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Rapid Appraisal of Riparian Condition
Technical Guideline for the mid north of South Australia

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Summary

- Riparian habitats are where terrestrial and aquatic ecosystems meet. They are vital sites in a catchment supporting high levels of biodiversity. This is true even for riparian areas adjacent to creeks and gullies that may flow with water only occasionally.
- Given the extensive degradation of riparian zones in Australia, there is a need for a rapid method of measuring riparian condition to underpin strategies for improved management.
- Riparian *condition* refers to the degree to which human-altered ecosystems diverge from local semi-natural ecosystems in their ability to support a community of organisms and perform ecological functions.
- The Rapid Appraisal of Riparian Condition assesses the ecological condition of riparian habitats using indicators that reflect functional aspects of the physical, community and landscape features of the riparian zone.
- The Rapid Appraisal of Riparian Condition index is made up of five sub-indices, each with a number of indicators: Habitat continuity and extent (HABITAT), Vegetation cover and structural complexity (COVER), Dominance of natives *versus* exotics (NATIVES), Standing dead trees, hollows, fallen logs and leaf litter (DEBRIS), and Indicative features (FEATURES).
- The Rapid Appraisal of Riparian Condition has been used in south-eastern Australia to examine relationships between grazing intensity and riparian condition.
- Testing of the Rapid Appraisal of Riparian Condition index confirms that it is a good indicator of the biodiversity and functioning of riparian zones.
- The Rapid Appraisal of Riparian Condition has been trialled on ephemeral creek systems around Burra in the mid north of South Australia. This Guideline incorporates modifications to the method to suit this region. This modified RARC suits drier regions with ephemeral streams and where riparian areas would naturally have had at least 30% tree cover.

Background

Riparian habitats are where terrestrial and aquatic ecosystems meet. They are vital sites in a catchment, supporting high levels of biodiversity and being critical in controlling flows of energy and nutrients between terrestrial and aquatic ecosystems (Naiman & Decamps, 1997). This is true even on creeks and gullies that carry flowing water only occasionally. Being at the boundary of terrestrial and aquatic ecosystems, riparian areas are powerful indicators of catchment quality (e.g. Rapport et al., 1998). Human settlement has always been focused on rivers and is often a major determinant of riparian structure and function (e.g. Dynesius & Nilsson, 1994). One of the biggest impacts on riparian areas has been the introduction of domestic stock, with grazing being the major land use over 60% of Australia's land surface (Wilson, 1990). Stock concentrate around water sources, which means riparian and wetland habitats, as well as those around artificial watering points in pastoral regions, suffer greater impacts from domestic and feral grazing herds than dryland areas (Robertson, 1997; James et al., 1999). These impacts have led to extensive loss of ecological condition in riparian areas in Australia.

Given the critical role of riparian areas within catchments, and their extensive degradation in Australia, there is a need for improved management of these areas. A baseline for improved management must be an understanding of current condition, and the factors which determine this. Thus, there is a need for a rapid method of measuring riparian condition, to enable assessment of a large number of sites in a catchment. There is an expanding field of research focused on rapid appraisal techniques to measure ecosystem condition or integrity (Fairweather, 1999; Boulton, 1999).

We have developed a rapid appraisal method for use at a large number of sites which is responsive to changes in grazing management. The method has been trialled in the mid north of South Australia, in collaboration with the Land, Water & Wool — Rivers Project Officer Kylie Nicholls, to determine the modifications necessary for this region. The modifications are based on Version 2 of the Rapid Appraisal of Riparian Condition (RARC). Given the drier climate and the ephemeral nature of most of the creeks in the region, indicators and scores have been adjusted to suit these conditions. These modifications will work for most riparian areas that would naturally have had trees in them. However, some riparian areas in this region may have naturally lacked trees. These riparian areas, which may only be able to be identified by a botanist familiar with the region, cannot be assessed using the same method. At the end of this Guideline, we have suggested possible approaches to deal with this issue.

Throughout this Guideline, *condition* refers to the degree to which human-altered ecosystems diverge from local semi-natural ecosystems in their ability to support a community of organisms and perform ecological functions (c.f. Karr, 1999).

Land, Water & Wool is a joint Australian Wool Innovation Ltd and Land & Water Australia program.

Rapid Appraisal of Riparian Condition (RARC)

Assessment methods incorporating indicators of geophysical and biological properties and processes are likely to provide reliable estimates of ecological condition in riverine ecosystems (Fairweather, 1999; Boulton, 1999). Ladson et al. (1999) described an index of stream condition based on 18 indicators that measure alterations to the hydrology, physical form, streamside vegetation, water quality and biota of streams. This project used a similar approach, and chose indicators to reflect functional aspects of the physical, community and landscape features of the riparian zone, as defined by Naiman & Decamps (1997) (see Table 1). Some of the indicators chosen reflect a variety of functions, e.g. different aspects of vegetation cover can play a role in reducing bank erosion, providing organic matter and habitat for fauna, and providing connections in the landscape. The RARC index for the mid north of South Australia is made up of five sub-indices, each with a number of indicator variables (see Table 2, overleaf). In summary they cover:

1. Habitat continuity and extent (HABITAT).
2. Vegetation cover and structural complexity (COVER).
3. Dominance of natives *versus* exotics (NATIVES).
4. Standing dead trees, fallen logs and leaf litter (DEBRIS).
5. Indicative features (FEATURES).

Table 1. Summary table of functions, components and indicators assessed in the RARC index.

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

* Vegetation cover = canopy, understorey and ground cover.

** Leaf litter includes any dead plant material such as leaves, grasses, twigs and bark.

Table 2. Sub-indices and indicators of the SA RARC, the range within which each is scored, the method of scoring for each indicator, and the maximum possible total for each sub-index (note that in Table 2 the indicators are not grouped by function as they are in Table 1).

Sub-index	Indicator	Range	Method of scoring	Total
HABITAT				11
	Longitudinal continuity of riparian vegetation (≥ 5 m wide)	0–4	0 = < 50%, 1 = 50–64%, 2 = 65–79%, 3 = 80–94%, 4 = ≥ 95% vegetated bank; with 1/2 point subtracted for each significant discontinuity (> 50 m long)	
	Width of riparian vegetation (scored differently for channels < or ≥ 10 m wide)	0–4	*Channel ≤ 10 m wide:* 0 = VW < 5 m, 1 = VW 5–9 m, 2 = VW 10–29 m, 3 = VW 30–39 m, 4 = VW ≥ 40 m *Channel > 10 m wide:* 0 = VW/CW < 0.5, 1 = VW/CW 0.5–0.9, 2 = VW/CW 1–1.9, 3 = VW/CW 2–3.9, 4 = VW/CW ≥ 4, where CW = channel width and VW = vegetation width	
	Proximity to nearest patch of intact native vegetation > 10 ha	0–3	0 = > 1 km, 1 = 200 m–1 km, 2 = contiguous, 3 = contiguous with patch > 50 ha	
COVER				12
	Canopy (> 4 m tall)	0–3	0 = absent, 1 = 1–5%, 2 = 6–30%, 3 = > 30% cover	
	Understorey (0.5–4 m tall)	0–3	0 = absent, 1 = 1–5%, 2 = 6–30%, 3 = > 30% cover	
	Ground (< 0.5 m tall)	0–3	0 = absent, 1 = 1–30%, 2 = 31–60%, 3 = > 60% cover	
	Number of layers	0–3	0 = no vegetation layers to 3 = ground cover, understorey and canopy layers	
NATIVES				9
	Canopy (> 4 m tall)	0–3	0 = none, 1 = 1–5%, 2 = 6–30%, 3 = > 30% cover	
	Understorey (0.5–4 m tall)	0–3	0 = absent, 1 = 1–5%, 2 = 6–30%, 3 = > 30% cover	
	Ground (< 0.5 m tall)	0–3	0 = none, 1 = 1–30%, 2 = 31–60%, 3 = > 60% cover	
DEBRIS				10
	Leaf litter	0–3	0 = none, 1 = 1–30%, 2 = 31–60%, 3 = > 60% cover	
	Native leaf litter	0–3	0 = none, 1 = 1–30%, 2 = 31–60%, 3 = > 60% cover	
	Standing dead trees (> 20 cm dbh)	0–1	0 = absent, 1 = present	
	Hollow-bearing trees	0–1	0 = absent, 1 = present	
	Fallen logs (> 10 cm diameter)	0–2	0 = none, 1 = small quantities, 2 = abundant	

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

Table 2. continued

Sub-index	Indicator	Range	Method of scoring	Total
FEATURES				8
	Native canopy species regeneration (< 1 m tall)	0–2	0 = none, 1 = scattered, 2 = abundant; with 1/2 point subtracted for grazing damage	
	Native understorey regeneration	0–2	0 = none, 1 = scattered, 2 = abundant; with 1/2 point subtracted for grazing damage	
	Large native tussock grasses	0–2	0 = none, 1 = scattered, 2 = abundant	
	Reeds	0–2	0 = none, 1 = scattered, 2 = abundant	

Photo 1. A site in good condition along the Hopkins Creek near Burra, South Australia (RARC score = 43; note continuous canopy of native trees, native shrub understorey, reeds and regeneration of canopy trees). Photo Kerri Muller.

Photo 2. A site in very poor condition in the mid north of South Australia (RARC score = 14; note lack of canopy cover, little shrub cover and small amounts of leaf litter). Photo Phil Price.

Photos 1 and 2 show contrasting sites in good and very poor condition in the mid north of South Australia. Details of the scoring for these sites can be found in the box below.

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

Sub-index	Good condition site (Photo 1)		Very poor condition site (Photo 2)	
Habitat	4 + 4 + 3 =	11	0 + 0 + 2 =	2
Cover	3 + 3 + 3 + 3 =	12	0 + 1 + 3 + 2 =	6
Natives	3 + 3 + 2 =	8	0 + 1 + 1 =	2
Debris	2 + 2 + 0 + 1 + 1 =	6	2 + 1 + 0 + 0 + 0 =	3
Features	2 + 2 + 1 + 1 =	6	0 + 1 + 0 + 0 =	1
Total		43		14

Applications of the Rapid Appraisal of Riparian Condition index

The RARC was initially developed as a tool to determine the impacts of grazing management practices on riparian condition, and to identify those practices which resulted in minimal impacts. We have now tested this approach in three areas of south-eastern Australia (see Figure 1); some results are presented below. Note that these results were obtained using the original version of the RARC, but this version developed for the mid north of South Australia would give very similar scores.

Figure 1. Location of sites where the RARC has been applied.

Murrumbidgee River

A total of 138 sites (each 1 kilometre in length) were surveyed between Gundagai and Hay, on private properties, crown land and State Forests (Jansen & Robertson, 2001a). The majority of sites on private property were in very poor condition, while sites on Crown Land (mainly Travelling Stock Reserves) were very variable. Most State Forest sites were in good to excellent condition (Figure 2a).

Gippsland

A total of 108 sites (each 150 metres in length) were surveyed in West and South Gippsland, at three types of sites — grazed paddocks on private properties, planted and fenced riparian areas on private properties, and remnant patches of uncleared native vegetation both on private properties and in reserves (Thompson et al., 2003). All private property sites were on dairy farms. The majority of sites were in very poor condition, with only remnant sites scoring above average (Figure 2b). It should be noted that most planted sites were relatively recently fenced, and their condition can be expected to improve as the plantings mature.

Goulburn-Broken

A total of 46 sites (each 200 metres in length) were surveyed in the upper and mid-Goulburn-Broken catchment, at grazed and ungrazed sites on private properties, and at ungrazed sites in reserves (Wilson et al., 2003). Again, the majority of sites were in very poor condition (Figure 2c). Like the Gippsland planted sites, many of the Goulburn-Broken ungrazed sites on private properties were relatively recently fenced, and their condition can be expected to improve as plantings mature.

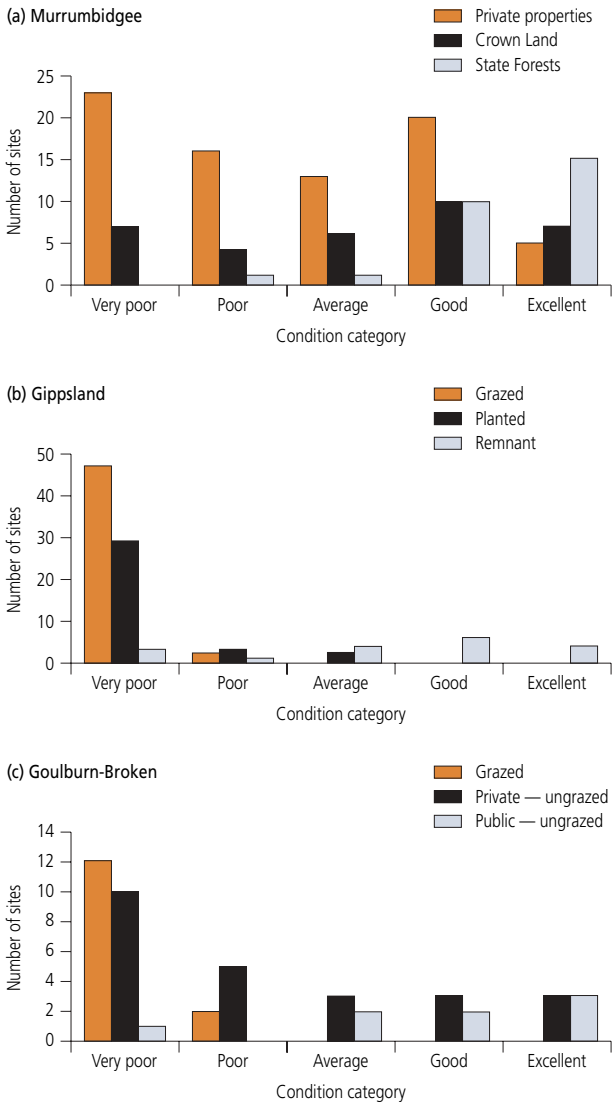


Figure 2. The number of sites scoring in each category (< 25 very poor, 25–30 poor, 30–35 average, 35–40 good and > 40 excellent) of the RARC index for three regions: (a) Murrumbidgee River, (b) West and South Gippsland, and (c) upper and mid-Goulburn-Broken catchment.

Riparian condition in relation to stocking rates

In all three regions, we examined the relationship between stocking rates and riparian condition, with Figure 3 below showing our results. Clearly, riparian condition declined with increased stocking rates, across all regions and a large range of stocking rates. Given the large number of sites in poor condition in all catchments, this suggests that with current management, stocking rates commonly used on private properties are too high to maintain riparian zones in good condition.

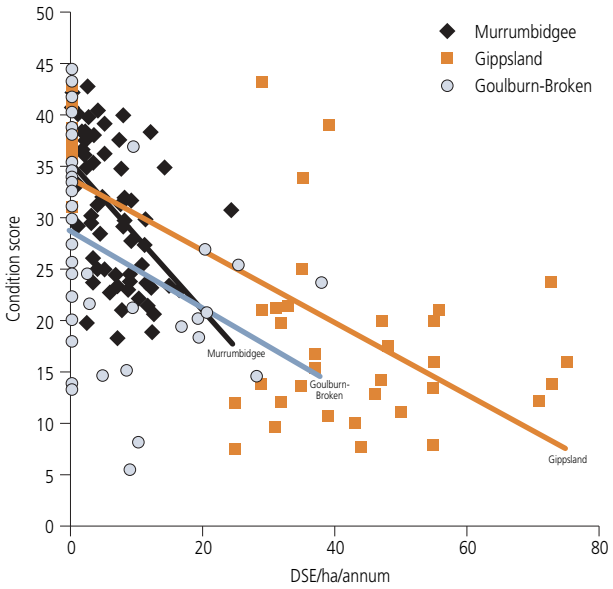


Figure 3. RARC condition scores in relation to stocking rates (DSE/ha/annum) for three regions: Murrumbidgee River, West and South Gippsland, and upper and mid-Goulburn-Broken catchment.

Riparian condition in the Burra region

The RARC was used in the Burra region to determine the current condition and health of riparian habitats and to test the methodology and its suitability in low rainfall areas. A range of sites were surveyed including grazed pastoral land and ungrazed Conservation Park land, on-farm fenced off sites and grazed floodplain country. The results showed the current condition of riparian sites in the Burra region were generally very poor. Total condition scores varied from 6.12 (very poor) at a grazed site up to 38.2 (good) at a Conservation Park site which has not been grazed for more than 10 years. There was a significant difference in total condition scores between grazed and ungrazed sites with the ungrazed sites generally scoring higher than the grazed sites (see Figure 4). Following this trial, it was felt that a modified RARC was required for more arid environments and this Technical Guideline is the result.

Photo: This was one of the highest scoring grazed sites in the Burra survey for riparian condition. Photo Kylie Nicholls.

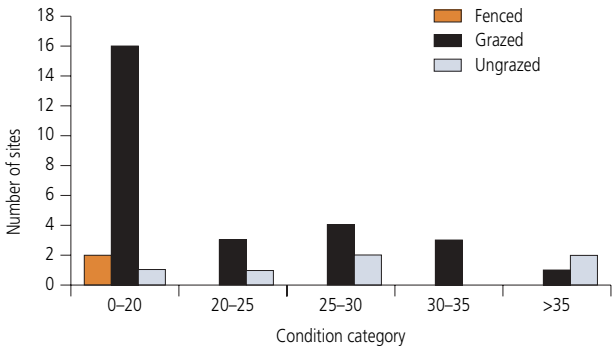


Figure 4: Frequency of total condition index scores for riparian sites under different management in the Burra region.

Sub-indices of the riparian condition index

There was variation across regions in relation to which sub-indices accounted for most of the variation in the total riparian condition score (Table 3). In the Murrumbidgee region, 85% of the variance in the total condition score was explained by the DEBRIS sub-index (scoring for leaf litter, fallen logs and standing dead trees). In Gippsland, 90% of the variance in the total condition score was explained by the NATIVES sub-index (scoring for native species in the vegetation cover and debris). In the Goulburn-Broken, 79% of the variance in the total condition score was explained by the COVER sub-index (scoring for % cover in each vegetation layer, and the number of vegetation layers).

Sub-index	Murrum-bidgee	Gippsland	Goulburn-Broken
COVER	0.42	0.83	0.79
DEBRIS	0.85	0.75	0.70
HABITAT	0.81	0.80	0.62
NATIVES	0.23	0.90	0.77
FEATURES	0.60	0.32	0.56

Table 3. Proportion of variance in the total riparian condition index score explained (R^2 value) by each sub-index for three regions: Murrumbidgee River, West and South Gippsland, and upper and mid-Goulburn-Broken catchment. The R^2 value was obtained by regressing the values for each sub-index against the total index scores for each site.

The DEBRIS sub-index consistently explained at least 70% of the variance in the total condition score, suggesting that management practices aimed at retaining standing dead trees and fallen logs would improve riparian condition scores in all regions. The HABITAT sub-index was also relatively consistent across regions, explaining at least 62% of the variance in total condition scores. This suggests that maintaining or restoring a continuous band of mixed riparian vegetation (trees, shrubs and grasses) is also important in all regions. In contrast, the NATIVES sub-index explained little of the variance in the Murrumbidgee but most of it in Gippsland. This sub-index indicates that in the Murrumbidgee, the canopy trees are predominantly native, there is little shrub cover, and the ground cover is predominantly exotic. In this region, there is little chance of altering this on a large scale. In Gippsland, however, the index indicates a lot of variability in the dominance of natives over exotics in all vegetation layers, and that management aimed at maintaining or restoring native species could significantly improve riparian condition.

Why is the RARC a useful tool? What does riparian condition tell us about the biodiversity and functioning of riparian zones?

The RARC has been tested against more detailed measures of the biodiversity and functioning of riparian zones in the Murrumbidgee and Gippsland regions. There was a significant positive relationship between litter decomposition rates in the soil and the COVER sub-index of the RARC score in both Summer ($r = 0.50$, $p < 0.05$) and Autumn ($r = 0.78$, $p < 0.01$), indicating that decomposition rates were higher where there was more vegetation cover in the riparian zone of the Murrumbidgee River (Robertson, Wassens & Jansen, in prep.). There were highly significant relationships between bird communities and all sub-indices, as well as the total RARC score ($r = 0.68$, $p < 0.0001$), indicating that riparian bird communities varied according to the condition of the riparian zone of the Murrumbidgee River (Jansen & Robertson, 2001b). Of particular significance ($r = 0.74$, $p < 0.0001$) was the DEBRIS sub-index (scoring for leaf litter, fallen logs and standing dead trees), indicating that retention of leaf litter and woody debris in riparian habitats is crucial to the survival of riparian bird communities. Many of the species most dependent on these features (for example, brown treecreepers) are threatened or declining throughout the agricultural regions of southern Australia (Ford et al., 2001).

Above: Healthy riparian area with a diversity of vegetation providing habitat for both aquatic and terrestrial animals, Hopkins Creek, South Australia. Photo Kerri Muller.

Right: A brown treecreeper. These birds live in riparian areas and their presence can be used as an indicator of riparian health. Photo Andrew Tatnell.

Inset: A red-backed kingfisher (*Halcyon pyrrhopygia*) which breeds in the mid north of South Australia. Photo Nicholas Birks.

r = correlation coefficient (indicates the strength of a relationship
p = significance (where $p < 0.05$ indicates a significant relationship)

In Gippsland, there was also a significant relationship (r = 0.59, $p < 0.0001$) between bird communities and the total RARC score, indicating again that riparian bird communities varied according to the condition of riparian zones in Gippsland (Thompson et al., 2003).

Given the importance of riparian zones in supporting high levels of regional biodiversity (Naiman & Decamps, 1997), and the links between riparian condition and biodiversity demonstrated here, the RARC is a useful tool for assessing riparian condition and hence biodiversity and functioning of riparian zones.

Applying the RARC: Steps in assessing riparian condition

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

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

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

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

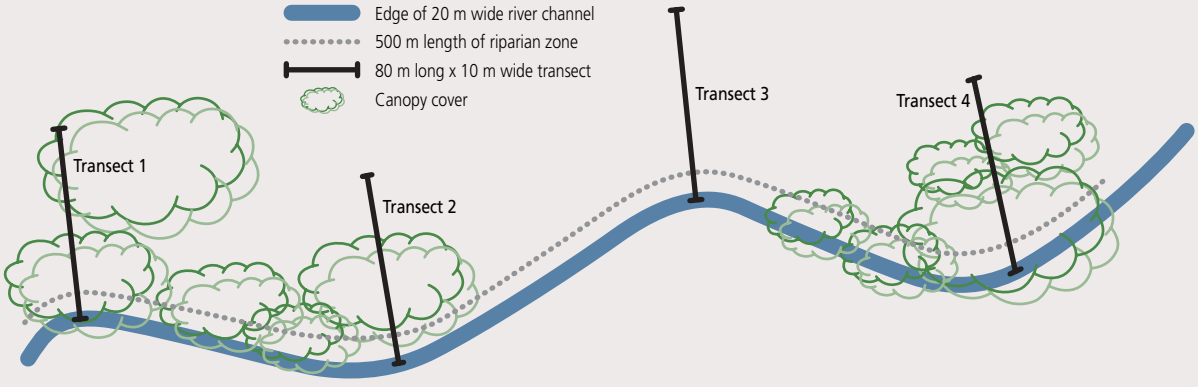
1 Determine site size

Site size must be determined according to the size of the management unit of interest. For example, our studies have examined impacts of grazing management on riparian condition, so management units have been individual paddocks. On the Murrumbidgee River, where paddocks are relatively large, a 1 kilometre length of the riparian zone was defined as a 'site', while in Gippsland, where paddocks are much smaller, a 150 metre length was used. Ideally, sites should be at least 200 metres long, with 500 metres being the preferred length where practicable. The RARC assessments carried out in the Burra region used sites that were 200 metres in length, and only one side of the stream was surveyed.

The transects at each site should ideally traverse the width of the riparian zone. However, this is not always easy to determine in the field. To simplify this, we use a transect length determined by the width of the creek or gully channel — 40 metres long for channels < 10 metres wide, and four times the channel width for larger creeks or rivers. A minimum width of 40 metres should be assessed, unless there is a very clear distinction between riparian and non-riparian areas. Where the riparian zone is clearly narrower than 40 metres or four times the channel width (for example, in a gorge), the transect length should be adjusted accordingly. Where the riparian zone is much wider than this (for example, on a lowland floodplain river), four times the channel width should be adequate to represent the riparian zone. Figure 5 illustrates a hypothetical river with the layout of the survey area and the transects indicated.

2 Score indicators

A sample scoring sheet can be found on page 16 of this Guideline. The complete scoring system is summarised in Table 2. Longitudinal continuity and proximity are given single values for the whole site. All other indicators are scored along four transects (10 metres wide; perpendicular to the direction of river flow) evenly spaced along the bank.



Calculation of condition scores for this hypothetical riparian sample site

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

Map			Score
200 m vegetated	150 m bare	150 m vegetated	1.5 (70% vegetated with 1 discontinuity)

Width of riparian canopy vegetation

Transect	Channel Width (CW)	Vegetation Width (VW)	Score
1	20	> 80	4
2	20	60	3
3	20	0	0
4	20	70	3

Vegetation cover

Transect	Canopy
1	3
2	3
3	0
4	3

Figure 5. Hypothetical river with length and transects marked. The scoring for the indicators in this diagram is shown (see page 16 for full score sheet).

HABITAT

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

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

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

0 = > 1 km, 1 = 200 m–1 km, 2 = contiguous, 3 = contiguous with patch > 50 ha

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

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

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

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

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

COVER (see Photo 3 below)

Vegetation cover within each layer is scored as follows:

Canopy cover (trees > 4 m tall): 0 = none, 1 = 1–5%, 2 = 6–30%, 3 = > 30%

Understorey cover (herbs, reeds, shrubs and saplings 0.5–4 m tall): 0 = none, 1 = 1–5%, 2 = 6–30%, 3 = > 30%

Ground cover (lichens, mosses, grasses, herbs, reeds and sedges to 0.5 m tall): 0 = none, 1 = 1–30%, 2 = 31–60%, 3 = > 60%

The number of layers of vegetation is scored as follows:

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

NATIVES (see Photo 4 overleaf)

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

Canopy cover (trees > 4 m tall): 0 = none, 1 = 1–5%, 2 = 6–30%, 3 = > 30%

Understorey cover (herbs, reeds, shrubs and saplings 0.5–4 m tall): 0 = none, 1 = 1–5%, 2 = 6–30%, 3 = > 30%

Ground cover (lichens, mosses, grasses, herbs, reeds and sedges to 0.5 m tall): 0 = none, 1 = 1–30%, 2 = 31–60%, 3 = > 60%

Photo 3. Canopy cover increasing from 1 to 3 (left to right). Photos Kylie Nicholls.

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

Photo 4. Exotic annual ground cover (left) *versus* native perennial tussock ground cover (right). Photos Kylie Nicholls.

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

DEBRIS (see Photo 5 above)

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

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

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

0 = absent, 1 = present

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

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

Leaf litter includes any dead plant material such as leaves, grasses, twigs and bark.

FEATURES

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

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

The abundance of large native tussock grasses (species such as lemon grass *Cymbopogon ambiguus*) and reeds (species such as *Phragmites*, *Typha* (Cumbungi) and *Carex* which are normally only found on riverbanks or in swampy areas) is scored as follows:

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

Photo 6 (below). *Cymbopogon ambiguus* (lemon grass) is a tall, summer growing perennial grass with blue-green leaves which smell strongly of citronella when crushed. In the mid north it is commonly found in creek beds and along riparian areas. It is generally not grazed by livestock. Photo Kylie Nicholls.

3 Analyse data

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

4 Benchmarking

The scoring system given here has been developed for a generalised riparian area in the mid north of South Australia, and may need to be adjusted for particular situations. Ideally, a number of relatively pristine sites in the region should be surveyed to provide a benchmark for the scoring system. The scores for each indicator can then be checked to ensure that all indicators are present, and that the maximum score can be achieved for each indicator. For example, along ephemeral creek systems, reeds may not be a suitable indicator due to a lack of permanent water. Benchmarking against relatively pristine sites is not always possible in highly modified catchments. In these situations, we can only make a 'best guess', based on local knowledge and historical information, about the appropriate scoring for each indicator in these catchments.

For the mid north of South Australia, advice should be sought from a local botanist or vegetation expert on the expected 'natural' vegetation for your region. For riparian zones naturally dominated by trees, this RARC method should be appropriate. However, for riparian zones that naturally lacked any tree cover, we recommend adjusting the scoring system as follows:

- for the habitat component, replace 'riparian canopy vegetation' with the expected dominant overstorey — this is likely to be a shrub layer. Thus, longitudinal continuity, vegetation width and proximity will all relate to a *shrub* layer, rather than a canopy (tree) layer.
- for the remaining components, exclude the indicators which relate to trees, i.e. canopy cover, native canopy cover, standing dead trees, hollow-bearing trees and native canopy species regeneration.
- adjust the size of fallen logs to include timber from shrubs (> 5 cm).

These alterations will reduce the maximum total score to 40. This means it will not be possible to compare these scores directly with those for naturally treed riparian zones.

Further information

We will be continuing to refine and update the original RARC so to get the latest version visit the websites www.landwaterwool.gov.au and www.rivers.gov.au. There you will find an Excel spread sheet which includes a printable field data sheet, and a data entry sheet. If you enter data for a site, it will automatically calculate the averages for each transect and the final sub-index and total scores for you. If you have a number of sites, you will need to save a separate worksheet for each site. There is also a field calculation sheet which you can print on the reverse of the field data sheet if you wish to calculate scores in the field (you may need a calculator to take the averages across the transects). There are also details about how the RARC can be tailored to a particular region and some examples of how this has been done in other parts of Australia. Hard copies of the RARC Technical Guideline for the mid north of South Australia are available from CanPrint Communications on freecall 1800 776 616. People trained in using the RARC in South Australia are listed overleaf, as well as other useful contacts and publications.

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Useful publications

Native Vegetation of the Murray Region, February 2006, Todd Berkinshaw, Greening Australia (South Australia) Inc., ISBN 0 9775143 0 7
A guide to the identification, protection and restoration of native vegetation communities and plant species of the South Australian Murray Darling Basin.

Riverways: Shortcuts to River Management Information in Australia, 2005, Greening Australia, ISBN 1 875345 77 9.
A quick guide to resources related to river management. Topics include rehabilitation and management, policy and planning, monitoring and evaluation.

Field Guide to the Plants of Outback South Australia, Frank Kutsche and Brendan Lay, Openbook Print.
Further information: The Manager, Pastoral Program, Department of Water, Land and Biodiversity Conservation, GPO Box 2834, Adelaide SA 5000.

Grasses, Gums & Groundcovers, a field guide to the common native plants of the Northern Agricultural Districts of South Australia, Mid North Grasslands Working Group, Custom Press.
Further information: Kylie Nicholls, PO Box 488, Clare SA 5453, Tel: 08 8842 3275, E-mail: fullbottlemedia@rbe.net.au

Publications for woolgrowers

The *Wool industry river management guides* bring together the latest science and recommended management practices for riparian areas within the context of a commercial wool growing property. The Guides are available for the high rainfall regions (above 600 mm) and sheep/wheat regions (300–600 mm) of Australia. Each book has over 200 full-colour pages.

In addition www.rivers.gov.au/lww will offer an active contents list which will give you a snapshot of what is in each section.

High rainfall zone: product code PX050951
Sheep/wheat zone: product code PX050952

Managing rivers, streams and creeks: A woolgrowers guide — is a summary of the key recommendations from the 'Wool industry river management guides' and provides an introduction to river and riparian management issues on farm.

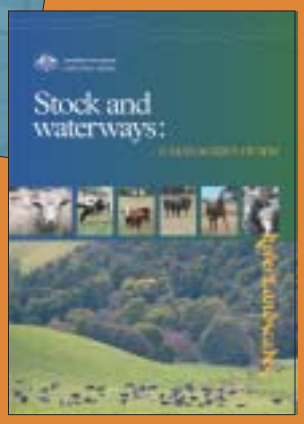
Product code PX051003

Are my waterways in good condition? — a checklist that provides colour coded pictures that you can use to assess the condition of your stream or creek. It is a quick and easy way to work out the health of the streams or creeks running through your property, and it suggests management actions to improve or maintain these vital parts of your farm.

Product code PB061114

River insights — a publication featuring the stories of ten woolgrowers and what has motivated them to manage their rivers, creeks and streams in ways that make both economic and environmental sense.

Product code PK050950



Stock and waterways: a manager's guide — offers practical advice on how stock farmers can manage riparian land both productively and sustainably, and includes a number of case studies from farmers throughout Australia who have seen the benefits of changing their management practices.

Product code PR061132

These products are available from CanPrint Communications on freecall 1800 776 616 in hard copy, or can be downloaded from — www.landwaterwool.gov.au or www.rivers.gov.au

Rapid Appraisal of Riparian Condition

Site:_____ Site number:_____ GPS start:_____

Date:_____ Observer:_____ GPS end:_____

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

Map	Score

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

Width of riparian canopy vegetation

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

Proximity

Score

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

Channel ≤ 10 m wide: 0 = VW < 5 m, 1 = VW 5–9 m, 2 = VW 10–19 m, 3 = VW 20–39 m, 4 = VW ≥ 40 m vegetated.
Channel > 10 m wide: 0 = VW/CW < 0.5, 1 = VW/CW 0.5–0.9, 2 = VW/CW 1–1.9, 3 = VW/CW 2–3.9, 4 = VW/CW ≥ 4.

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

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

Canopy and understorey cover: 0 = none, 1 = 1–5%, 2 = 6–30%, 3 = > 30%. *Ground cover*: 0 = none, 1 = 1–30%, 2 = 31–60%, 3 = > 60%.

Debris

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

Leaf litter and native leaf litter cover: 0 = none, 1 = 1–30%, 2 = 31–60%, 3 = > 60% (leaf litter includes any dead plant material such as leaves, grass ,twigs and bark). *Standing dead trees (> 20 cm dbh) and hollow-bearing trees*: 0 = absent, 1 = present. *Fallen logs (> 10 cm diameter)*: 0 = none, 1 = small quantities, 2 = abundant.

Features

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

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

Calculation of scores

Site number:_____

Longitudinal continuity of riparian canopy vegetation

Score	A

Width of riparian canopy vegetation

Average	B

Proximity

Score	C

Vegetation cover

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

Debris

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

Features

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

Totals

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

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