natural and altered) and the animals that we might expect to find in them. In Appendix 2 is a list of all Tasmanian birds (excluding seabirds) with their specific habitat requirements.

Cleared and grazed streambanks

Streambanks that have been cleared of native vegetation and grazed are usually dominated by short pasture grasses and there is often bare, compacted ground on the banks. Few animals like these conditions — mostly large farmland birds and insects, rather than those that normally occur in riparian areas. Magpies and crows will use these areas, and provide benefits to the farm by eating beetles, grubs, grasshoppers, etc. which can damage pastures. Birds of prey will also use these areas, and provide a service by eating carrion, grasshoppers and mice and rats.

Cleared and grazed streambank.
Photo Michael Askey-Doran collection.



Gorse and grass dominated riparian area.

The bare, compacted ground and the high nutrient levels favour introduced plants over natives, leading to insects and other small animals living in the soil and ground cover being limited, and often dominated by a few exotic species. The lack of stream shade and few large pieces of wood in the stream mean that water quality can be poor, with little habitat for fish and other animals to live in.

Gorse or hawthorns and grass

Some riparian areas have patches of woody weeds such as gorse or hawthorns. Exclusion of grazing from these areas can result in the spread of these weeds, which is not a desirable outcome. Whilst these woody weeds can provide habitat for pest animals such as sparrows, starlings, and rabbits they can also provide valuable habitat for native animals. A number of small birds (e.g. wrens) and mammals (e.g. possums, wallabies, wombats, potoroos, bettongs and bandicoots) will use prickly shrubs such as hawthorn for nesting and refuge areas, if there are suitable areas nearby where they can feed (e.g. areas of long grass).

Right: Fenced long grass. Photos this page and opposite Michael Askey-Doran collection unless credited otherwise.

Willow dominated riparian area. Photo Rae Young.

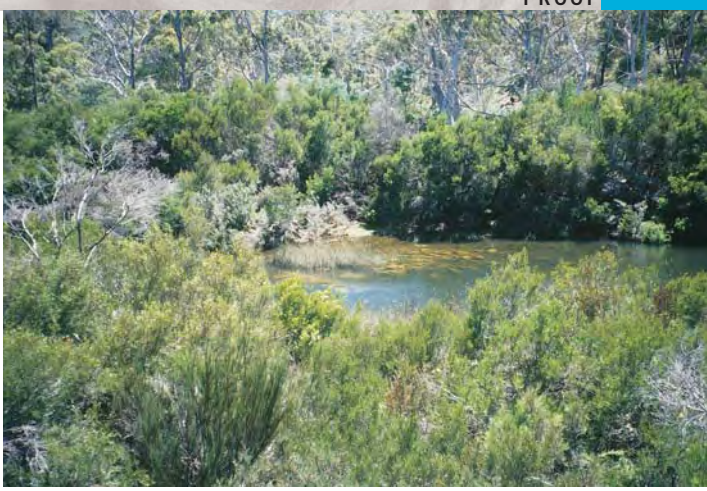
Willows

Riparian areas dominated by willows provide habitat for a limited range of animals. Some birds and mammals will use the trees for shelter and foraging, but for many species they do not provide suitable habitat. The nutritional value of dead willow leaves is low, and cannot be utilised by most in-stream animals that depend on inputs of native leaf litter. Dead willow wood also rots much more quickly than that of native trees, so its habitat value for fish and other animals is limited.

Long tussock grasses

Native tussock grasses provide habitat for many small insects, reptiles and frogs that cannot live amongst short pasture grasses. These in turn provide food and feeding areas for a wider range of birds in addition to the larger farmland birds found in pasture areas. These may include waterbirds (e.g. herons and plovers), as well as grassland birds (e.g. pipits and chats). These birds will consume insects in the pastures adjacent to riparian areas. Native reeds and sedges growing along the banks will reduce erosion and provide habitat for waterbirds including ducks and swans, as well as grassbirds and wrens.

Open grassy woodland.



Shrubby riparian vegetation.

Open grassy woodland

Riparian areas with a mix of native grasses and scattered native trees can provide habitat for a range of animals. Larger birds such as magpies, crows and birds of prey will readily use these areas because they provide good perching sites as well as suitable open areas in which to forage. Hollows in the scattered trees provide nesting sites for birds and mammals such as cockatoos and parrots, bats and possums. Smaller birds that forage in open areas, such as chats, robins and pipits will also use these areas, as will wetland birds such as ducks, swans, herons and egrets. Frogs can be found in reeds and sedges along the banks. Areas of shade and woody debris in the water will provide habitat for fish and other in-stream animals. The lack of a shrub layer and only a few trees means that small bush birds and mammals may lack shelter and be absent. Noisy miners particularly like these open, 'park-like' habitats, and can be quite common. They also tend to chase away smaller birds, particularly other honeyeaters.

Shrubby riparian vegetation

Good riparian vegetation will have a diverse mix of native plant species of lots of different types, including grasses and herbs, reeds and sedges, a mix of shrubs of different heights, and a tree layer of one or more species, with seedlings of the trees and shrubs evident. There will also be dead timber and leaf litter on the ground and in the stream. These components will provide shelter, nesting sites and foraging sites for a diverse range of animals, including small bush birds and mammals, bats, lizards and frogs, as well as fish, platypus and other animals in the stream. Larger birds and mammals will also use this riparian vegetation for perching and nesting sites, even if they forage over a wider area including nearby paddocks and open areas. All of these animals will help to control insect pests on the farm. The riparian area will also provide habitat for a wide range of beneficial insects that perform services such as pollination and maintenance of soil health.

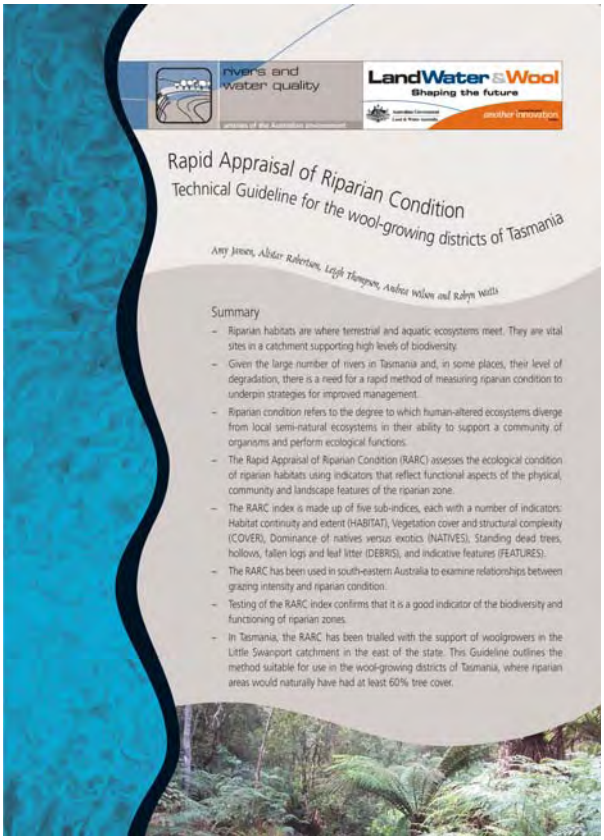
For more information on animals found in Tasmania, see "Birds on farms" (Donaghey 2005) and the DPIW website.

Platypus. Photo Andrew Tatnell.

Photo at left Michael Askey-Doran collection. Other photos this page Laura Eves.

How healthy is my river?

The key to a healthy river is a healthy riparian area, and this is where your management can have an impact. The 'health' (or condition) of a riparian area is a measure of how well it can perform all of the functions discussed earlier. It can be determined by examining a number of indicators, which are related to the key functions. To assess the health of your riparian area, fill in the checklist provided on the following page. In the remainder of this section you will find explanations of the importance of each of the indicators used in the checklist, and some photographic examples. These indicators can be examined at any time, along your stretch of river bank. There are also some larger-scale indicators of river health that will be discussed later. A more in-depth assessment of riparian condition is the Rapid Appraisal of Riparian Condition, which uses similar indicators, and can be used for comparisons and monitoring of riparian areas.



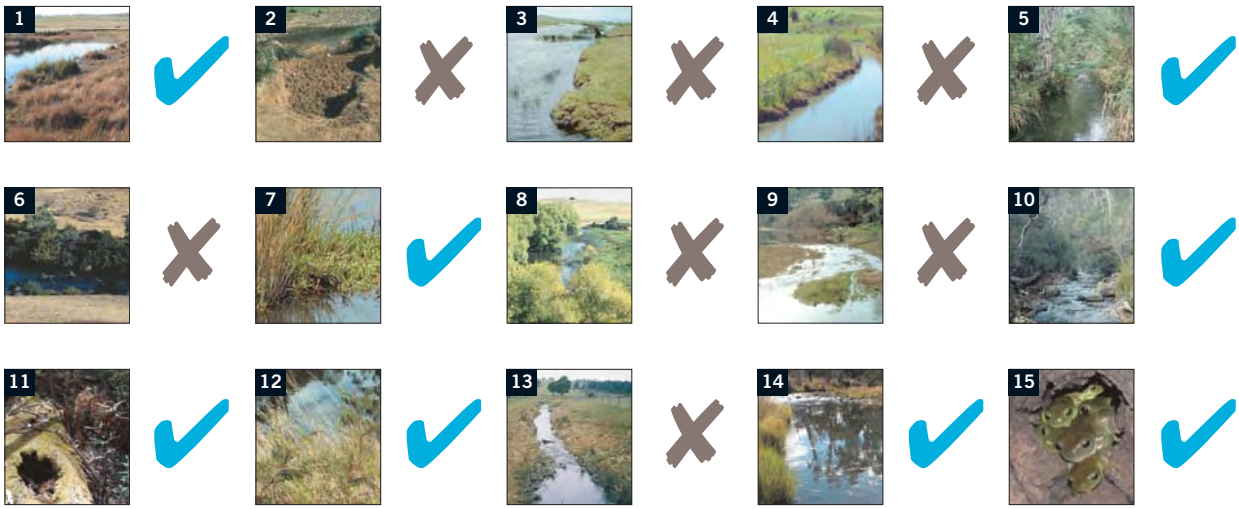
For details about the 'Rapid Appraisal of Riparian Condition: Technical Guideline for the wool-growing regions of Tasmania', see page 76.

Sheep grazing in riparian areas can cause a decline in stream health. Photo Michael Askey-Doran collection.

Stream health checklist

Answer yes or no to the questions below		Yes	No
1	Does vegetation (of any kind) cover at least 85% of the ground in your riparian area?		
2	Is the ground in your riparian area soft, spongy and full of organic matter, with no pugging evident along the banks?		
3	Does vegetation provide some shade along the banks?		
4	Are the majority of plants in your riparian area deep-rooted perennial species?		
5	Is there a mix of different kinds of plants, including trees, shrubs, grasses, herbs and reeds in your riparian area?		
6	If the answer to 5 is **yes** is the strip of native vegetation along the banks at least 5 metres wide and continuous?		
7	Are there reeds and other plants growing in-stream, particularly if riparian vegetation is lacking?		
8	Is your riparian area dominated by native plant species?		
9	Is your riparian vegetation connected to other patches of native vegetation?		
10	Is there leaf litter and fallen logs on the ground and in the water?		
11	Are there standing dead trees and hollow-bearing trees in your riparian area?		
12	Are there seedlings of the local native trees and shrubs in your riparian area?		
13	Have there been any alterations to the channel which have caused a change in the frequency or timing of flood events?		
14	Is the water clear and free of surface scums of algae?		
15	Is there a diversity of small woodland birds (e.g. robins, honeyeaters, wrens, fantails), mammals (e.g. bandicoots and bettongs), frogs, reptiles and native fish in your riparian area?		

If you answered "yes" in the majority of these boxes there is a good chance your river is in good health. The boxes answered "no" provide an indication of where work may still be needed. An explanation for what each these checklist indicators means can be found in the next few pages.



1 Bare ground. Does vegetation (of any kind) cover at least 85% of the ground in your riparian area?

Effects of bare ground:
- increased runoff
- increased sediment, nutrients entering water
- loss of good farming land
- aquatic life smothered

Bare ground can be a result of natural erosion processes along rivers, particularly on vertical banks or after major flooding events. However, bare ground caused by overgrazing and trampling may indicate that the health of the riparian area is declining.

2 Effects of pugging and soil compaction. Is the ground in your riparian area soft, spongy and full of organic matter, with no pugging evident along the banks?

Effects of pugging:
- increased runoff
- increased sediment, nutrients entering water
- poor habitat for soil organisms
- increased bank erosion

Soil compaction and pugging, caused by hard-hooved animals, damage the soil structure and exacerbate the problems caused by bare ground in riparian areas.

3 Shade along the banks. Does vegetation provide some shade along the banks?

Effects of lack of shade:
- aquatic animals killed by high temperatures
- nuisance algae and aquatic plants grow unchecked

Shade along the banks, preferably in the form of overhanging trees or shrubs, or at least tall reeds, helps keep water temperatures low and reduces light levels. This is particularly important in small streams with low flows, where shade can really make a difference. Clearly larger rivers are not going to be shaded by vegetation out in the middle. However, shade along the banks will benefit aquatic animals and reduce algal growth.

4 Deep-rooted plants. Are the majority of plants in your riparian area deep-rooted perennial species?

Effects of shallow-rooted plants:

- less stable banks
- higher water tables
- increased risk of salinity problems
- more prone to drought

Deep-rooted plants, particularly trees and shrubs, but also native perennial grasses, help stabilise the banks. The roots of these plants extend right through the depth of the bank as far as the mean low water level of the stream, and are the major contributor to bank stability, particularly in sandier soils.

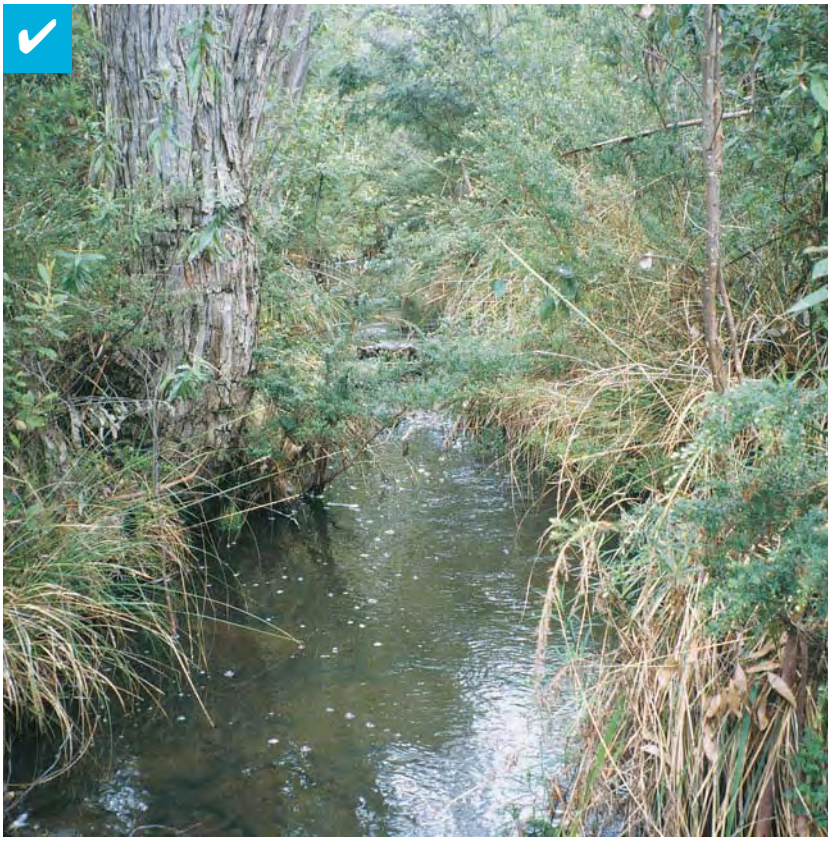
Large photo Ian Rutherfurd.

5 Several different kinds of plants. Is there a mix of different kinds of plants, including trees, shrubs, grasses, herbs and reeds in your riparian area?

Effects of lack of diversity:

- less suitable habitat for riparian animals

A mixture of different kinds of plants, including trees, shrubs, grasses, herbs and reeds, provides structural diversity and contributes to all the key riparian functions. Apart from the benefits already discussed, a range of different kinds of plants provide food and habitat (places to live and breed) for a wide range of animals which depend on riparian areas. For example, many species of woodland birds depend on a shrubby layer for perches and places to hide, while reptiles require low shrubs and tussocks. Many different sorts of insects and other invertebrates such as spiders live in different types of plants, and are important both as predators of other insects and as food for other animals.



6 Riparian buffers and corridors. If the answer to 5 is "yes" is the strip of native vegetation along the banks at least 5 metres wide and continuous?

Effects of lack of a corridor:

- difficult for small native animals to move across open paddocks between patches of native vegetation
- plants and animals cannot recolonise isolated patches of vegetation
- narrow strips are more prone to weeds and the effects of disturbance

A continuous strip of vegetation, in addition to helping perform the functions discussed above, will also provide a 'corridor', allowing native birds and other animals to move around the landscape. This is particularly important in dry landscapes such as the Midlands, where floodplains have been largely cleared. To be effective, a corridor must be at least 5 metres wide, but the wider the better. A width of 30–40 metres would provide a useful corridor for the majority of animals.

7 Reeds and rushes. Are there reeds and other plants growing in-stream, particularly if riparian vegetation is lacking?

Effects of lack of aquatic plants:

- less suitable habitat for aquatic animals
- increased flow rates and more bank erosion

In the absence of much riparian vegetation, aquatic plants can provide cover, sources of food and shelter from predators for aquatic animals. They also help slow the river and protect the banks from erosion.

Photo Roger Charlton.

8 Native plants. Is your riparian area dominated by native plant species?

You may need some help with this one if you are unfamiliar with different kinds of plants. However, the common weeds, such as willows, gorse, hawthorn, briar rose and blackberries, as well as the majority of annual (short-lived) pasture grasses and weeds are introduced species, while the majority of other woody species (trees and shrubs) and many perennial (long-lived) grass, herb and reed species are native. While many introduced species of plants can provide **some** important riparian functions, such as helping to stabilise banks, shading the stream and providing some habitat for native animals, native species of plants generally perform these functions better. Native animals generally prefer to use native plant species for food and living places, simply because they are adapted to them.

Effects of willows:
- widening of small channels
- narrowing of large channels
- logs provide poor fish habitat due to rapid breakdown
- seasonal leaf drop reduces water quality
- outcompete native species

9 Connectivity. Is your riparian vegetation connected to other patches of native vegetation?

Riparian vegetation will function best as a corridor if there are other patches of remnant native vegetation connected to it, through which native animals can move. It is recommended that a minimum of 30% of your property should remain uncleared or be restored to native vegetation, and that the patches should be linked by corridors, to provide the best possible chance for native animals, particularly small birds, mammals and reptiles, to survive.

Photo Danielle Warfe.

10 Logs and leaf litter. Is there leaf litter and fallen logs on the ground and in the water?

Effects of lack of debris:

- little habitat and food for aquatic and riparian animals
- flood waters more powerful, causing more erosion
- riparian soils dry out more quickly

Logs in the riparian area, as well as in-stream, provide important habitat for a variety of small animals. Leaf litter on the ground and falling into the stream, provide an important food source and hiding place for large numbers of small insects and other invertebrates. In fact, a large proportion of aquatic organisms in natural systems rely almost entirely on leaf litter for food and nutrients. Riparian areas which look 'untidy', with lots of logs and litter, etc. are much better places for animals than areas where all of the debris has been removed and should not be 'cleaned up'.

11 Dead trees and hollows. Are there standing dead trees and hollow-bearing trees in your riparian area?

Effects of lack of dead trees and hollows:

- few perches and roosts
- lack of nesting sites

Standing dead trees, and hollow-bearing trees (hollows are usually present in large old trees which have dead broken-off branches), provide perching and nesting places for a variety of birds and mammals, including parrots, bats, owls, etc. While a large number of dead trees is clearly not a good sign, particularly if there are no live ones, by keeping a few they will add to the habitat value of your riparian area.

Photo Roger Charlton.

12 Seedlings. Are there undamaged seedlings of the local native trees and shrubs in your riparian area?

Effects of lack of regeneration:
- no replacement of existing plants when they are lost

If riparian areas are to remain healthy, there needs to be continuous regeneration for different species to persist. Grazing and browsing animals can damage seedlings every time they start to sprout, so that they never grow. If there has been a flood or fire which has stimulated regeneration, it is a good idea to exclude stock until the seedlings have grown enough to be safe from browsing.

Photo Amy Jansen.

Other indicators

Some other indicators can be used to assess the 'bigger picture' of the health of the river system as a whole — as part of the landscape and over time. To assess these indicators, you will need to become familiar with your river over time and learn how it functions within the landscape.

13 Extent and frequency of flooding. Have there been any alterations to the channel which have caused a change in the frequency or timing of flood events?

Role of flooding:
- floods supply floodplains with water, sediment and seeds
- flood disturbance brings new life to riparian zones

Upstream dams and diversions can affect the frequency and timing of flood events in your section of the river. This can have consequences for the vegetation in the riparian area, which has adapted over a long period of time to a particular pattern of flooding. Too much water and some plants may die from waterlogging, while too little water and some soils may become too dry for riparian plants. The disturbance caused by flooding is also important for the regeneration of many riparian species. Flooding opens up new spaces for plants to colonise, releases seed from canopies and stimulates germination from the soil seed bank. Levee banks, channel straightening and deepening, either on your property or upstream, can affect the extent of flooding, perhaps preventing any flood waters from reaching the riparian area (except in very large floods). The riparian area is unique because it does flood regularly, so reducing flooding here means that the vegetation will gradually change from a riparian community to one adapted to drier and/or less disturbed sites, with consequent loss of diversity and other values.

14 Water quality. Is the water clear and free of surface scums of algae?

Effects of poor water quality:

- death of aquatic life
- overgrowth of nuisance plants and algae in-stream
- unhealthy for stock and people

Detailed assessment of water quality requires laboratory analysis, but a few simple indicators can be assessed on-site. Clear water, with no sediment, that enables you to see the bottom of the channel, is a good sign that soil is not being washed in from up-slope or upstream. Green scums of algae that cover the surface of the water can be a sign of high nutrient levels and/or light levels. On smaller streams, and near headwaters, water quality can be influenced by what is happening in your riparian area. However, as you move further downstream and into bigger rivers, water quality may be determined much more by what is happening upstream, which you may not be able to influence.

Inset photo Roger Charlton.

15 Diversity of small animals. Is there a diversity of small woodland birds (e.g. robins, honeyeaters, wrens, fantails), mammals (e.g. bandicoots and bettongs), frogs, reptiles and native fish in your riparian area?

It should be clear from the discussions above that many elements go into making a good place for small native animals to live. If there are lots of these often present, then clearly your riparian area is functioning well in this respect. However, lots and lots of starlings, sparrows and rabbits are clearly not what we want! It matters what **kinds** of animals are present. Patient looking and listening might be required to detect some of these animals.

Photo Peter Davies.

Photo Vin Lam.

Controlling sheep acces to riparian land (right side of diagram) is the key step to maintaining waterways in good condition. Illustration Paul Lennon.

The table below shows the relationships between the indicators discussed earlier and the key functions of riparian areas. A tick shows a positive link between the indicator and the function, while a cross indicates a negative impact.

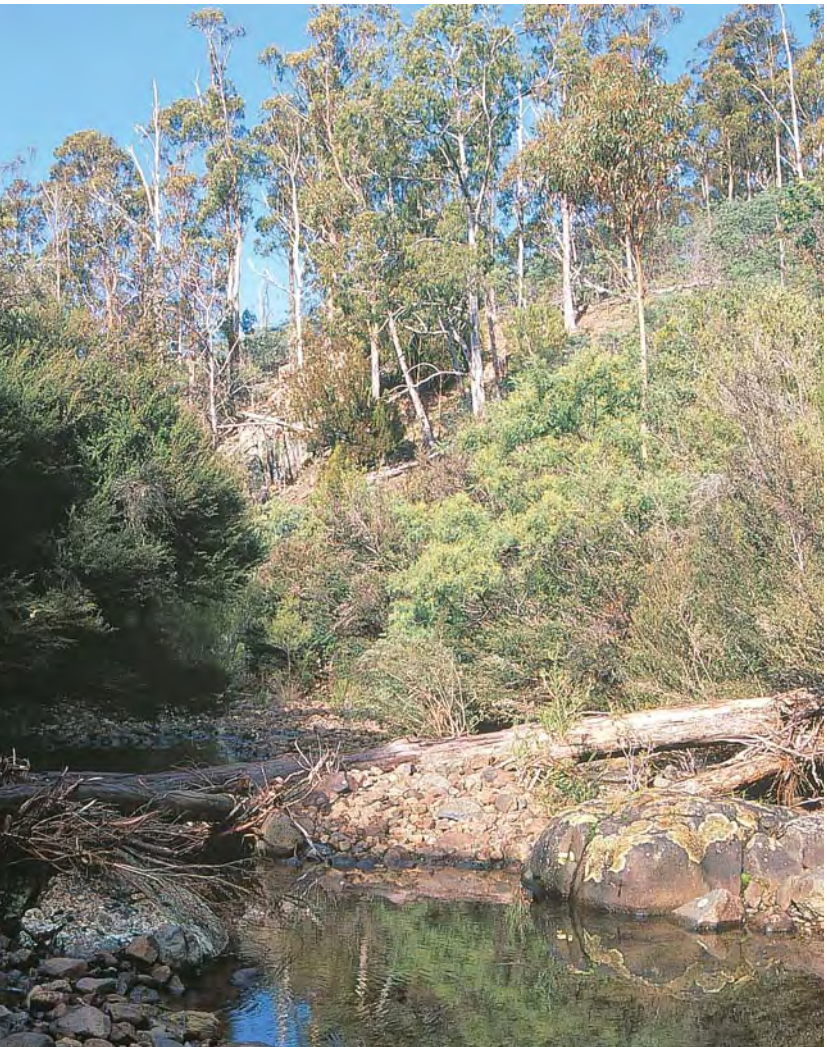
	Functions						
Indicators	Trap sediment	Stabilise banks	Store water and energy	Filter and buffer water	In-stream life	Riparian life	Corridors
Bare ground	✘	✘	✘	✘	✘	✘	✘
Pugging, soil compaction	✘	✘	✘	✘		✘	
Shade				✔	✔		
Deep-rooted plants	✔	✔	✔				
Diversity of plants	✔	✔			✔	✔	✔
Continuous vegetation	✔	✔	✔	✔	✔	✔	✔
Aquatic plants	✔	✔	✔		✔		
Native plants		✔	✔	✔	✔	✔	✔
Connectivity					✔	✔	✔
Debris	✔			✔	✔	✔	✔
Dead trees and hollows						✔	
Seedlings	✔	✔	✔	✔	✔	✔	✔

Managing rivers — how can we do it?

There are a number of things we can do to improve the condition and health of our rivers and riparian areas. Restoring at least some of the key functions of riparian areas will provide many benefits — to our native plants and animals, to the quality of our water, and to our wool growing enterprises and other uses of riparian areas and rivers. This section looks at some of the key issues related to managing and restoring rivers including:

1. Appropriate widths for the riparian zone
2. Retaining native vegetation
3. Revegetation
4. Managing stock
5. Weed management

This stretch of river is in good condition. Making decisions that will protect and maintain this asset is a part of managing natural resources so that they can provide a range of positive environmental, economic and social benefits. Photo Michael Askey-Doran collection.



1. How wide should my riparian area be?

There is no simple answer to this question; it depends on a variety of factors such as:

- the management objectives
- the size of the river and its floodplain
- the location of your area along the catchment
- the slope of the surrounding landscape.

The following table provides a summary of the *minimum* widths of native riparian vegetation that are considered necessary to achieve particular management objectives. The best width will vary depending on the circumstances and the condition of the existing riparian zone. As a general rule, wider is better and will last longer. A well managed riparian area will enable you to achieve increases in both productivity and environmental condition. Wider riparian buffers reduce weed invasion, provide greater shade to the stream, reducing water quality problems and improving habitat quality. Healthy, wide riparian zones help prevent erosion, ensuring your land stays where it belongs rather than disappearing down the river to your neighbours.

Management objective	Recommended minimum width
Improve water quality	10 metres
Reduce streambank erosion	Half the channel width
Maintain natural light and temperature levels	10 metres
Provide food inputs and in-stream habitat	10 metres
Provide habitat for riparian life	30 metres
Provide corridors	10 metres

Further information, 'Managing riparian widths', *Fact Sheet 13*, Land & Water Australia.

2. Getting native plants back along your river

Retaining native vegetation

Retaining healthy riparian vegetation is the cheapest and most effective way of preventing degradation, as there is usually no rehabilitation required. Maintaining healthy native vegetation may simply mean keep managing it the way you already are. At most it may require fencing and monitoring for weeds. These native riparian areas are also an important source of seeds to help the recovery of downstream areas.

In areas where the native vegetation has been lost, some form of intervention is likely to be needed. Options include natural regeneration, direct seeding, and planting. Each of these options is discussed on the following pages.

Photo Greening Australia.

Photo Laura Eves.

WOOLGROWER PERSPECTIVES

Andrew and Diana Cameron, Marathon

"I started fencing off the creek 15 years ago, back in the last wool boom. It has started regenerating naturally. So I fenced off about two or three kilometres then. There has been very little tree recovery but there has been good native grass and tea-tree recovery, but not many eucalypts. Game are pretty hard on eucalypts. Where there is native vegetation there is not much point doing replanting. As long as the ground is stable, that is the most important thing. If there is tea-tree and sedges and tussocks and then it is OK. We have got 75% of the property in reserve and then on top of that we have got streamside exclusion zones for several kilometres."

Below: Remnant native vegetation provides a source of seeds for downstream areas. Photo Michael Askey-Doran collection.

The transformation between 1986 and 2004, where the only difference has been a fence to exclude stock. Photos Biz Nicolson.

Natural regeneration — the best, easiest and cheapest method

Natural regeneration is a cheap and easy way to revegetate riparian areas. For natural regeneration to be successful there needs to be a ready supply of seeds stored in the soil or in the canopy of plants on site or upstream. The fact that there appear to be no small seedlings at the moment does not mean there are no seeds in the soil, as any new seedlings may be grazed immediately. Once stock are excluded anything that germinates naturally will have a better chance of surviving.

Nature has an enormous capacity to heal and rebuild the landscape, just fence the stream, remove livestock, sit back and do nothing! Pioneer plants are the first to establish along rivers, often in large numbers. Species such as Silver wattle *Acacia dealbata* and Tree everlasting *Ozothamnus ferrugineus* are pioneer species found along rivers in the Midlands. These plants help rebuild the river landscape. The roots hold, condition and cool the soil ready for other seedlings. A variety of species will eventually dominate the landscape and pioneer plants will only appear again in large numbers when the land is trying to repair itself after damage from flood, fire, overgrazing or other disturbances. Simply fencing from livestock allows long grass to establish and this alone has many positive effects for the river including holding the soil, providing habitat for many small insects, reptiles, frogs and birds that cannot live amongst short grasses, filtering pesticides and nutrients and allowing the soil to become softer and more permeable to water, reducing runoff into the stream. If there is no regeneration after several years planting will need to be undertaken.

Tea-tree seedlings germinate after floods. Photo Rae Young.

3. Revegetating riparian areas

Revegetating riverbanks is in some ways a last resort option. That is, it is required where there is little or no native vegetation and the chances for natural regeneration are limited. In Tasmania, revegetation needs to be carefully considered as it involves significant investment in time, effort and resources. However, when successful it can deliver multiple benefits to both the river and the property.

Purpose of planting and methods

Revegetation of streambanks is usually done:

- to stabilise streambanks
- to improve water quality
- to provide habitat for fauna
- to provide economic benefits.

The aims of the planting will determine the approach to revegetation taken. For example, planting to improve water quality may be most effective along the small drainage lines that run through paddocks. Planting to stabilise banks will be most effective at the toe of the bank and on areas susceptible to erosion.

Once the aims of the revegetation are established it will be important to identify methods. The work may involve several techniques depending on the nature of the site or a single method. Whether it is direct seeding or planting or both, plants and seeds will need to be sourced, equipment and materials (fencing, growing or bulking mediums etc) organised.

The two most common methods used in revegetation are direct seeding and planting nursery stock. Planning is an essential part of successful revegetation and should occur at least 12 months ahead. Planning needs to consider:

- seed collection
- ordering plants, which are likely to require time to grow — up to 18 months depending on method (tubestock, advanced plants, longstem tubestock)
- site preparation (weed control, ripping)
- monitoring and maintenance.

WOOLGROWER PERSPECTIVES

Frank and Milly Youl, Barton

"The long-term plan is to fence the river off. We have got it fenced in odd places, we have got a bit more to do there. We haven't done any replanting but when we fence off there will be enough things happen, silver tussock and tea-tree and stuff that will be there to do that."

Photos Laura Eves.

Replanting was necessary at this location since there were no nearby sources of seed for natural regeneration.

Photo Michael Askey-Doran collection.

Planting

Planting is an effective means of revegetating areas and the outcomes are usually more predictable than for direct seeding. A number of different methods can be used including tubestock, longstem tubestock and advanced plants.

Tubestock plants

Tubestock are grown from seed with an initial addition of fertiliser, grown for 6 months and put outside for hardening after 2 months. They are the easiest way to put in a large number of plants as they are relatively cheap and easy to plant. The site needs to be well prepared, with the removal of competition for water and nutrients from introduced grasses. If the site is in a flood prone area spot spraying is adequate. Planting can be undertaken when the ground is moist and unlikely to dry out for some months. Plant losses can be high if there is an extended dry spell after planting. Guarding will need to be undertaken if browsing is a problem.

Advanced plants

More advanced plants are potted on from tubestock with fertiliser mixed into the soil and grown for 18 months in 140 mm pots or 24 months in 200 mm pots. In sites where browsing animals are a problem a few well grown trees may be a better option than many smaller cheaper trees that don't survive. Advanced plants have bigger root systems, are less likely to dry out, can withstand outbreaks of grazing and competition for moisture from surrounding grasses. Investing in a few advanced trees every year can have a significant effect on the landscape.

Photos Rae Young.

Left: Before replanting this site was prepared by herbicide spraying to reduce competition from weeds. Right: It was planted with a mix of trees and shrubs. Photos this page and opposite page Rae Young.

Success of plantings using different types of nursery stock

The table below shows the success of plantings of different types of nursery stock at two different sites on the Macquarie River. It is clear that survival varied greatly between the different sites, but larger plants tended to do better.

Per cent survival after two years:

	Lewisham	Beaufront
Plant type	% survival	% survival
Advanced plants (140 mm)	15.3	19.2
Advanced plants (200 mm)	21.5	50.5
Longstems	18.9	50.5
Tubestock	20.1	6.9

Longstem plants

Longstems are started as seedlings germinated in trays without fertiliser then pricked on into tubes with a special concentrated nutrient regime that aims to stimulate vertical growth but burn off roots (i.e. limit root expansion). These plants remain in tubes for 18 months, making sure the outer layer of the stem is hardened. Advantages of longstems and advanced plants include their improved tolerance to drought because of more deeply penetrating root systems and a capacity to cope with grazing because of their height.

Planting involves making a metre deep hole using a waterjet or post hole digger and the entire plant except for the top 5–10 cm is immersed into the cool, moist sub-soil. Soil is put back into the hole and watered well to remove air pockets. The plant now becomes a live cutting with each leaf node producing roots. The plant quickly develops a robust root system, allowing it to withstand floods and extended dry spells. With a large root system in moist ground these plants grow very quickly and are ideal for erosion control or in dry areas. Plants are more expensive than regular tubestock and take longer to plant.

Regrowth at the site one year later.

Regrowth at the site two years later.

Direct seeding

Direct seeding is quick, cheap and effective. Direct seeding of native trees and shrubs, like any field crop, requires excellent site preparation and watering or follow up rains to get good results. The areas to be sown need to be completely bare as grass and weeds will compete with germinating seed. Direct seeding is not appropriate if the site is likely to erode or if in a flood prone area as seed may wash away; however it is ideal along feeder creeks especially if near irrigated paddocks where the site can be watered. Direct seeding can be completed by contractors or by hand spreading of seed. Direct seeding is ideal for revegetating on a broadscale as very little effort is required, it's quick, easy and can be very effective if the conditions are right.

A simple form of direct seeding is the use of slash cut from local bank species; tea-tree works particularly well for this purpose. This can be pinned down with ringlock on bare areas. The capsules on the tea-tree will drop seeds and the slash will protect the seedlings from browsing and weather. Choose slash containing grey and woody capsules closed at the top.

The ground may need to be prepared including weed removal and ripping / scarifying the soil. On bare patches it may simply be a matter of using a heavy rake on any areas that have formed a hard crust that might inhibit germination and moisture absorption.

Species selection

The species used in riparian revegetation should reflect the locality and purpose of the planting. Local native plants provide the specific food, habitat and structure that birds and other animals require. Seeds and plants will be of the same 'provenance' which means that they will already be adapted to local temperature and other environmental conditions. Information on the common native plants found in riparian areas in some of Tasmania's wool growing districts can be found in Appendix 1.

Position of plants

When revegetating, the siting of different species is also important. The riparian area can be broken down into sections, each of which have slightly different characteristics, and consequently support different types of plants. For example, along some rivers woolly tea-tree most commonly occurs right on the edge of the stream, whilst blackwood and dogwood occur further back. Tea-tree may find it too dry further back from the river whilst the blackwood and dogwood may find it too wet right on the river's edge. It is important to try and replicate this pattern when revegetating the banks. It will also improve the success of your revegetation.

Sedges and herbaceous species are important in protecting the toe area of riverbanks. Species such as *Carex*, *Juncus*, *Schoenus* and *Eleocharis* have extensive underground root systems, which bind the soils. Many nurseries grow these plants, but they should also be encouraged to establish along the river if they occur locally.

Grasses and sedges in the clumps that have fallen from the tops of the banks can establish and help stabilise the toe, but this will only happen once some of the stream energy has been reduced. In some cases other actions may be needed to stabilise the banks before revegetation of the toe and vertical faces of banks can be proceed.

The soils on the bank faces are generally unfriendly, being compacted and having limited fertility. The banks are under regular pressure from the erosive action of water and any vegetation which establishes may be washed away. There may be a need to reduce the angle of the banks and run a heavy rake over them in order to break up any surface crusts, prior to revegetation.

To successfully revegetate the tops of riverbanks, a range of local tree, shrub and groundcover species can be used. The roots of trees and shrubs will penetrate deep into the soil profile helping to bind the soils together.

The information in Appendix 1 indicates where in the riparian area each species is likely to grow.

Different types of plants suit different parts of the riparian area.

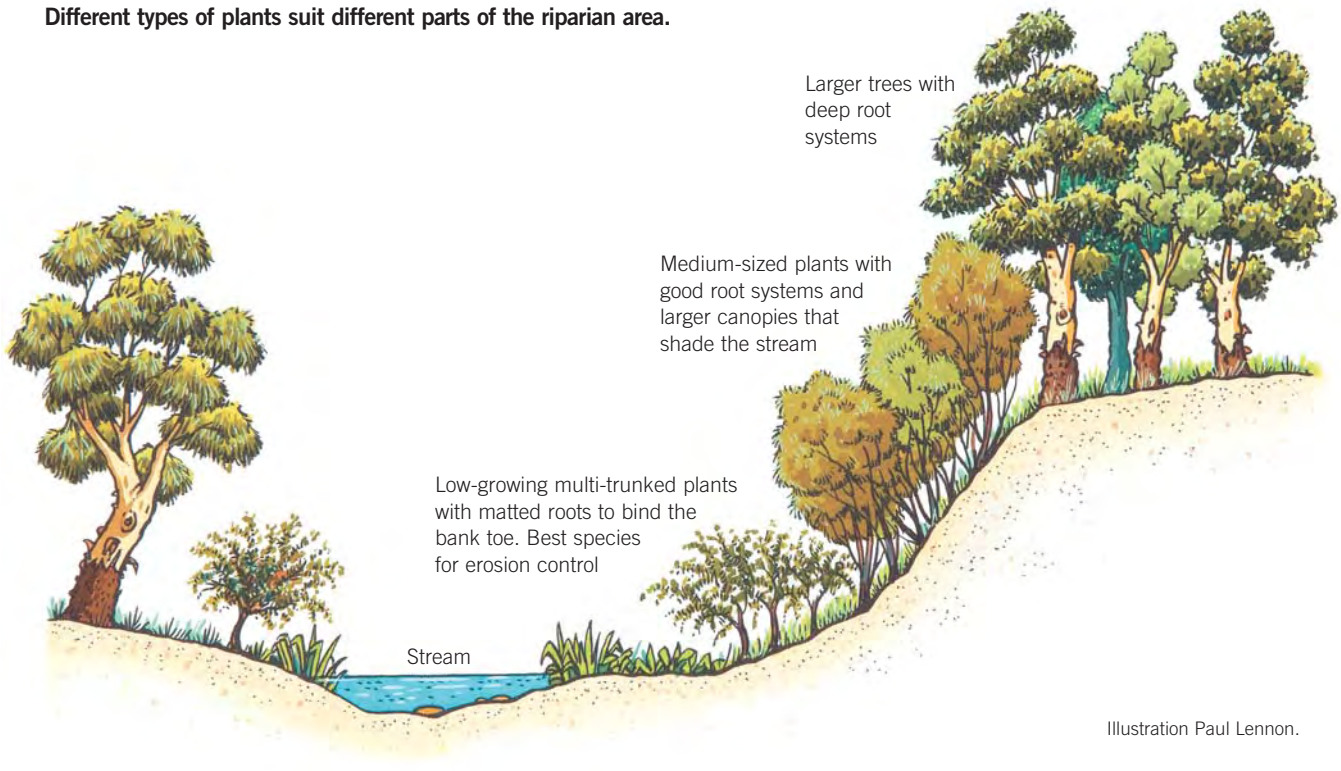
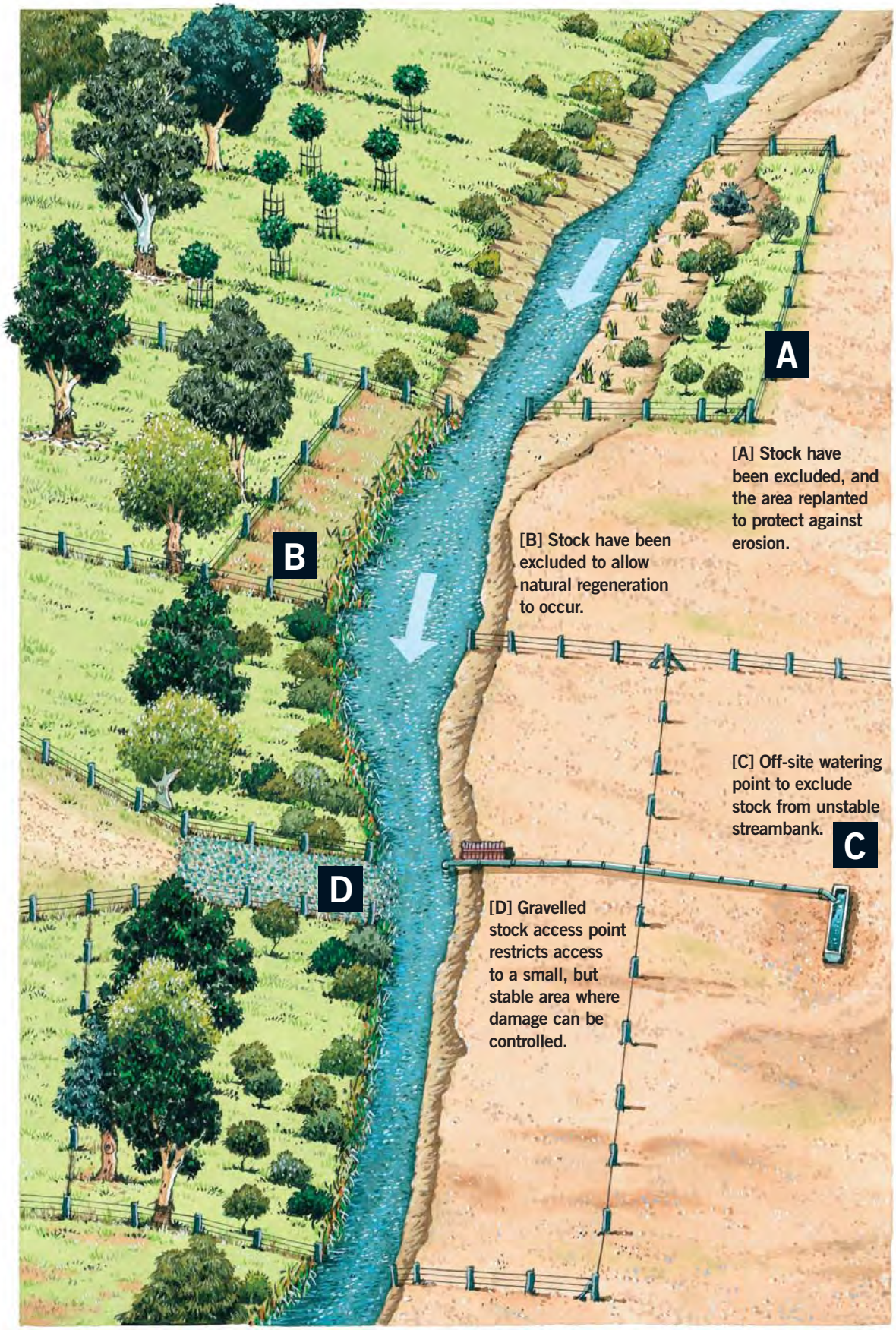
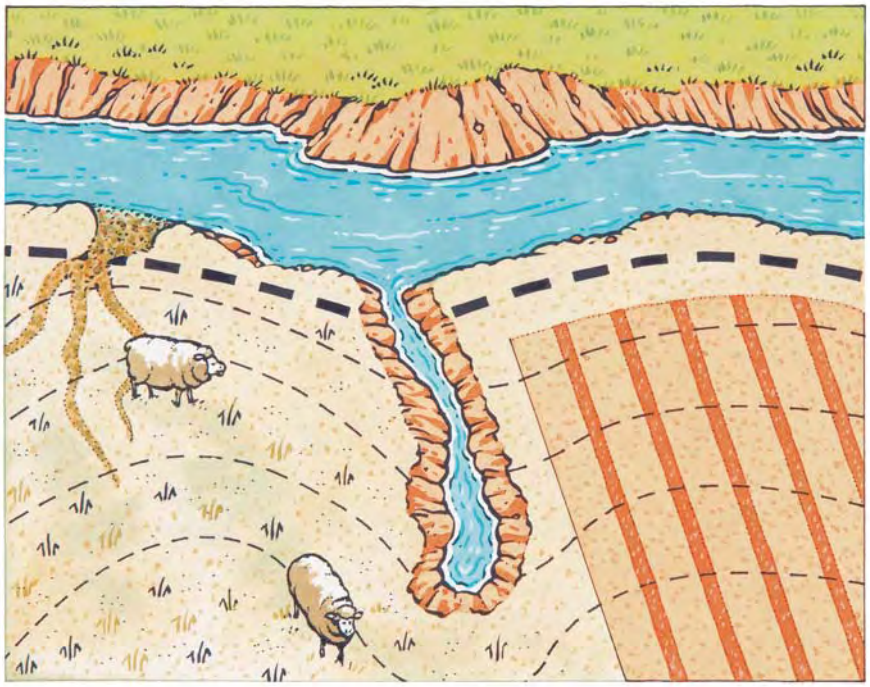


Illustration Paul Lennon.

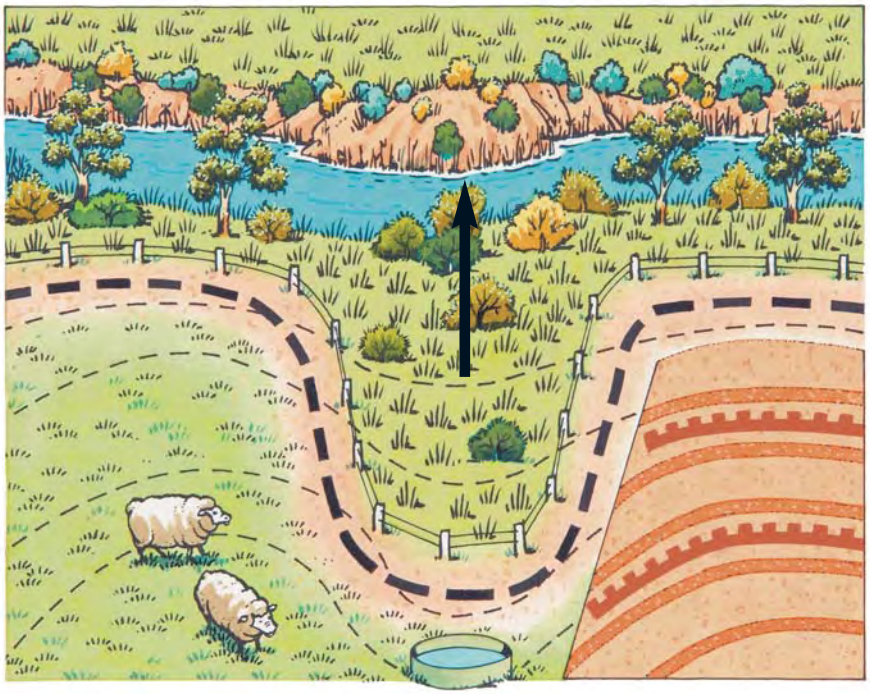


This diagram illustrates how management needs can vary along a watercourse and how you can stage your efforts of revegetating and restricting stock access to when time and resources are available. Illustration Paul Lennon.



Stock tracks
Erosion gully
Cropland
Vehicle track
Contours
Degraded pasture

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



Riparian vegetation
Grass filter strip
Pasture
Cropland
Vehicle track
Contours
Contour banks
Concentrated flow
Fence
Off-stream watering

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

Placing feed and water troughs away from the creek can control stock and reduce erosion. Photo Roger Charlton.

4. Keeping stock where they belong

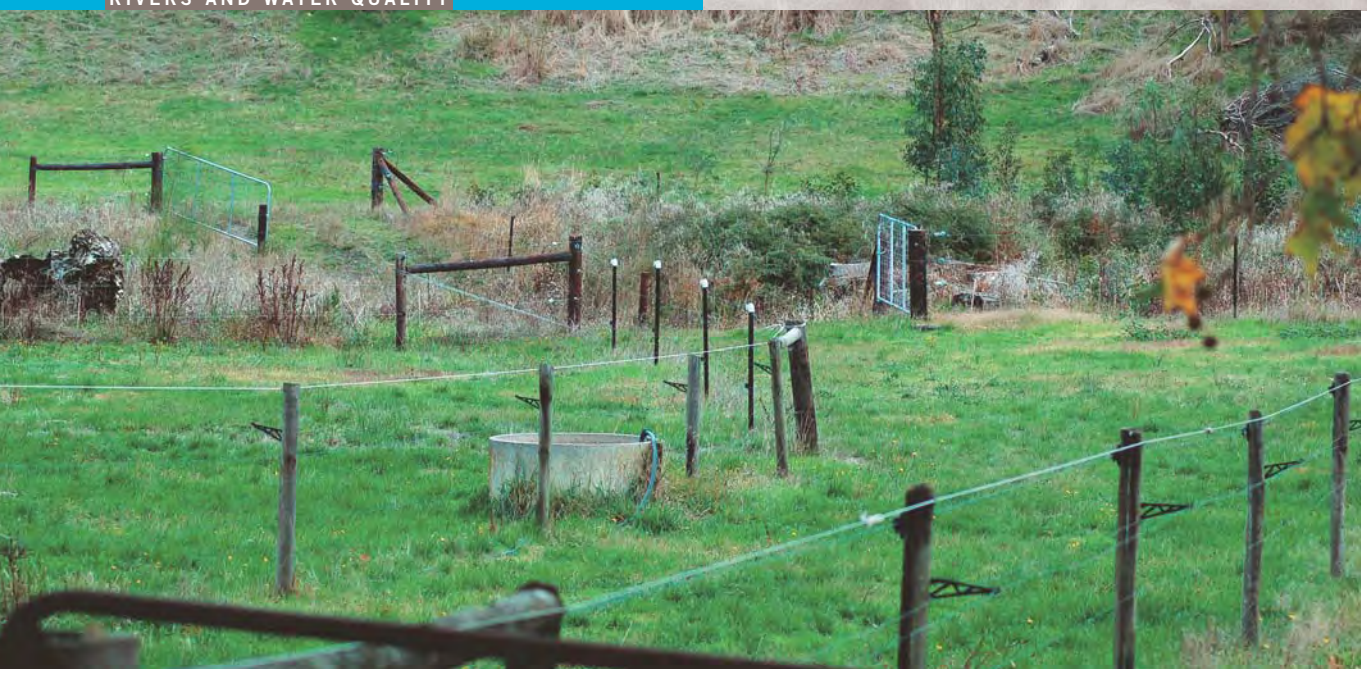
In order to protect plantings or maintain a healthy river environment, it is important that access by stock is controlled. This generally means fencing, but does not necessarily result in stock being totally excluded, rather the timing and stocking rate is carefully managed. Ideally riparian areas should be fenced above the limits of the highest flood, to minimise flood damage to fencing, etc. However, if this is not possible, or if grazing is to be totally excluded, there are a number of things to consider. The location and type of fencing used will depend on the purpose, topography, size of the area, flood regime and stock type.

Uncontrolled stock access. Photo Michael Askey-Doran collection.

Grazing principles

There are a number of techniques which can be used to reduce the impact of grazing in riparian areas (and other parts of the property if you wish to maintain healthy native vegetation in your grazing paddocks). These are:

1. Balance animal demand with available feed:
   - Determine stocking rates so that available feed is utilised, but there is enough plant material left to allow the plants to regrow and to protect the soils, conserve moisture and trap sediment. A minimum of 70% plant cover should be maintained at all times.
2. Distribute livestock impact evenly across the landscape:
   - Use a variety of tools such as fencing (temporary or permanent) and watering points to control where stock graze so that no particular areas become overgrazed (see following pages).



Well fenced stock crossing. Photo Roger Charlton.

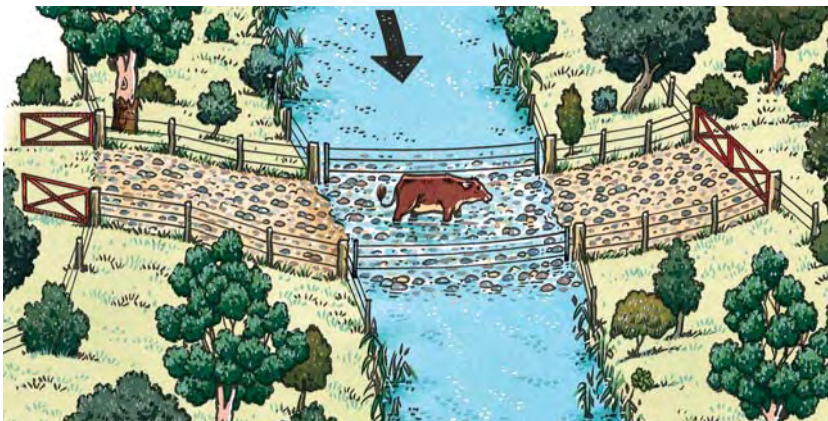
3. Minimise or avoid grazing at vulnerable times, including:
   - For riparian areas this may be when soils and banks are saturated and vulnerable to damage from trampling.
   - When there is little available green feed available, and livestock are likely to start browsing trees and shrubs.
   - Periods when native grasses are flowering and setting seed. Some native grasses handle being grazed quite well, but if they are never able to set seed, they will eventually be lost from the site, leading to a decline in feed quality and loss of perennial plants.
   - Periods after fires and floods, while recovery from the disturbance is occurring, and when many native plants are likely to germinate.
4. Allow areas rest after being grazed:
   - Plants need some time, during the growing season, to rest so that they can rebuild roots and put on new growth for their long-term survival.

Stock watering options

Given the choice, stock generally prefer to drink clean water from a trough rather than muddy, contaminated water in a stream. Keeping stock out of streams permanently will involve providing alternative watering. Several options exist:

- Formed access points at suitable sites along the watercourse. They should be situated on the inside of meander bends in areas which already have a hardened base. Alternatively, the area can be protected with rocks or other materials to prevent erosion. Points chosen should be relatively flat and stock should not be able to move up or downstream or into adjacent riparian areas. Note that these principles also apply if you need to construct crossing points on your stream, to allow movements of stock between paddocks on opposite sides.

An example of how a stock crossing can be constructed to minimise damage to the waterway. Illustration Paul Lennon.



– Water troughs outside the riparian zone. Water can be fed to troughs by gravity or pumping. These can be set up to be shared between two paddocks, or as a central watering point in a cell grazing system.
– There is a range of pumps available, including solar powered, electric and nose pumps (which allow cattle to regulate water in the trough).

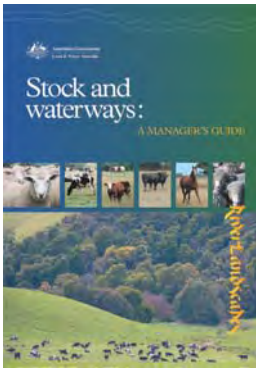
One of the most effective ways to provide off-stream watering is to capture water in higher country using a dam and then gravity feed down to troughs. These may be used as a central watering point in a cell grazing system, shared between paddocks, or moved periodically to spread grazing pressure and improve feed utilisation. The dam needs to be large enough to store enough water for stock needs throughout the year or longer and evaporation losses need to be taken into consideration.

Gravity fed water is the cheapest option but if this isn't possible water can be pumped from the stream to troughs or to a higher storage point where it can then be gravity fed to troughs down slope. There is a range of pumps available including ram pumps which use the streamflow to operate a ram that pumps a smaller volume of water up to a storage tank, solar powered and air–driven pumps.

For further information about pumps and fences (described overleaf), see publications section beginning on page 75.

Managing Streamsides: Stock control, fencing and watering options, David Wright and Terence Jacobson, DPIW.

Stock and waterways: A manager's guide, Jillian Staton and Jenny O'Sullivan, LWA.



Above: Portable trough. Photo Jenny O'Sullivan.

Below: This "ecotrough", developed by David and Ruth Read, shows reeds planted in a restricting container. When grown the reeds will keep the water temperature down. Photo David and Ruth Read.

Above: Nose pump. Photo Michael Askey-Doran collection.

Below: Solar powered pump with back up petrol pump. Photo Roger Charlton.

Fencing options in flood prone areas

Fencing streams is sometimes easier said than done. Streams with high banks that can be fenced above the limits of the highest flood can be fenced using regular farm fencing but streams on the floodplain can be a challenge. In order to ensure the streambank and channel remain stable and benefit the property, an adequate width needs to be fenced (preferably more than 6 metres). Fencing on floodplains can be achieved more readily when the fencing is parallel to water flow but this is often not possible and minimising flood damage to fences can be achieved in a number of ways.

There are a number of fencing options available for riparian areas. These include:

- drop and lay down fences
- electric fences
- suspended fences and flood gates
- non-electric suspended fences
- electrified flood gates
- permanent and semi-permanent electrified stream crossing fences
- semi-permanent fences with disposable sections
- mesh flood gates
- electronic fences.

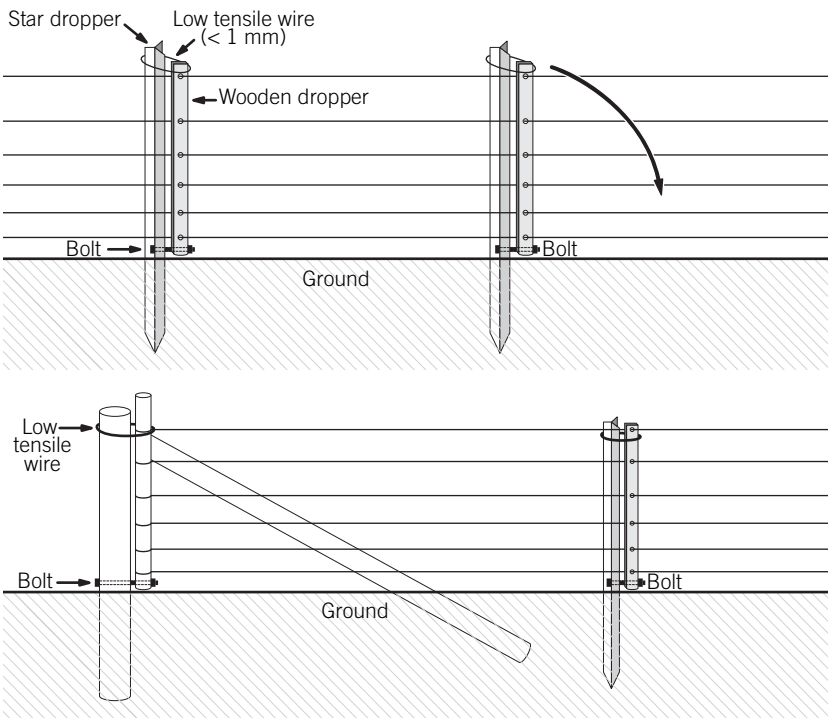
These types of fences are discussed in more detail in the publications listed on the previous page.

Electrified chain flood gate. Photo Jenny O'Sullivan.

Drop and lay down fences

Ian Bell has designed an innovative drop down fence (as seen on ABC's *The New Inventors* program) that has panels hinged at the bottom and held in place by a tension bolt at the top. When flood debris pushes against a slack wire underneath the mesh, the bolt is released and the fence lays flat on the ground allowing flood water and trash to pass over. Once the flood has passed the panel can be lifted up and re-hung using the tension bolt.

Other drop/lay down fence designs



Drop/lay down fence. Upper diagram showing drop-down wooden posts at star droppers and bottom diagram showing drop-down end strainer post. Photo Ian Bell.

5. Are weeds a problem?

Weeds like disturbed environments. Rivers are naturally prone to soil disturbances, and water provides a means to disperse weed seeds. Weeds will out-compete native species for light and nutrients, often growing faster than their native counterparts. The number and diversity of weeds in riparian areas increases as the stream or river flows downstream from the healthier headwaters and into more highly developed and fertile alluvial soil flats. Weed infestations can also occur in highly degraded sites once grazing pressure is removed, particularly if there is a lot of bare ground and nutrient levels are high (both are common if livestock previously spent large amounts of time in the riparian area).

WOOLGROWER PERSPECTIVES

Valerie Le Maitre, Lochiel

"We also have to keep track of the invasiveness of some of the odds and ends, which have come in. I think it is impossible to remove the crack willows and the cumbungi and that sort of stuff but I think an effort should be made to control it the best we can. I mean there should be an ongoing mechanism where you have been funded or after you have expended the money and paid for specific cleaning up of the river."

Photo Laura Eves.

Crack willow infests many rivers in Tasmania. Photo Lizzie Pope.

Willows

Willows are a major environmental weed in the wool growing areas of Tasmania. Being naturally riparian species, they are perfectly adapted to colonising and thriving along Tasmania's rivers.

Generally, two methods for removing willows on the bank are used:

- cutting the willow off at stump level and painting it with a herbicide
- poisoning (stem injection, frill cuts or ring-barking) the entire tree on-site and cutting it off at stump level once dead.

Whatever method is used it is important that the stumps are retained in the ground to stabilise the streambanks until native vegetation has established. Willows growing in the stream channel are not so straightforward. Advice should be sought before their removal.

Top: Cut stump. Above: Stem injection. Below: replanting following willow removal. Photos Lizzie Pope.

It is important not to remove too much willow in a short period of time because:

- the greater the amount of willow removed from a river the greater the chance for problems such as erosion, and the harder it will be to manage any subsequent problems. Too much willow removal can impact on the ecology of the river
- the potential to release silt and destabilise soil is high. This will increase turbidity and blanket aquatic habitat with silt
- duty of care: we should always be good neighbours, and excessive clearing of willows can lead to water quality, flooding and channel stability problems downstream. It is important to work cooperatively with all landowners along the river.

WOOLGROWER PERSPECTIVES

Lindsay and Rae Young, Lewisham and Green Valley

"We have removed all the willows from half of the river and this winter we are going to plant longstems to try and get some native vegetation going. The other half of the river I want to actually do it the opposite way; get the native vegetation going before we remove the willows. Because at the moment the willows are the only things that are providing any shade at all for the river, for the fish or whatever."

Photo Laura Eves.

Other weeds

Gorse and hawthorn do not receive as much attention as willows but are significant riparian weeds. Traditionally gorse is controlled by fire, however this can be a problem in fire sensitive riparian vegetation. Fire is only a stop-gap measure as gorse has prolific soil seed banks and germinates freely after fire. Gorse removal needs to be done in a systematic way that may require a number of years of continued action. Hawthorn can be eradicated by the cut and paint method used for willows.

Before removing hawthorn, blackberries or gorse from riparian areas it is important to identify the role that they play in bank stability and habitat provision. Blackberries can protect seedlings from browsing animals. When no other riparian vegetation exists, blackberries and hawthorn should be left in place, or removed in small sections at a time (revegetating areas as they are cleared). In landscapes where little remnant vegetation remains, riparian areas, even if they are dominated by introduced species, may provide the last refuge for native animals.

Use only herbicides registered as suitable in water-courses. Seek advice from DPIW on the most suitable herbicide to use and how it should be applied.

Further information

Willow Management Guideline, Rivercare, DPIW.

Guideline for safe and effective herbicide use near water, Rivercare, DPIW.

Strategic planning for willow management in Tasmania, 2003, Tasmanian Conservation Trust.

'Controlling willows along Australian rivers', *Technical Guideline*, no. 6, LWA.

Photo Laura Eves.

WOOLGROWER PERSPECTIVES

Damian Gee, Royslea and North View

"As kids we used to go down to the waterhole on St Paul's River with Mum in a vehicle and have a swim for an hour or so in the afternoon. It used to be all thick with gorse on the floodplain there. As part of the Landcare project we mulched the gorse and it did a good job. It is starting to come back in places so I will need to come in and spray it or rip it up to get on top of it. At a certain stage of the gorse, when it is really young, coming up from seed and shooting, the sheep actually eat it when it is still soft. The gorse was knocked down with a big roller on the front of the tractor and then behind it was mulched 6 inches into the ground. The gorse was over 10 feet high in places."

Photo Roger Charlton.

Small photo at left Amy Jansen. Other photos Laura Eves.