Margaret River Action Plan

2003

Prepared for the Cape to Cape Catchments Group

by

Genevieve Hanran-Smith

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How to use this river action plan

This report was prepared for the Cape to Cape Catchments Group and landholders in the catchment of the Margaret River.

Sections 1 and 2 provide background information on the river action plan and the study area. Section 3 discusses river ecology. Section 4 details the methodology used in assessing the condition of the rivers. Sections 5 and 6 outline the management issues identified and provide general management advice and recommendations. Maps showing foreshore condition rating, fencing status, river features, management issues and weeds are included in Section 7 with specific management advice for each section of river.

Figure 11 uses colour codes to show the foreshore conditions of the whole river system. It also provides an index to assist with locating specific sections of river.

Acronyms

NHT	Natural Heritage Trust
CALM	Department of Conservation and Land Management
CCCG	Cape to Cape Catchments Group
GeoCatch	Geographe Catchment Council
WRC	Water and Rivers Commission
DOLA	Department of Land Administration
AMR Shire	Shire of Augusta-Margaret River
Fisheries	Department of Fisheries
SWCC	South West Catchments Council

Cover photo:

Acknowledgments

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Reference details

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Summary

The Margaret River is situated in the Cape to Cape subregion. The river is approximately 60 km long with a catchment area of 470 km^2 (Pen, 1999). The upper reaches are mainly within native vegetation in State Forest. Some of the tributaries in the upper reaches have been identified as having considerable natural values. In the middle and lower reaches the river mostly drains cleared farmland and rural-residential developments. In the middle reaches it passes through National Park as well as the township of Margaret River.

The aim of the foreshore condition survey was to provide landholders and the Cape to Cape Catchments Group with information on the condition of the river so that it can be better managed. The surveys were conducted in June and July 2002 using the Foreshore Condition Assessment method developed by Dr Luke Pen and Margaret Scott (Pen & Scott, 1995). Many landholders assisted with the surveys.

A summary of the foreshore condition ratings and length of fencing for the river is presented in Tables 1 and 2 below.

The Margaret River is in reasonably good condition for much of its length. Within State Forest in the upper reaches and National Park in the middle reaches, the river is in excellent condition. Approximately 65% of the river from State Forest to the coast has been assessed as B grade, i.e. weed infested. However, over a third of this is low level weed infestation in areas dominated by native species. Only 6% of the river has been classified as degraded and erosion prone.

The Margaret River retains many of the features of a healthy waterway. Native fringing vegetation occurs along most of the river, stabilising the banks and providing habitat, shade and leaf litter. There are deep permanent pools, densely vegetated shallow runs, riffles, rapids and cascades, in-stream vegetation, large woody debris and vegetated backwaters.

Issues of concern identified during the foreshore surveys and community consultation were:

- Loss of native fringing vegetation and degradation of remaining vegetation by stock grazing and trampling.
- Weeds.
- Pumping during summer and autumn and the effect on the ecology of river pools.
- On-going degradation of tributaries of the Margaret River and the effect on the water quality and ecology of the river.
- Loss of floodplain habitat and the effect on the ecology of the river.
- The obstruction to the migration of native fish and lampreys created by the three weirs within the townsite.
- Stormwater pollution from the township of Margaret River adversely affecting water quality.
- The opening of the river mouth by human interference and the effects on the ecology of the estuary due to very low water levels.

In response to these issues, recommendations have been made in this report to protect and improve the condition of the Margaret River.

Table 1: Summary of foreshore condition rating of the Margaret River from where it leaves State Forest at Challis Rd to the coast

Condition Rating	South Bank		North Bank	
	Total Length	Total %	Total Length	Total %
A (pristine)	9.5 km	24%	12.0 km	30%
B (weedy)	27.8 km	71%	24.8 km	63%
C (erosion prone)	2.1 km	5%	2.6 km	7%
D (ditch)	0.0 km	0%	0.0 km	0%

Table 2: Length of fenced and unfenced areas on the Margaret River and length of fencing required

	Length Fenced	% of Length	Length Unfenced	% of Length	Fencing Required	% of Length
South bank	11.2 km	14.2 %	28.2 km	35.8 %	15.4 km	19.5 %
North bank	4.6 km	5.8 %	34.8 km	44.2 %	4.7 km	6 %
Total fenced	15.8 km	20 %	63 km	80 %	20.1 km	25.5 %

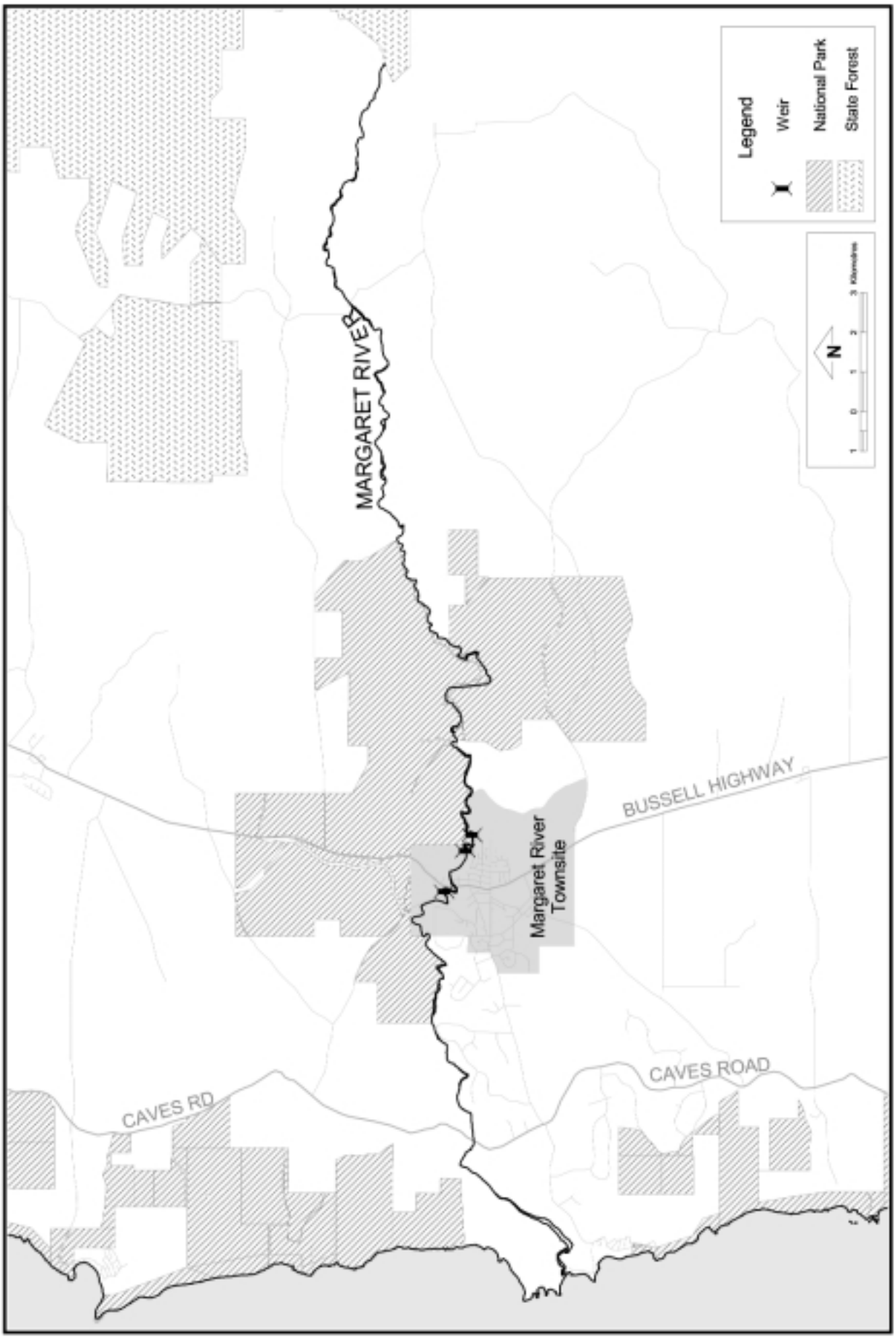


Figure 1: Locality map

1. Introduction

Background

Many Western Australian rivers are becoming degraded as a result of human activity within and along waterways and through the off-site effects of catchment land uses. The loss of native fringing vegetation, erosion and invasion of weeds and feral animals are some of the more pressing problems. Water quality in our rivers is declining with many carrying excessive loads of nutrients and sediment, and in some cases contaminated with synthetic chemicals and other pollutants (WRC, 1999a).

Recognising the pressures on the Margaret River the Cape to Cape Catchments Group, assisted by GeoCatch, applied for Natural Heritage Trust (NHT) funding to develop the Margaret River action plan. The project was funded through the National Rivercare component of NHT, which operates under the goal: *To ensure progress towards the sustainable management, rehabilitation and conservation of rivers and to improve the health of these river systems.*

The Cape to Cape Catchments Group (CCCG) was formed with support from the AMR Shire and SWCC following a community meeting in November 2000. The aim of the group is '*to work with the community and management agencies to manage the Cape to Cape catchments and their associated riparian and marine environments so that natural systems, people and their activities co-exist in a healthy, productive and sustainable way*'.

Study aims

The primary aims of this river action plan are:

- To produce a description of the state of the Margaret River and recommendations to guide works to improve the health of the river.
- To provide a benchmark against which the local community's future work to protect and rehabilitate the rivers can be gauged.
- To provide a tool to guide the use of the funding and assistance available for fencing, weed control, erosion control, planting and rehabilitation of native vegetation.
- To provide a sound technical basis for future funding or project submissions.

It was an important aim of the project to involve landholders wherever possible. Much of the river surveying was conducted with landholders and three community meetings were held to report results of field assessments and obtain feedback.

2. Study area

The Margaret River has been investigated from where it leaves State Forest at Challis Rd to the coast. The location of the study area is shown in Figure 1. Background information about the study area is discussed below.

Margaret River and its catchment

The Margaret River is the only true river system within the Cape to Cape subregion. It is a small river, approximately 60 km in length with a catchment area of 470 km^2 (Pen, 1997). The upper reaches, which divide into creek-size north and south branches, are within State Forest in the Blackwood Plateau. There are areas of pine plantation in the headwaters although the majority of the upper catchment is uncleared.

Swamps and floodplains are found along the two branches. They are well vegetated, in an isolated location and an important wetland habitat. This is indicated by the fact that five of the endemic freshwater fish of the south-west are known to occur in this area, including the very rare Balston's pygmy perch (*Nannatherina balstoni*) and the relatively restricted mud minnow (*Galaxiella munda*) (Pen, 1997).

In the middle reaches the Margaret River drains farmland. Land use in this area includes beef and dairy cattle grazing, sheep grazing, potatoes, orchards, vineyards, olives, and bluegums. Subdivision continues to occur in this area.

Both east and west of the Margaret River township the river is contained within National Park. The largest tributary, Bramley Brook, is also partly contained within National Park. It joins the Margaret River west of Bussell Highway.

Three weirs have been constructed on the river within the township. Before Ten Mile dam was constructed the dams created by the two easterly weirs were used for the town water supply. The weirs present a barrier to the upstream migration of native fish and lampreys.

Residential subdivision continues to occur along the river to the east of town. Stormwater from the township drains to the river. Special Rural development occurs west of town on both sides of the river but particularly on the south side. Some grazing occurs here, also orchards and vineyards. Rapids and cascades are common along this section of the river.

West of Caves Rd there is some Special Rural development as well as a large vineyard. Much of the north-west side of the river is contained within an uncleared reserve.

Towards the coast the river forms a small very narrow north-easterly orientated lagoon. The main lagoon is about 1 km long and about 200 m wide, thereafter tapering to about 10 m wide over a distance of 2 km. The lagoon, which has an area of about 20 ha, is connected to the ocean via a 500m long, 50 m wide entrance channel that twists around a headland. The north-western side of the estuary is public bushland and although the land adjacent to the opposite bank is cleared, the estuary retains a good buffer of wetland and riparian vegetation along most of its length (Pen, 1997).

Landform and soils

The Margaret River occurs within three distinct landform units. The river begins in the Blackwood Plateau, a gently undulating area of moderately raised land formed on sedimentary rock. It then flows through the Margaret River Plateau. The Margaret River Plateau is formed on granitic and gneissic basement rock of the Leeuwin Block. Finally it crosses the Leeuwin-Naturaliste Coast before reaching the ocean. The Leeuwin-Naturaliste Coast is a narrow strip of land, 0.2 to 6 km wide running along the coast between Cape Naturaliste and Cape Leeuwin. It is a discontinuous ridge of Tamala Limestone, with the underlying Leeuwin Block granite being exposed in places.

Within the Blackwood and Margaret River Plateaux and the Leeuwin-Naturaliste Coast, the river is contained within four land systems[1] as identified by Tille and Lantzke (1990). These land systems contain a variety of soil types. There is a brief description of the land systems and the soil types below (Tille & Lantzke, 1990).

Blackwood Plateau

In the Blackwood Plateau the river flows through the Treeton Hills.

[1] Land systems are defined as an area, or group of areas, throughout which there is a recurring pattern of topography, soil and vegetation (Tille and Lantzke, 1990)

Treeton Hills land system

The Treeton Hills are undulating rises to rolling low hills on lateritised sedimentary rocks, 80-120 m above sea level. The dominant landform pattern is of gently inclined ridges and hill crests with gently to moderately inclined sideslopes down to valley floors. These may be narrow and v-shaped, but are more commonly broad and poorly drained with alluvial soils. On the crests and sideslopes, yellow-brown gravelly duplex soils and pale, grey mottled soils occur. Areas of deep bleached sands and ironstone outcrop may also be present in these areas. The ironstone often exists on the crests.

Along the Margaret River are alluvial flats with well drained red-brown and grey loamy soils. Less well drained floodplain and valley flats also exist in areas along the river.

The river is contained within a broad valley with large areas of floodplain, particularly on the southern side.

Margaret River Plateau

Within the Margaret River Plateau the river is found within the Wilyabrup Valleys land system.

Wilyabrup Valleys land system

The Wilyabrup Valleys form undulating to rolling low hills. Generally they have incised from an elevation of between 80-100 m above sea level down to between 20-40 m.

The sideslopes of the valleys commonly have yellow-brown gravelly duplex and red-brown gravelly, gradational soils. Some patches of deep bleached sands, shallow gravel over ironstone or rocky soils occur on these slopes.

East of Margaret River town the river is contained within alluvial flats with well drained red-brown and grey loamy soils. Less well drained floodplain and valley flats also exist in areas along the river. West of town the river is mainly contained within a narrow v-shaped valley with steep slopes in places.

Leeuwin-Naturaliste Coast

Within the Leeuwin-Naturaliste Coast the river continues in the Wilyabrup Valleys with the Gracetown Ridge land system on the north. At the coast the river enters the Kilcarnup Dunes land system.

Gracetown Ridge land system

The Gracetown Ridge consists of sand dunes that have lithified to form Tamala Limestone. It rises from sea level to a height of between 140-210 m above sea level.

The Ridge has a gently undulating crest and moderately inclined sideslopes. Soils are deep, brownish yellow, siliceous sands. In some places, these sands are shallow with outcropping limestone.

Although the Ridge rises directly from the ocean or granitic coastline, much of the western slopes are overlain by the more recent Kilcarnup Dunes land system.

Kilcarnup Dunes land system

The Kilcarnup Dunes usually rise from sea level to a height of 100 m, but can be as high as 200 m above sea level. The most recently formed dunes consist of pale calcareous sands and are sparsely vegetated. The older dunes tend to be more densely vegetated and have an accumulation of organic matter in the topsoil. Blowouts are sometimes present. In the oldest dunes, aeolianite has begun to form and this, combined with the build up of organic matter, has resulted in dark calcareous sands containing limestone rubble.

Climate

The area has a Mediterranean climate with hot, dry summers and mild, wet winters. The annual rainfall decreases from about 1100 mm in the west to 900 mm in the east.

Vegetation

The flora of the Cape to Cape subregion is part of the Menzies and Warren subdistricts (Darling District) of the South-West Botanical Province (Beard, 1990). The Menzies subdistrict is characterised by woodland and forest of jarrah (*Eucalyptus marginata*), or jarrah-marri (*E. marginata-Corymbia calophylla*) with blackbutt (*E. patens*), flooded gum (*E. rudis*) and bullich (*E. megacarpa*) found in some areas. The dominant vegetation communities of the Warren subdistrict are

karri forest (*E. diversicolor*) on deep loams and forest of jarrah-marri on the leached sands. Extensive paperbarks (*Melaleuca*) and sedge swamps exist in the valleys.

The area is situated within a region known for its high level of species diversity with many species located only in the south-west. Around 66% of the Cape to Cape subregion is covered with native vegetation (Hopkins, Morgan & Shepherd, 2001). Much of this is within State Forest in the east of the region and along the coast. The central plain has been heavily cleared and the remaining remnants are generally small and dispersed.

Very generally, the main vegetation communities along the river are:

- jarrah-marri forest with blackbutt, bullich and *Hakea lasianthoides* - east of town
- karri forest - within town
- marri-jarrah forest with peppermint (*Agonis flexuosa*) between town and Caves Rd
- Heathlands on shallow rocky soils and granite outcrops with *Kunzea* spp., *Darwinia citriodora* and *Hakea trifurcata* - mainly between Bussell Highway and the coast.
- Melaleuca woodland - towards the coast.

Species composition within the vegetation communities changes along the river depending on topography and soil type. When developing a species list for revegetation the first step should be to collect a list of species close to the area to be planted.

Appendix 1 contains species lists for the different vegetation communities and can be used as a guide to selecting species for revegetation.

Fauna

Landholders have observed the following species of fauna along the Margaret River:

Water rat	*Hydromys chrysogaster*
Brushtail possum	*Trichosurus vulpecula*
Western grey kangaroo	*Macropus fuliginosus*
Southern brown bandicoot or quenda	*Isoodon obesulus*
The long-necked or oblong turtle	*Chelodina oblonga*
Marron	*Cherax teniumanus*
Dusky moorhen	*Gallinula tenebrosa*
Grey teal duck	*Anas gracilis*
Pacific black duck	*Anas superciliosa*
White-faced heron	*Egretta novaehollandiae*
Cormorant	*Phalacrocorax* spp.

Various types of bush birds, frogs and reptiles have also been sighted as well as foxes, rabbits and cats.

Five of the freshwater fishes of the south-west are known to occur in the Margaret River. The very rare Balston's pygmy perch (*Nannatherina balstoni*) and the relatively restricted mud minnow (*Galaxiella munda*) are found in the river above Cane Brake Pool. Three estuarine species are also found. Exotic pest species such as gambusia (*Gambusia holbrooki*), redfin perch (*Perca fluviatis*) and carp (*Carassius* spp.) are known to occur in the river (Morgan, Gill, & Potter, 1998).

The pouched lamprey (*Geotria australis*) has been found in large numbers in the Margaret River. For more information on the lamprey see Section 3 of this report.

There are two species of marron native to the south-west. One species is restricted to the Margaret River and the other is widespread throughout the rest of the marron range. The Margaret River now contains both species due to translocation of marron by people. The abundance of the Margaret River, or 'hairy', marron has declined since the mid-1980s. It is locally extinct, being no longer found downstream of Cane Brake Pool. Its abundance in this area is declining relative to the other species of marron (Molony, 2002).

Heritage

Aboriginal people have occupied south-west Western Australia for at least 38 000 years (Pearce and Barbetti, 1981). By the time of British colonisation in 1829, Aborigines of the south-west represented a distinctive socio-cultural bloc, extending from Jurien Bay in the north-west to Esperance in the south-east. The thirteen groups comprising this bloc are now collectively known as Noongar[2], meaning 'man' or 'person'.

The area of land between Bunbury and Cape Leeuwin, on the coast and as far inland as Nannup, was traditionally occupied by the Wardandi group (Berndt, 1979; Tindale, 1974). The Wardandi moved throughout their territory in nuclear families or larger bands, coming together for social and ceremonial purposes that coincided with the availability of food sources, such as estuarine fish. They maintained elaborate oral traditions and spiritual beliefs and had complex social arrangements (Bates, 1985; Berndt, 1979).

Information compiled from the oral history of the Noongar people indicated that rivers, estuaries and wetlands generally were very important to these communities, in both a practical and a spiritual sense.

The seasonal movement of Aboriginal groups related to the exploitation of various resources available in the different environmental situations. The early writers noted the Aboriginals tended to congregate around waterways during the summer, and move inland during the winter months. Captain Stirling in 1827 recorded that the Aboriginal groups frequented the coast during the summer to fish, and migrated to higher grounds during the winter to hunt kangaroo and other game and gather roots (O'Conner *et al*., 1995).

Five sites have been recorded with the Register of Aboriginal Sites (Department of Indigenous Affairs) on the Margaret River. They are a burial site, two artefact sites, a mythological/artefact site, and a burial/artefact site. There may be other sites within the area which have not yet been entered on the Aboriginal Sites Register.

The earliest European account of the area was made in 1622, when the *Leeuwin* of the United East India Company recorded the presence of 'Leeuwin's Land'. Later explorers included Matthew Flinders who named Cape Leeuwin in 1801, and Nicholas Baudin who named Hamelin Bay, Cape Naturaliste and Geographe Bay.

The earliest recorded European settlement in the region occurred in Augusta in the 1830s. While European settlement came at the cost of the indigenous lifestyle, there is evidence that, initially, the relationship between the Aboriginal inhabitants and the first settlers in Augusta were comparatively good. An increase in the number of settlers in the south-west and competition for limited food resources led to conflict and a rapid decline of the traditional Aboriginal culture.

In the early 19th century a number of unsuccessful settlements occurred in the area. From 1850 onwards a new wave of pastoral settlements and a growth in the timber industry saw a more permanent settlement pattern and a steady population growth that lasted until the 1920s.

During the 1920s and 1930s, a joint venture between the British Government and the Western Australian State Government introduced the Group Settlement Scheme to establish a dairy industry within the State. The scheme did not result in the expected long-term population growth due to a variety of factors, including the inexperience of the landowners and the economic depression of the 1930s. Although the scheme was not a total success, it opened up previously unused land and, in conjunction with other settlement patterns, provided the incentive to establish community services and infrastructure. The scheme did facilitate the declaration of several townships. Since this time, Margaret River has grown to be the central focus of urban growth in the region.

Land tenure

The whole of the Margaret River and a varying width of foreshore is within unclaimed Crown land and is the responsibility of the Department of Land Administration. There are also many areas of foreshore reserve where management responsibility is with the Shire of Augusta-Margaret River (AMR). These reserves are listed below.

[2] There are several spellings of this name.

Table 3: Reserves on the Margaret River

Reserve number	Management responsibilty	Purpose
34481, 4647	AMR	Public recreation
34178	AMR	Public recreation
38650 locations 3845 & 4478	AMR	Recreation
27633	AMR	Park & recreation
36014, 4687	No formal vesting	Public recreation
44471, 5059	AMR	Foreshore management
40264	AMR	Public recreation
43432	AMR	Public recreation
43268 4981	AMR	Foreshore protection & recreation
8431, 4661	AMR	Protection & preservation of caves & flora and Health & pleasure resort
43268, 4981	AMR	Foreshore protection & recreation
41545	AMR	Recreation
18720	AMR	Park & recreation
32437	AMR	Park & recreation

3. River ecology

To assist with understanding the values and condition of the Margaret River some background information on river habitats is outlined below. This information comes from *Managing Our Rivers* by Dr Luke Pen (Pen, 1999).

For more information on the ecology of south-west rivers readers should refer to the list of references at the end of this chapter.

Habitats

There are a great diversity of habitat zones and elements in a natural stream. This variety of habitats supports a diverse array of plants and animals. River fauna of the south-west is shown in Figure 2. Flora of the Margaret River is listed in Appendix 1.

Habitat zones

River pools

Over the summer season most of the water in the river is in deep river pools. The pools provide an essential summer drought refuge for many river animals, including waterbirds, turtles, water rats, fish, crayfish, shrimp and mussels, and are integral to the survival of many aquatic animal populations.

Undisturbed river pools are usually surrounded by dense fringing vegetation and are well shaded and provided with snags and woody debris along their edges.

Riffles, rapids and cascades

These habitats occur where water flows swiftly over an irregular stream bed, over and between rocks and from one rocky terrace to another. As well as providing habitat for particular macroinvertebrates they have two very important functions. They help to oxygenate the water and the sound they make enables some species to find their preferred habitat.

Runs and low flow channels

Long reaches of unobstructed stream flow, where the flowing water has a flat surface, are often called runs. In the south-west they are the low flow channels that wind their way across the floodway between pools. The low flow channels are often well supported and overhung by fringing and in-stream native vegetation.

Floodplains and backwaters

In terms of habitat, floodplains are generally broad areas of low flat land adjacent to the main floodway of the river. Each year floodplains are inundated to some degree by floodwaters, creating a seasonal habitat which may be used for feeding and breeding by a variety of animals such as tiny crustaceans, burrowing crayfish, birds, frogs and fish. Floodplains may also be part of broader wetland systems which in winter become very swampy through groundwater rise or the build up of rainwater over a clay layer. Floodplains are an integral part of the river ecosystem. There is an exchange of water, nutrients, and living creatures between the river and its floodplain, which is essential to the proper functioning of a healthy river ecosystem.

When secondary channels become disused and form pools they are referred to as backwaters. The still or slow flowing water in the backwaters is often the preferred habitat of species that are unable to cope with fast flow.

Habitat elements

Habitat elements are found within the zones outlined above in differing combinations to provide a large variety of habitats.

Riparian vegetation

Riparian vegetation has a number of important functions as discussed in Section 5 of this report. In regard to habitat, native fringing vegetation is important as it contributes hard oily tannin rich leaves to fuel the food web, and provides shade throughout the year helping to keep water temperature low.

Snags and woody debris

Snags are fallen trees and large branches lying in the river channel. They are important to the ecology of river systems. Apart from generally helping to slow the flow of water, woody debris alters its flow, creating eddies and small isolated zones of turbulence or still water which provide 'micro-habitats' for a range of tiny animals and plants. Furthermore, tree trunks and branches add a huge surface area to a river environment, creating a woody habitat for certain species to use for all or part of their life cycle. Tree trunks lying close to or on

the river bed provide cover or a sturdy roof for burrowing animals, such as marron or gilgies.

Shade

Shade provides an essential refuge for aquatic animals to escape the heat of the sun, as well as generally keeping water temperature down.

Aquatic vegetation

Aquatic vegetation includes plants that are found submerged in, floating on or emerging from water. It provides a specialist habitat for certain animal species, such as fish and hunting spiders, as well as cover for fish, shrimps and crayfish and valuable breeding and nursery habitat for fish during spring.

Leaf litter

Leaves and twigs collect in pools or in areas of still or slightly flowing water and form an important micro-habitat for a large range of aquatic organisms, from large crayfish to microscopic bacteria and fungi which break down the organic material and initiate the natural food web. Piles of leaves and twigs can also provide cover for certain fish species, aquatic insect larvae and juvenile crayfish, but only if there is a slight flow of water through the material to maintain well oxygenated conditions.

Rocks and stones

Although vegetation dominates river habitats in the south-west, rock and stone are important habitat elements. Rocks create a myriad of micro-habitats in which a broad range of animals and plants can find a home. Rock also limits the growth of trees and shrubs over water and creates sunlit habitat. For example, the smooth rocky bed of the rapids area on the northern branch of the Margaret River supports the growth of algae in the shallow swiftly flowing sunlit waters. Finally, the water flow over rocky stream beds helps to oxygenate the water, improving the quality of habitats downstream.

The catchment

The riparian ecosystem is determined not only by climate, habitats and the living creatures within it, but also by the nature of the much larger catchment beyond, as wind and water carry vegetable matter, inorganic sediment, dissolved organic material, salt and nutrients into the river system (Pen, 1999).

The habitat value for riverine animals is also affected by the nature of the catchment. Many riverine animals make use of the broader river system, such as seasonal creeks, and floodwaters and adjacent riparian lands, at some stage in their life cycle.

Useful references on river ecology

Pen, L.J. (1999) *Managing Our Rivers*. Water and Rivers Commission, Perth.

Water and Rivers Commission (2000) *Stream Ecology*. Water and Rivers Commission River Restoration Report No. RR7.

Water and Rivers Commission Water Note 8, *Habitat of rivers and creeks*.

Water and Rivers Commission Water Note 9, *The value of large woody debris (snags)*.

Water and Rivers Commission Water Note 12, *The values of riparian zones*.

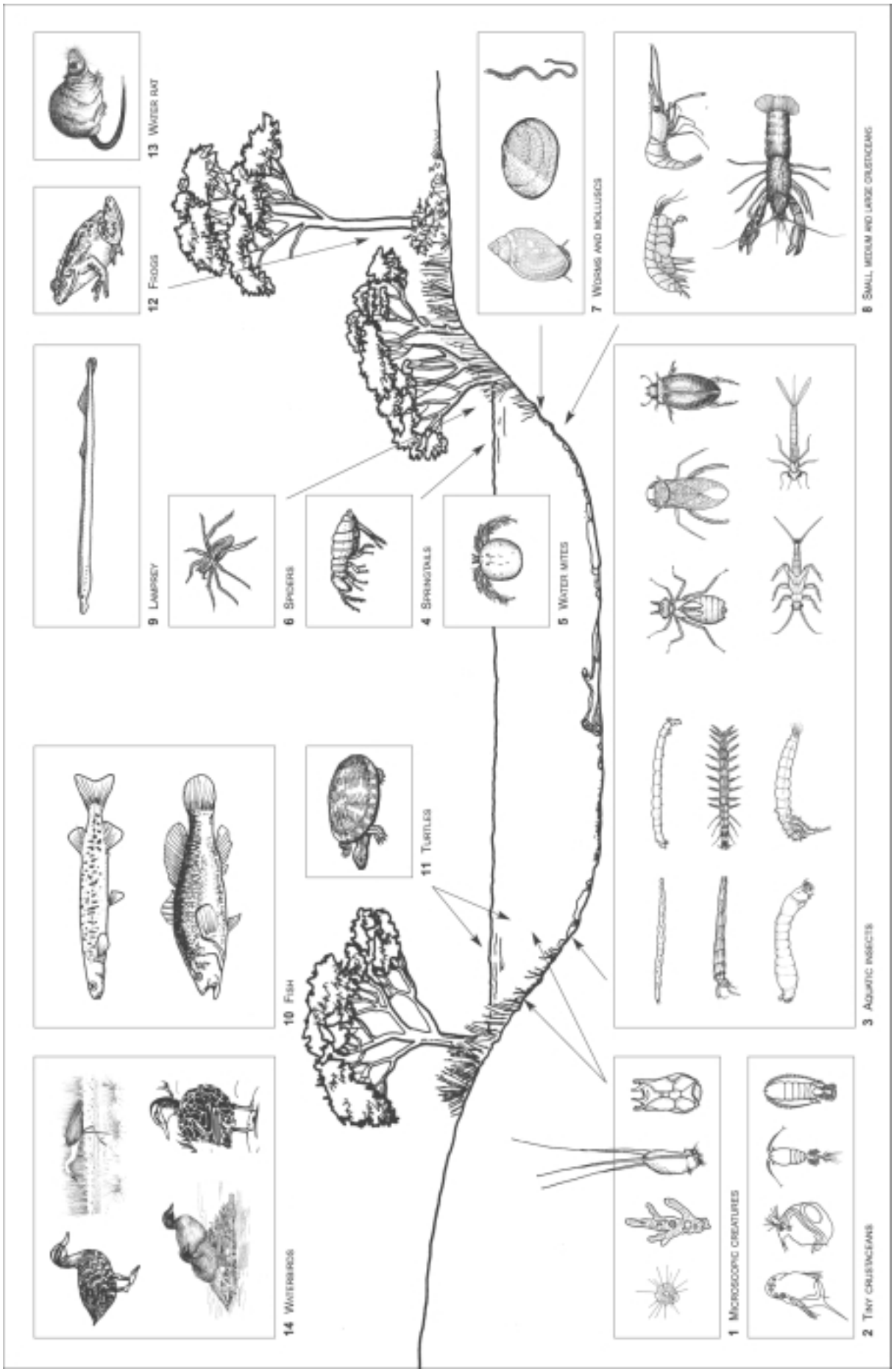


Figure 2: River fauna of south-western Western Australia

The pouched lamprey[3]

The pouched lamprey (*Geotria australis*) belongs to a group of primitive eel-like jawless fish. Their mouths consist of a suctorial disc, lined with tiny teeth, and a toothed tongue, which they use to extract muscle tissue and blood from their prey. Fossil evidence suggests that lampreys have been in existence for over 280 million years and have changed little in that time (Potter *et al*., 1986).

The pouched lamprey occurs in the temperate regions of the southern hemisphere, being found in the rivers of southern South America, southern Australia and New Zealand.

The pouched lamprey spends most of its adult life at sea, re-entering the rivers and embarking upon an arduous upstream migration, during winter and spring, to permanent fresh headwater creeks where it spawns and dies. Larval lampreys spend about four years filter feeding from burrows in soft sediments before metamorphosing into miniature adults and moving to the ocean.

The adult pouched lamprey is about 650 mm long, and marine adults are a brilliant cobalt blue in colour with bright greenish lateral stripes. On entering fresh water, adults become drab brown, with males developing a large sac or pouch, which hangs down just below the mouth. The function of the pouch is unknown. Young larval lampreys range in length from 30-80 mm, have no eyes and are a dull brown or black in colour.

In moving upstream lampreys must negotiate rapids and climb waterfalls, and these days also dams and weirs, in order to reach their breeding habitat. Lampreys are good climbers, using their suctorial mouths to gain a grip on wet surfaces and whipping their bodies upwards to inch their way up and over obstructions. In very wet weather, lampreys will leave the water and snake their way cross-country to get around the most challenging obstructions.

During the early stages of the migration, lampreys are susceptible to blood poisoning and internal bleeding. Many other animals die from injuries and exhaustion incurred while to attempting to climb or get around the more hazardous obstructions. Sometimes lampreys get lost in wet weather by following the flow of water from roads and paddocks with the result they become stranded the next day and quickly die in the sun (Pen *et al*., 1991).

[3] This information on the pouched lamprey is from Water and Rivers Commission Water Note 14: Lamprey guides.

4. Study methodology

Community involvement

This river action plan was developed in consultation with the community. Many of the landholders took part in the assessment of the river at their property. Others provided information and assistance. Following completion of the survey work, three community meetings were held to report results of the field assessments, to discuss recommended management and to obtain feedback.

River foreshore condition assessment

The Pen-Scott method of riparian zone assessment was used. This system provides a graded description of the river foreshore that runs from pristine (A grade) through to a ditch (D grade). A summary of the grades of the Pen-Scott system follows (Pen & Scott, 1995). These are also illustrated in Figure 3 and the photos on the following pages.

A grade foreshore

A1: Pristine

The river embankments and/or channel are entirely vegetated with native species and there is no evidence of human presence, or livestock damage. This category, if it exists at all, would be found only in the middle of large conservation reserves where the impact of human activities has been negligible.

A2: Near pristine

Native vegetation dominates but introduced weeds are occasionally present in the understorey, though not to the extent that they displace native species. Otherwise there is no human impact. A river valley in this condition is about as good as can be found today.

A3: Slightly disturbed

Here there are areas of localised human disturbance where the soil may be exposed and weed density is relatively heavy, such as along walking or vehicle tracks. Otherwise, native plants dominate and would quickly regenerate in disturbed areas should human activity decline.

B grade foreshore

B1: Degraded - weed infested

In this stage, weeds have become a significant component of the understorey vegetation. Although native species remain dominant, a few have probably been replaced or are being replaced by weeds.

B2: Degraded - heavily weed infested

In the understorey, weeds are about as abundant as native species. The regeneration of some tree and large shrub species may have declined.

B3: Degraded - weed dominated

Weeds dominate the understorey, but many native species remain. Some tree and large shrub species may have declined or have disappeared.

C grade foreshore

C1: Erosion prone

While trees remain, possibly with some large shrubs or grass trees, the understorey consists entirely of weeds, mainly annual grasses. Most of the trees will be of only a few resilient or long-lived species and their regeneration will be mostly negligible. In this state, where the soil is supported by short-lived weeds, a small increase in physical disturbance will expose the soil and render the river valley vulnerable to serious erosion.

C2: Soil exposed

Here, the annual grasses and weeds have been removed through heavy livestock damage and grazing, or as a result of recreational activities. Low level soil erosion has begun, by the action of either wind or water.

C3: Eroded

Soil is being washed away from between tree roots, trees are being undermined and unsupported embankments are subsiding into the river valley.

D grade foreshore

D1: Ditch - eroding

Fringing vegetation no longer acts to control erosion. Some trees and shrubs remain and act to retard erosion in certain spots, but all are doomed to be undermined eventually.

D2: Ditch - freely eroding

No significant fringing vegetation remains, and erosion is completely out of control. Undermined and subsided embankments are common, as are large sediment plumes along the river channel.

D3: Drain - weed dominated

The highly eroded river valley has been fenced off enabling colonisation by perennial weeds. The river has become a simple drain, similar if not identical to the typical major urban drain.

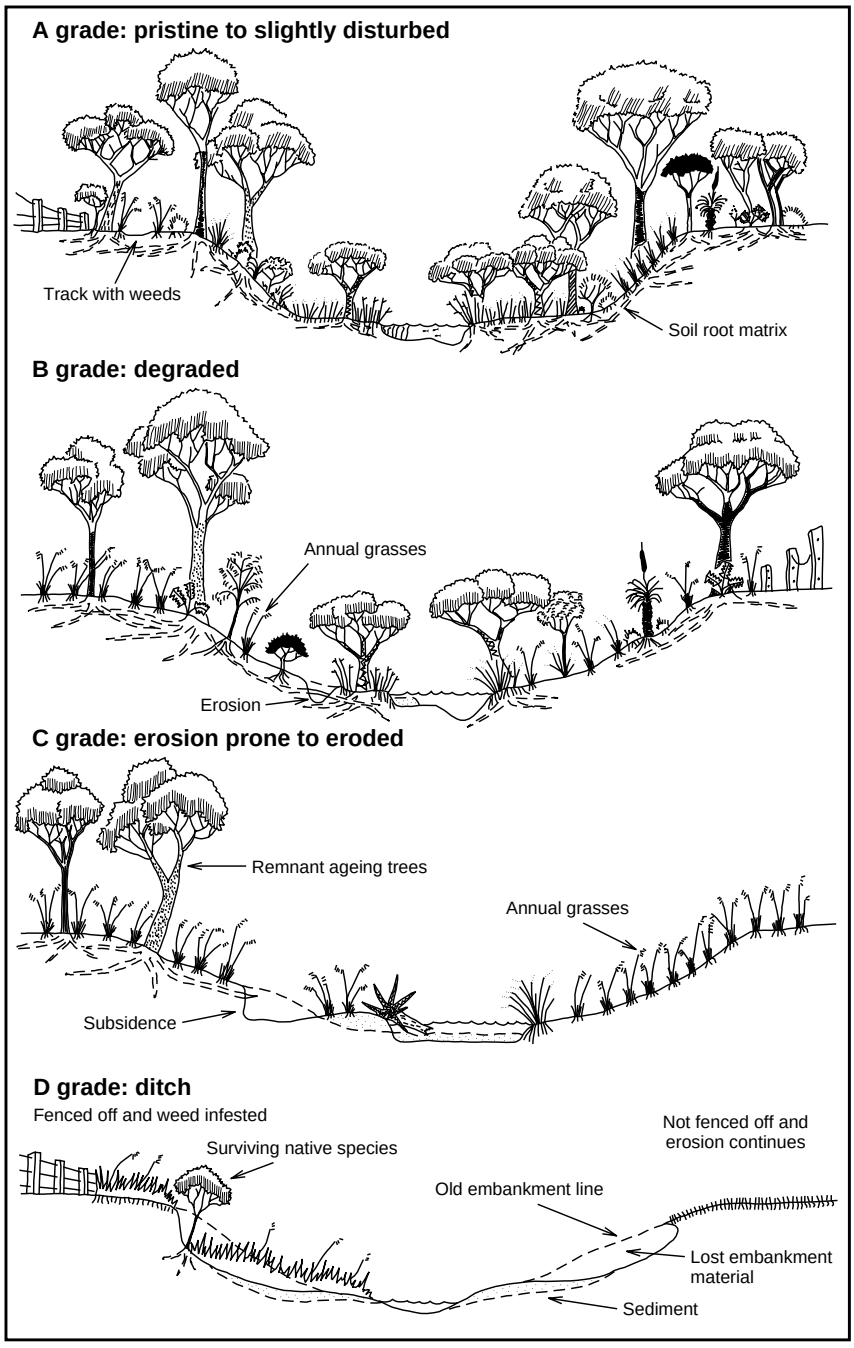


Figure 3: The four grades of river foreshore condition - (A) pristine to ditch (D)

A grade foreshore. Native fringing vegetation protects the banks from erosion and traps sediment and organic material before it reaches the river.

A grade foreshore. Fringing vegetation provides habitat, shade and leaf litter, important elements of a healthy river ecosystem.

B2 - B3 grade foreshore. Weeds have become a significant component of the understorey vegetation.

B3 grade foreshore. Weeds dominate the understorey, restricting the regeneration of native species.

C2 foreshore. Trees remain though there is little evidence of regeneration. The shallow-rooted weedy understorey provides no support to the soil, making the banks vulnerable to erosion.

C1-C2 foreshore. Native understorey has been degraded through stock grazing and trampling. A vital component of a healthy river ecosystem has been lost from this C grade foreshore.

5. Management issues

Management issues vary throughout the catchment depending on landform and soils, past and current land management and use, and livestock access. The issues identified for the Margaret River are summarised below.

Loss of native fringing vegetation

Native vegetation remains along much of the Margaret River although often in a very narrow band. The species diversity varies considerably depending on historical stock access and past land use management practices. In some areas there is a complete suite of native species present whilst other areas are dominated by a few species.

There are a number of areas that have been used for stock watering and many of these retain little or no native vegetation. Many are now fenced to control stock access and are regenerating, although very slowly in places.

Native riparian vegetation has many values as discussed below.

Erosion control

The roots of trees and large shrubs anchor the river embankments in place and prevent them from slumping and subsiding in to the channel. The finer roots of shrubs, sedges and rushes hold the banks together, preventing soil from being washed away and protecting trees and shrubs from being undermined.

Dissipating flow

Riparian vegetation increases the roughness of the riverbanks, which serves to dissipate the energy of running water thereby reducing the erosive capacity of the flow. The type of vegetation present determines the extent to which water velocity is decreased. Widely spaced trees are not as effective in reducing velocity as rushes and sedges.

Sediment and nutrient retention

Riparian vegetation slows overland movement of water resulting in sediments and nutrients being deposited on land prior to reaching the river channel. This effect is known as buffering. Grasses, rushes, sedges and shrubs are most effective in achieving this buffering effect. The wider the buffer zone, the more effective it is.

Ecological values

Native fringing vegetation provides a range of habitats for many species of flora and fauna, particularly species that are restricted to moist or aquatic environments. Aquatic plants and animals are reliant on the leaf litter, insects and organic debris provided by riparian vegetation. Branches and fallen trees provide habitat for aquatic fauna. The shade provided by fringing vegetation is important in keeping water temperature low. Many native aquatic plants and animals cannot tolerate high water temperature. Lower temperature also reduces the risk of algal growth. Vegetation along stream systems also provides a corridor along which fauna can move and may link areas of remnant vegetation.

Weed invasion

Numerous species of weeds were encountered during the field surveys of the rivers. Many of these are shown on the maps. Blackberry and pennyroyal are the worst weeds in the upper reaches of the river. Only small infestations of bridal creeper were sighted in this area. Close to the town a variety of garden escapees are found. In the lower reaches of the river arum lily and bridal creeper are a serious problem.

Weeds compete with native vegetation and restrict regeneration. They are a threat to biodiversity and cost agricultural industries over $3.3 billion each year (Agriculture and Resource Management Council of Australia and New Zealand, Australian and New Zealand Environment and Conservation Council & Forestry Ministers, 1999).

Stock access

The level of stock access to the Margaret River has decreased over the last ten to fifteen years due to fencing and changes in land use. However, there are areas of the river that are unfenced or have fences in bad condition and stock have access to the river in these areas. There is also a number of stock watering points still in use. Problems related to unrestricted stock access include:

- loss of native fringing vegetation;
- weed invasion;
- compacted soils;

• erosion; and

• poor water quality.

Management of the river after fencing is important. Lack of management can lead to weed problems, an increase in rabbits and possible erosion problems, particularly where woody debris is blocking the channel.

Stock watering points

Areas of the river where stock watering has been concentrated are often devoid of vegetation with very compacted soil. Although many of these points on the Margaret River are now fenced there is very little regeneration of native vegetation and low level erosion is occurring.

Water quality

Background

Monitoring in the Margaret River has been conducted by the Water and Rivers Commission and its predecessors for over 60 years. Kathryn Hardcastle of Water and Rivers Commission has supplied the following information on water quality using data collected from the last four years at points upstream and downstream of the town. Results have been grouped to enable simple analysis.

It is worth noting that the majority of data for the Margaret River comes from its lower parts (below town) as the upper parts of the river cease to flow during most summers. In general terms the water quality is worse and more variable downstream of the townsite.

For a more detailed analysis of the water quality of the Margaret River and other Cape to Cape streams please see the Cape to Cape Stream Condition Project report (Hunt, 2003).

Nutrients

Concentrations of both nitrogen and phosphorus in the Margaret River are generally low to moderate. Figure 4 shows nutrient data for the Margaret River; concentrations vary considerably between and within years but tend to be highest in winter and spring in response to increased runoff. Concentrations often exceed the guideline for protection of aquatic ecosystems, however only biological testing would confirm if these levels are causing problems for river fauna.

Figure 5 shows average nutrient concentrations in summer and winter, and indicates proportions of organic (particulate) and dissolved fractions of nitrogen and phosphorus. In winter proportions of organic nitrogen (those bound to particulate matter) are high (between 60 and 80 per cent) most likely due to soil erosion and animal wastes. In summer the proportion of organic nitrogen is significantly reduced and dissolved forms of nitrogen become more prevalent. The situation with regard to phosphorus does not change significantly with the seasons and organic forms routinely constitute between 90 and 99 per cent of total concentrations. During winter, organic phosphorus is generally bound to particulate matter while during summer, organic phosphorus is usually bound with phytoplankton.

Sediments

The only indicator of sediment transport in the monitoring program is turbidity. Turbidity may be high in response to runoff during rainfall events, localised erosion problems, disturbance by stock or vehicles, and also as a result of algal blooms. Turbidity levels in the Margaret River are generally low (below 20 NTU) and it would seem that sediment transport in the Margaret River is not of serious concern.

Dissolved oxygen

Dissolved oxygen levels are generally acceptable. Some deoxygenation events (where concentrations fall below 20 per cent) have been recorded in the later summer period, possibly due to the breakdown of organic material in-stream and reduced river flow. Low oxygen levels are potentially a risk to aquatic fauna and oxygen levels can be enhanced by increasing areas of turbulence, such as through creation of riffles.

Salinity

The Margaret River remains fresh throughout the year, although discrete incidences of brackish water have been recorded in the late summer period and are most likely due to the concentration of salts in-stream by evaporation.

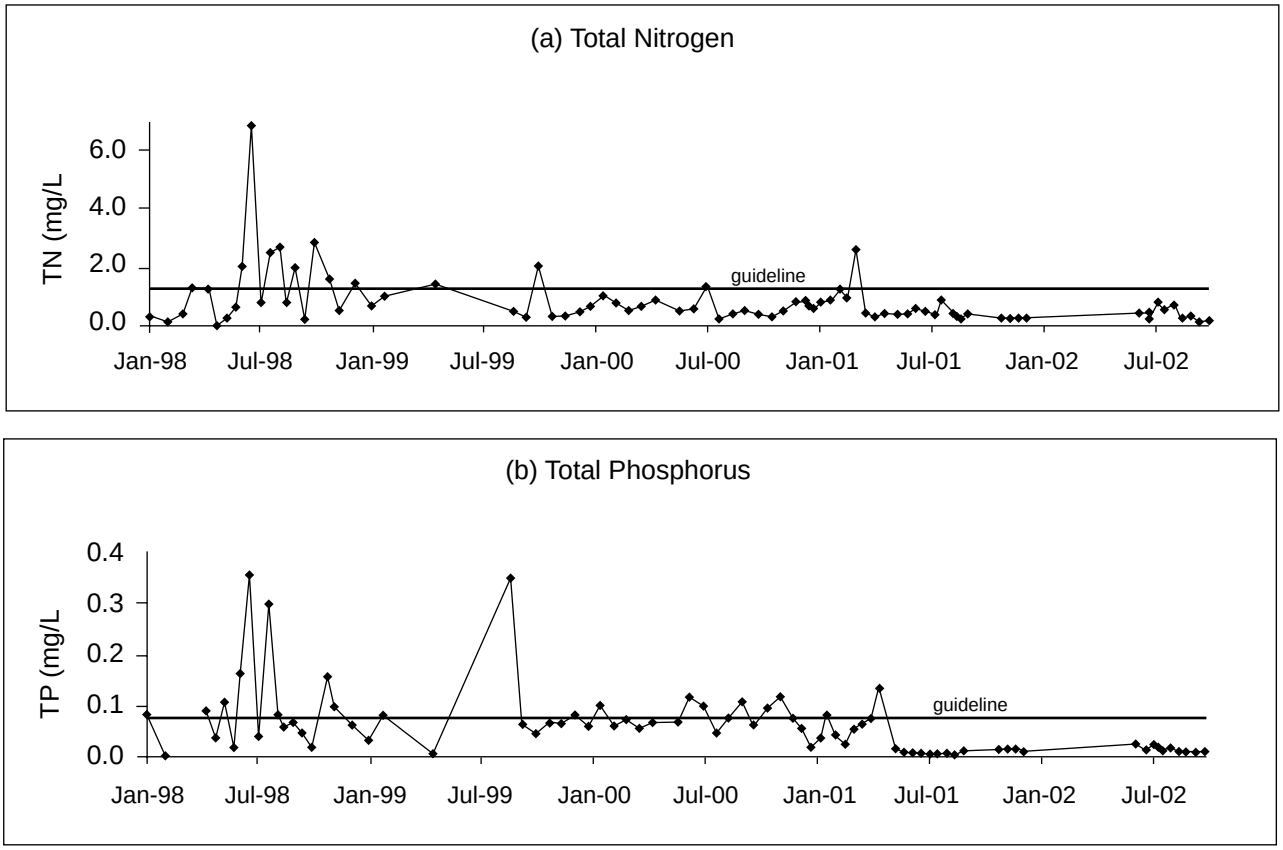


Figure 4: Total nutrient data for the Margaret River: (a) total nitrogen; (b) total phosphorus

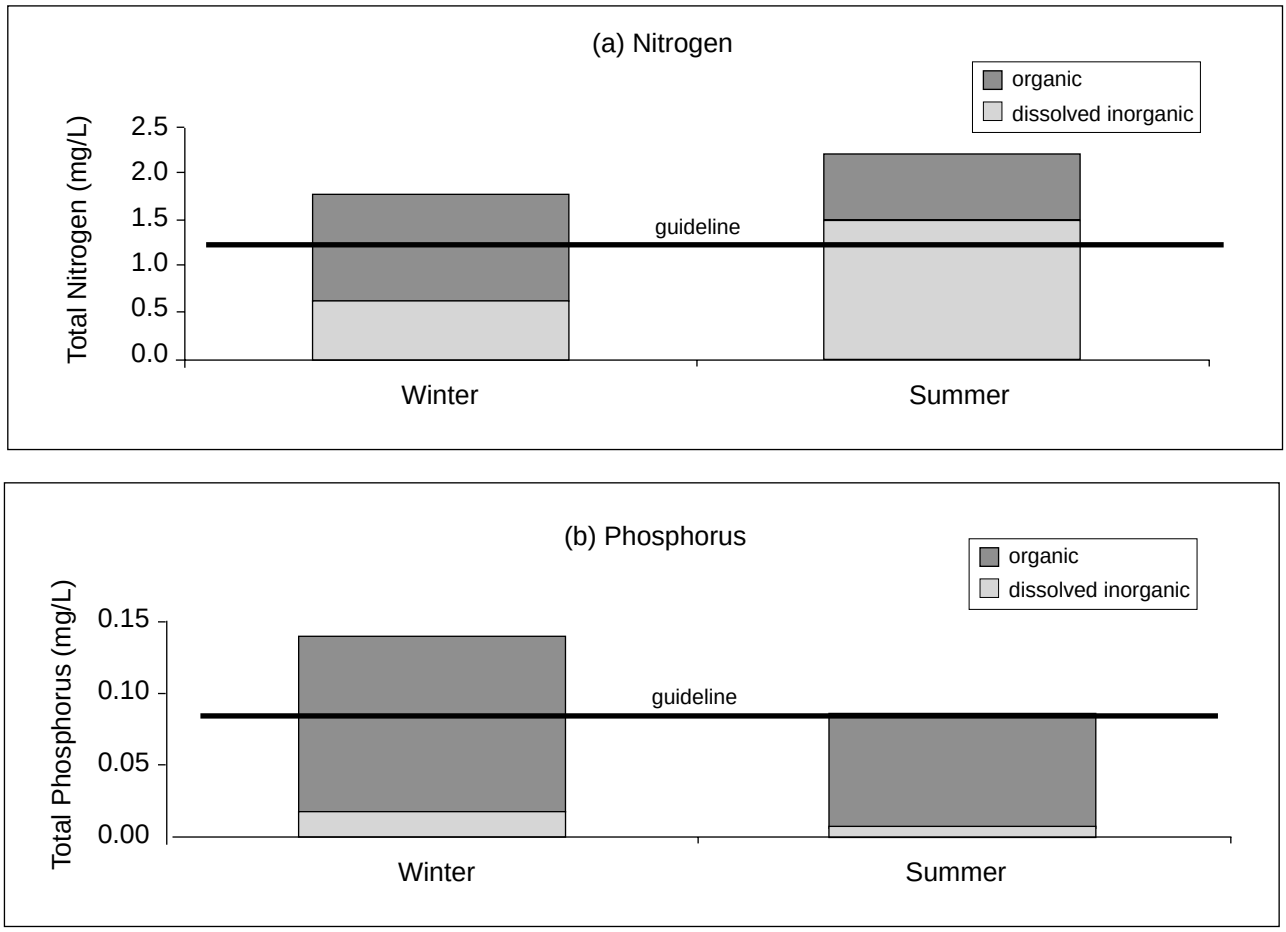


Figure 5: Forms of nutrients in the Margaret River: (a) nitrogen; (b) phosphorus

Ecology

The Margaret River retains many of the habitat zones and elements of a natural stream. There is native fringing vegetation along most of the river, stabilising the banks and providing habitat, shade and leaf litter. There are deep permanent pools, densely vegetated shallow runs, riffles, rapids and cascades, large woody debris, in-stream and aquatic vegetation and some vegetated backwaters.

Concerns regarding the ecology of the river include:

- The effect on the ecology of river pools of pumping during summer and autumn, especially in the middle reaches of the river. This is of particular concern in view of decreasing rainfall. The river pools provide an essential summer drought refuge, integral to the survival of many aquatic animal populations (Pen, 1999). This issue was raised by a number of landholders during the foreshore surveys.
- Much of the floodplain along the Margaret River is cleared and many of the tributaries are degraded. The exchange of water, nutrients and living creatures between the river and its floodplain are essential to the proper functioning of a healthy river ecosystem (Pen, 1999). The seasonal habitats are used for feeding and breeding by a variety of animals such as tiny crustaceans, burrowing crayfish, birds, frogs and fish.
- The native fringing vegetation is very narrow and degraded in places. Continued stock access and uncontrolled weed infestations will lead to further degradation of riparian vegetation.
- The three weirs on the Margaret River present an obstruction to the migration of native fish and lampreys. The dams created by the weirs also provide an ideal habitat for exotic pest fish species such as gambusia (*Gambusia holbrooki*), redfin perch (*Perca fluviatilis*) and carp (*Carassius* spp.).
- The opening of the river mouth by human interference and the effect on the ecology of the estuary due to very low water levels.

Erosion and siltation

Banks sometimes naturally erode on bends, however when vegetation is cleared, they can become unstable causing extensive erosion along the floodway and the build up of sediment that is washed downstream (WRC, 1999a). While some level of erosion and deposition is natural within any riverine system, the acceleration of these processes can cause management problems.

Erosion is not a major problem on the Margaret River. In areas where the banks are bare through stock access or human use low level erosion is occurring. Cleared tributaries in the catchment are also susceptible to erosion and may be contributing sediment to the river.

Issues associated with erosion problems include:

- loss of valuable soil;
- loss of fences as the river course deviates;
- poor water quality resulting from increased turbidity and nutrients;
- increased flood potential due to the silting up of the channel;
- filling of summer pools;
- increased channel width and loss of agricultural land;
- reduced visual amenity associated with the river; and
- further loss of native riparian vegetation as severe erosion problems cause subsidence.

6. Management advice

Where to start

The main principles for river management are: conserve the best pieces first, move on to those reaches showing signs of recovery, and then treat the more degraded parts of the system. This advice applies to both individual properties and the river system as a whole.

It is extremely cost effective to protect areas of river still retaining native fringing vegetation. Continued stock access will result in on-going degradation to fringing vegetation and the need for revegetation to ensure the river remains stable and healthy. Revegetation, including site preparation and plant guards, costs in the vicinity of $40,000/ha.[4]

Work on the more degraded parts will be easier if the river upstream is in good condition. Weed infestations will impact on areas downstream.

The Vasse River Action Plan contains excellent advice on planning a restoration and revegetation project. Parts of this advice are included in Appendix 2 of this river action plan.

Stock control

The control of livestock access is the most important management tool in the protection and restoration of waterways and fencing is the best method to achieve this.

APACE Green Skills and Pen (1995) provide some good advice with regard to the placement of fences alongside waterways. This advice is detailed below.

'Ideally, fences should be placed above the river valley (Figure 6). Depending on the steepness of the embankment, the fence should be placed 5 m to 20 m back from the edge of the river valley (Figure 6 A). Five metres is sufficient for a shallow valley a couple of metres deep but a broader zone, greater than ten metres, is required for valleys deeper than five metres. The purpose of fencing off the shoulders of the river is to enable trees on the upper part of the embankment and those above the river valley to anchor the adjacent land, and thereby prevent subsidence.

In the case of shallow river valleys, there is little chance that embankments will subside. Nevertheless, fence-lines should be located above the river valley (Figure 6 B). This is because fences and firebreaks located within the river valley will be damaged and eroded by floodwaters. When they occur, firebreak washouts can be severe and contribute large quantities of sediment to the river system.

If the river valley is particularly broad and floodplains have been cleared for grazing, fencing them off may mean sacrificing good farmland. In this case it is necessary that only those areas that are prone to water erosion or stock damage, such as embankments and secondary river channels which only flow strongly at times of flood, need to be fenced off (Figure 6 C). Some of these fence-lines will be prone to flood damage, but this can be minimised if fences run, as much as possible, parallel to the direction of floodwaters.

In the flatter and broader valleys it may be acceptable to use fences to control the level of grazing rather than to exclude it altogether. A careful watch would need to be kept to ensure that the grazing is sustainable and is not so heavy as to prevent the regeneration of native trees, shrubs and sedges.'

Fencing and control of stock access may lead to an increase in weeds and weed control may be required for a few years to assist natural regeneration. Vigilance will be needed to pre-empt any serious weed invasion, for example, bridal creeper.

The provision of off-site or restricted access watering points may be required if the river is to be fenced. Information on design and construction of crossings and watering points can be found in the references listed below.

Useful references on stock control

Water and Rivers Commission Water Note 18, *Livestock management: Fence location and grazing control*.

Water and Rivers Commission Water Note 6, *Livestock management: Construction of livestock crossings*.

Water and Rivers Commission Water Note 7, *Livestock management: Watering points and pumps*.

Water and Rivers Commission Water Note 19, *Flood proofing fencing for waterways*.

[4] This figure is calculated at 4 plants/m^2 at 50 cents /plant. It does not include the cost of planting. Site preparation costs have come from a WRC draft Water Note on the costs of river restoration.

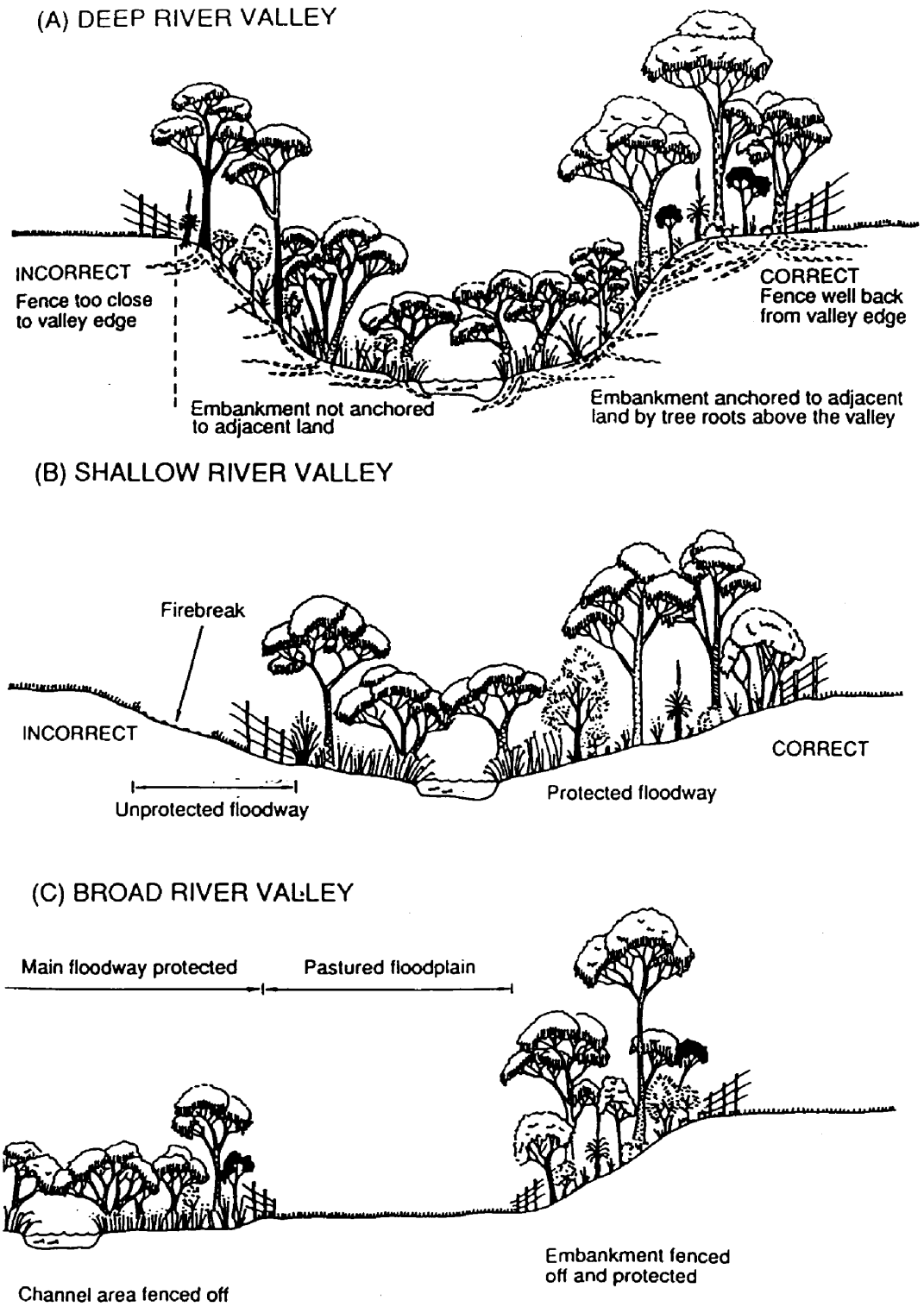


Figure 6: The correct placement of fences in relation to the river valley: (A) the deep river valley, (B) the shallow river valley and (C) the broad river valley with broad flood-plain (APACE Green Skills & Pen, 1995)

Regeneration and revegetation

In areas that still retain native trees and understorey, natural regeneration will occur. Control of stock access and invasive weeds is essential to this strategy. Natural regeneration can be assisted by making small piles of branches and burning to promote germination through smoke and heat. Smoke water can also be applied to encourage germination. Another technique to assist regeneration involves laying the seed bearing parts of native plants directly onto the ground, allowing seeds to fall from them. This is called brushing.

Sections of the rivers that have been heavily grazed and cleared contain more weeds and have a diminished seedbank. Options for these areas include: direct seeding, brushing with woody natives that contain seed, pre-seeded matting and planting of tube stock. The riparian zone should be planted in a wide band with a mixture of deep rooted trees and shrubs. A diverse suite of local native species should be planted including trees, shrubs, sedges, rushes, herbs and native grasses. This not only improves the habitat value of the foreshore, but also provides a matrix of different root structures which will improve bank stability and assist in erosion control.

Good site preparation is often crucial to successful revegetation. Elements that need to be considered are weed removal, soil amelioration and preparation of the soil surface for direct seeding or planting. Pest control and ongoing control of weeds also need to be factored into the project. Planting and sowing at the right time of year, and at the appropriate depth will also influence the success of the revegetation effort.

Appendix 1 contains species lists for the different vegetation communities along the river and can be used as a guide to selecting species for revegetation. Species composition within the vegetation communities changes depending on topography and soil type. When developing a species list for revegetation the first step should be to compile a list of species close to the area to be planted.

The different revegetation techniques are outlined below:

Direct seeding

Direct seeding has a few distinct advantages over other methods:

- it is less time consuming and requires less labour than planting tube stock;
- a mixture of trees, shrubs, sedges and ground covers can be planted at the same time, resulting in a plant community with a natural look;
- it is less expensive than providing tube stock. There are many areas on the river that have good potential for the collection of local provenance[5] seed; and
- the natural root development of seedlings grown from seed usually results in plants developing deep taproots, requiring less follow-up care.

However, direct seeding can be less reliable than planting, due to predation, specific germination requirements not being met, and poor conditions for direct seeding. Direct seeding may not be possible when high winds or strong water flow is present.

Planting

Planting is the appropriate technique for embankment and in-stream revegetation, and where direct seeding is difficult due to insufficient seed, excessive weed competition etc. Only species native to the local area should be used. A rule of thumb guide for planting densities is 500:50:5 herb/sedges to shrubs to trees. Sedges and rushes should be planted in spring, when the water table is beginning to fall and the soil is still moist. Other seedlings should be planted when they are actively growing, the surrounding soil is moist and follow-up rain is likely (usually between May and July). Care should be taken to ensure that specimens are not root bound, and that minimal damage to the roots occurs when removing from pots.

Brushing

The use of brush is an excellent technique in all zones apart from the channel bed. This technique can be used to spread seed and assist with erosion control simultaneously. Brush should be harvested from plants

[5] *The term provenance is used to identify the geographic origin of seeds or parent plant. Often, genetically distinct local forms or varieties of a plant have evolved to suit a specific range of conditions, including soil, climate and water regimes. Direct seeding with local provenance seed ensures that the resulting plants will be suited to the localised environmental conditions and maintain the ecological integrity of existing native plant communities (GeoCatch, 1999).*

at seed maturity and laid immediately on to the revegetation site. Brush along the embankment should be secured in place. Species suitable for this technique are those which retain seed on the plant, but shed it when the plant dries out. This includes many of the myrtaceous species (e.g. peppermints, teatree, paperbarks, marris, jarrah, blackbutts, Astartea, Kunzea).

Pre-seeded matting

Pre-seeded matting involves spreading seeds onto an appropriate fibremulch, and laying the mat on-site in early winter after germination. This technique is excellent for steep embankments, since it provides erosion control and revegetation in a single stage. It is only suitable for seeding with rushes and sedges, since matting usually requires rolling to transport to site.

Useful references on natural regeneration and revegetation

Bradley, J. (1988) *Bringing Back the Bush: The Bradley Method of Bush Regeneration*. Lansdowne Press, Sydney.

Buchanan, R.A. (1989) *Bush Regeneration: Recovering Australian Landscapes*. TAFE Open Training and Education Network, Strathfield, NSW.

Scheltema, M. (1993) *Direct Seeding of Trees and Shrubs*. Greening Western Australia, Perth.

Water and Rivers Commission (1999) *Revegetation: Revegetating riparian zones in south-west Western Australia*. Water and Rivers Commission River Restoration Report No. RR4.

Water and Rivers Commission (1999) *Revegetation: Case studies from south-west Western Australia*. Water and Rivers Commission River Restoration Report No. RR5.

Water and Rivers Commission (1999) *Using rushes and sedges in revegetation of wetland areas in the south west of WA*. Water and Rivers Commission River Restoration Report No. RR8.

Water and Rivers Commission Water Note 20, *Rushes and sedges*.

Stock watering points

Some suggested rehabilitation techniques for old stock watering points that are bare and compacted are outlined below:

- Brushing will slowly assist regeneration through trapping seed and leaf litter as well as providing an initial seed source. Regeneration may be slow because of compacted soil. However, this technique is very cheap and easy to implement. The brush will need to be secured in place. See above for further information on brushing.
- The site can be lightly ripped to loosen the soil and then covered with brush or jute matting to control erosion. The brush or matting needs to be secured in place. Local native plants can then be planted into the brush or matting.
- A post hole digger can be used to dig holes for planting. A crow bar should be used to loosen the edges of the hole before planting so that the roots can spread.

Protection of plants from kangaroos and rabbits may be required.

It is recommended that experimental rehabilitation techniques be trialled. The sites should be monitored and the effectiveness of the different techniques evaluated. This information can then be passed on to the community to assist with rehabilitation of the C grade sections of the river.

Weed control

Weed invasion is a major threat along the Margaret River and within the catchment. Fencing the rivers and restricting stock access will result in the need for extra weed control. There is a need for coordinated weed control across the whole catchment for any eradication and control to be really effective.

A coordinated strategy for control of blackberry and bridal creeper, including restoration of native vegetation after control, is a priority.

In foreshore areas, removal or control of weeds must be completed with great care. In the riparian zone the erosive power of water requires consideration when

planning a weed strategy. Clearing weeds in an unplanned manner could result in erosion in the river channel.

Weed control principles to keep in mind include:

- Weeds thrive in disturbed areas and areas of bare ground.
- Fire promotes weeds. Burning a remnant which is weed infested will only make the weeds worse, unless there is follow-up weed control and revegetation. Native plants cannot compete with the rapid growth of weeds, which then become a greater fire hazard.
- Aggressive perennial weeds that spread readily along riparian corridors are the most important to concentrate on eradicating, for example, arum lily, blackberry, bridal creeper, watsonia, and pennyroyal.
- If weed control is carried out, revegetate to prevent further weed invasion in the bare soil.
- Some native plants look and act like weeds. Do not begin weed control until you are sure a plant is a weed.

Chemical control of weeds on waterways requires careful consideration. Issues which must be considered prior to any type of chemical control include the effects of the herbicides on native flora and fauna and the impact on water quality. The use of Roundup Biactive is recommended.

The Cape to Cape Catchments Group Coordinator and the Department of Agriculture can provide specific advice on weed control methods.

Useful references for weed identification and methods of control

Dixon, B. & Keighery, G. (1995) 'Suggested methods to control weeds'. In: *Managing Perth's Bushlands*, Scheltema, M. & Harris, J. (eds). Greening Western Australia, Perth. WA.

Hussey, B.M.J., Keighery, G.J., Cousens, R.D., Dodd, J. & Lloyd, S.G. (1997) *Western Weeds: A Guide to the Weeds of Western Australia*. Plant Protection Society of Western Australia, Victoria Park, Western Australia.

Hussey, B.M.J. & Wallace, K.J. (1993) *Managing Your Bushland*. Department of Conservation and Land Management, Como, Western Australia.

Water and Rivers Commission (1999) *Revegetation: Revegetating riparian zones in south-west Western Australia*. Water and Rivers Commission River Restoration Report No. RR4.

Water and Rivers Commission Water Note 22, *Herbicide use in wetlands*.

Water and Rivers Commission Water Note 15, *Weeds in waterways*.

Water quality

Waterways in agricultural areas receive large quantities of nutrients, either dissolved in water, adhering to small soil particles eroded from the land or contained within dead plant and animal material, including manure washed from paddocks. Outlined below are a number of ways to minimise soil erosion and nutrient loss (Pen, 1999).

Vegetative buffers

Vegetated buffers alongside waterways can intercept and slow runoff and thereby trap suspended sediment, including organic material. Research has shown that vegetative buffers 10-50 m wide can achieve phosphorus and nitrogen filtration rates in the order of 50-100% (Pen, 1999). A vegetative buffer need not be of native vegetation and can be a simple grassy strip which is fenced off to control grazing. The nutrients assimilated by the vegetation can be utilised by crash grazing or preferably in hay production since the latter does not involve livestock returning nutrients to the grassy border as urine and manure.

Vegetation within the waterway itself forms a longitudinal buffer which similarly slows the flow rate, prevents erosion and traps soil, sediment and organic matter.

Farming practices (Kingdon, 2000)

In reducing soil erosion, the key is to keep reasonably high levels of vegetation on the soil for as long as possible, and especially during times of high erosion risk. Achieving these conditions requires:

- use of reduced tillage and direct drilling;
- use of crop and pasture rotations that include well managed perennial grasses and legumes;
- in row cropping, use of permanent raised beds and controlled traffic;
- managing organic matter by retaining stubble and including pastures in a crop rotation; and
- keeping vigorous plant growth through appropriate soil, crop and water management.

Cultivation along the contours, rather than perpendicular to them, will slow the rate at which water flows across the land, reducing soil erosion by as much as 50% (Pen, 1999).

Soil testing and fertiliser use

Fertiliser is generally applied according to traditional practice, usually some time before the winter/spring growing season. Today, we know that after a number of years of fertiliser application, many soils are rich in nutrients but may be deficient in a few trace elements (Pen, 1999). Soil should be tested to determine fertiliser requirements and avoid excess application of nutrients, a portion of which will find their way into waterways.

Useful references for protecting water quality through farming practices

Kingdon, B.K. (2000) *Fertiliser Use Guidelines for the Swan Coastal Plain of WA*. Vasse-Wonnerup LCDC, Busselton WA

Prosser, I., Karssies, L., Ogden, R. & Hairsine, P. (1999) 'Using buffers to reduce sediment and nutrient delivery to streams'. In: *Riparian Land Management Technical Guidelines: Volume Two: On-ground Management Tools and Techniques*, Price, P. & Lovett, S. (eds), LWRRDC, Canberra.

Feral animal control

Rabbits are evident along the rivers and in the catchment. Rabbits severely impact on native vegetation and hinder regeneration and revegetation. Landholders and managers are encouraged to control rabbits through baiting, shooting, fumigation and destruction of warrens.

The value to native fauna of vegetated corridors along the rivers is undermined by the presence of foxes. Foxes can be controlled by baiting and shooting. The effectiveness of fox control is greatly improved if undertaken on a large scale, involving as many landholders as possible.

Specific advice on rabbit and fox control can be obtained from the Department of Agriculture.

Erosion control

Erosion is not a serious problem on the Margaret River. The cohesive, stable soils and the presence of native fringing vegetation for most of the length have meant that erosion is minimal. There are areas of low level erosion occurring on some tracks and stock access points.

A number of approaches to erosion control as outlined in the Capel River Action Plan by Kirrily White and Sarah Comer are discussed below (GeoCatch, 1999).

It should be noted that a detailed river geometry survey and a variety of calculations are usually required for the correct design of restoration works. It is also important to remember that rivers are part of a dynamic system, that is, they are in a constant state of change. Care should therefore be taken when attempting to predict the outcome of alterations to channel form and capacity. Site specific technical advice should be obtained prior to commencing any form of physical modification to the river channel. The Cape to Cape Catchments Group Coordinator and Water and Rivers Commission engineers can assist with providing technical support.

Point bars

Once a riverbank becomes disturbed to the point where it is actively eroding, there is large potential for this erosion to create further erosion downstream through the formation of point bars. Currents remove material from the outside banks of meanders and deposit it on the inside banks, where water moves more slowly, forming a point bar (Raine & Gardiner, 1995). Over time these sand bars trap more sediment and continue to accumulate; they may even start to support in-channel vegetation growth. Some point bars are located and shaped in such a way that they actually divert the river flow on to the opposite bank further downstream,

thus creating a new erosion point on the next outside bend. This cycle of erosion and deposition often continues downstream, and is the classic symptom of a river in which the hydrological balance has been disturbed (Figure 7).

Removal of point bars may sometimes be needed in order to halt the progression of the erosion downstream. Generally, this should be undertaken in conjunction with other forms of restoration and care must be taken not to exacerbate the disturbance to the river channel. As discussed previously, a detailed river geometry survey of the localised problem areas is required before this type of restoration procedure should be contemplated.

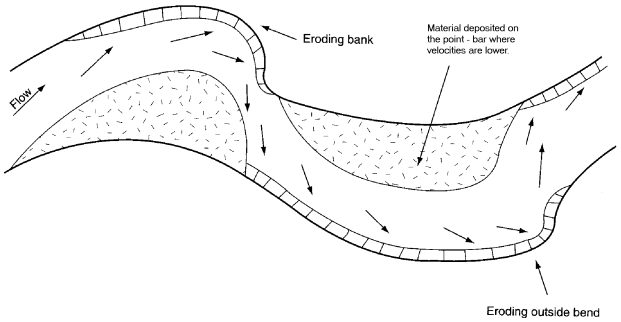


Figure 7: Outside bend bank erosion – arrows mark the direction of flow showing that outside bends have the greatest erosion potential, so the meanders migrate downstream (Raine & Gardiner, 1995).

Undercutting

Undercutting often occurs in conjunction with the formation of point bars. Material is scoured from the toe of the bank, resulting in loss of bank support; this often results in subsidence as illustrated in Figure 8 (Raine & Gardiner, 1995). Previous experience has shown that undercutting can be prevented by supporting and protecting the toe of the bank. Generally undercutting will occur where there is a meander. If this is the case, only the outside bends need to be supported as the flow velocity on the inside bend is much lower. Once an outside bend is stabilised, the corresponding inside bend will usually adjust its width to cater for the change in flow.

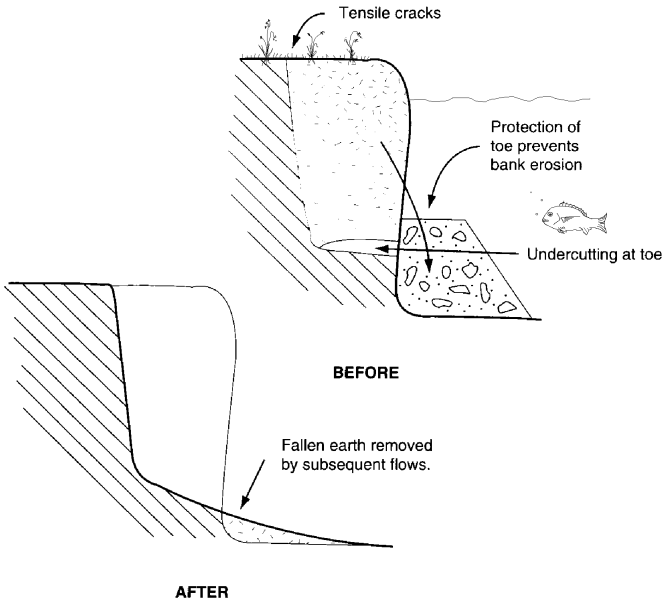


Figure 8: The use of structural works, such as a rock toe, will prevent the process of undercutting (adapted from Raine & Gardiner, 1995).

Bank slumping

Bank slumping can occur when poorly drained material within the bank becomes heavy with saturation and collapses into the river channel (Figure 9). This can occur without prior undercutting. It will often occur in response to the loss of native deep rooted vegetation providing bank support. The best way to manage this problem is to exclude stock with fencing set well back from the river channel, and revegetate the foreshore with suitable species. *Raine & Gardiner (1995) provide the following advice on this process:*

Replant the toe with species that can withstand high flow velocities (e.g. native sedges). This replanting should be dense with spaces between plantings of less than 1 metre.

Replant the middle to upper bank areas with fast growing, deep rooted trees and large shrubs. These will hold the bank together, enhance drainage and remove excess moisture through transpiration.

Vary the species that are planted to ensure differing root structures.

Extend plantings from the toe to the floodplain. If a narrow band of trees is planted, this may serve only to add to the weight of the bank without providing the necessary network of root support.

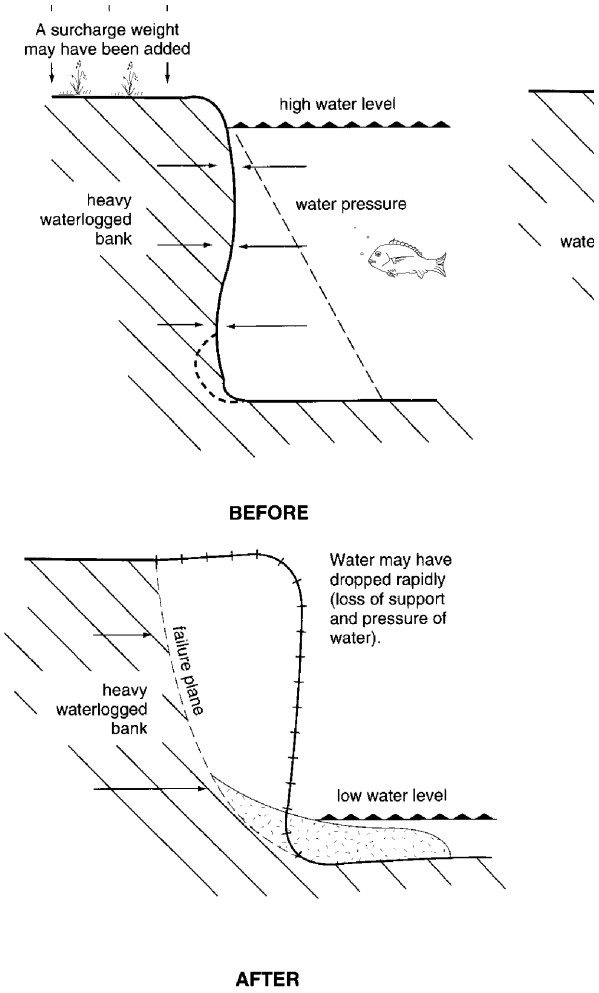


Figure 9: The process of bank slumping caused by excessive weight and lack of support (adapted from Raine & Gardiner, 1995).

Large woody debris

Snags, or large woody debris, are a natural component of the river system. They play an important role in the river ecology, by providing a range of flow conditions within the channel and by providing habitat for aquatic life forms.

Occasionally snags can divert the flow onto the bank and subsequently cause erosion in areas lacking support from native vegetation. While de-snagging rivers has been a common practice in the past, the current management emphasis is to leave as much woody debris as possible in order to provide habitat for aquatic plants and animals. Rather than removing large woody debris from the channel, the offending object should be repositioned at an angle 20°-40° to the stream bank (Figure 10). This action will minimise the effect of the snag on the flow levels and direction, while maintaining the habitat available for plants and animals that benefit from low flow conditions. Large woody debris can also be added to deflect flows from unstable areas.

Useful references on erosion control

Pen, L.J. (1999) *Managing Our Rivers*. Water and Rivers Commission, Perth.

Water and Rivers Commission (2001) *Stream Stabilisation*. River Restoration Report No. RR 10.

Raine, A.W. & Gardiner, J.N. (1995) *Rivercare – Guidelines for Ecologically Sustainable Management of Rivers and Riparian Vegetation*. Land and Water Research and Development Corporation. Canberra.

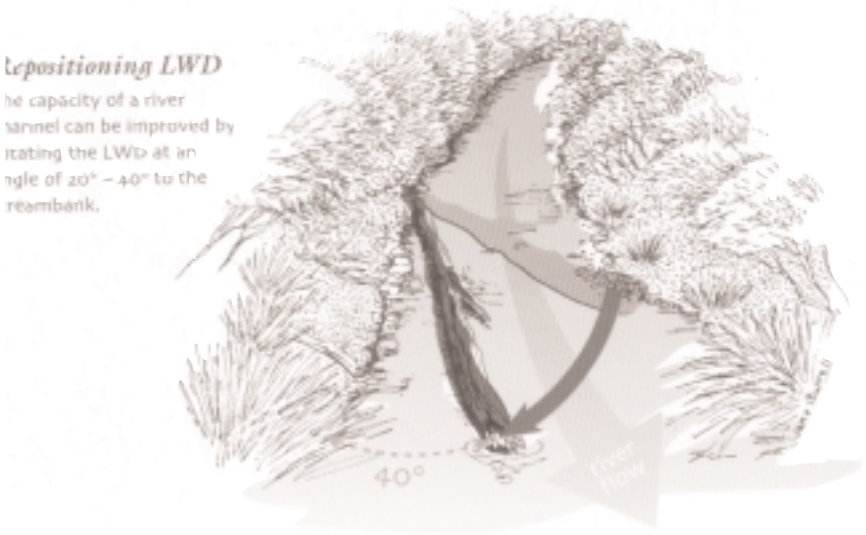


Figure 10: Repositioning large woody debris (Gippel et al., 1998).

General recommendations

It is recommended that landholders consider the following:

1. Make the commitment to protect the river and tributaries, and restrict stock access.
2. Fence the river and tributaries to exclude stock permanently, or to achieve management that allows for bank stability and native vegetation establishment and protection. Utilise funding to fence the river and its tributaries.
3. Eradicate weeds, particularly invasive weeds, dominating the riparian zone.
4. Consider widening the riparian zone in various ways; options include commercial trees, commercial plantings of native shrubs for seed, flower production, dried foliage etc.
5. Use management techniques that will minimise soil erosion and nutrient loss to waterways.

It is recommended that the Cape to Cape Catchments Group consider the following:

Fencing and revegetation

1. Encourage and support community effort to fence the river to enable control of stock access. Apply for funding to assist landholders with fencing costs.
2. Provide encouragement and support to landholders to undertake revegetation using a diverse suite of local native species (including trees, shrubs, sedges, rushes, herbs and native grasses).
3. Develop a restoration site to demonstrate effective revegetation techniques, particularly in areas infested with kikuyu.
4. Extend the focus of waterways management to include the protection and rehabilitation of tributaries to maximise the stripping of sediments and nutrients before they reach the river channel, and to restore important ecological functions.
5. Coordinate trials of rehabilitation techniques for old stock watering points and disseminate this information to the community to assist with rehabilitation of the C grade sections of the river.

Weed and feral animal control

6. Encourage, coordinate and support the community in weed control efforts on a catchment scale.
7. Work with the Water Corporation, Department of Agriculture, the Shire of Augusta-Margaret River, the Department of Land Administration and landholders to develop and implement a coordinated strategy for blackberry control on the river. Restoration of native vegetation after control should be part of the strategy.
8. Encourage and support control of bridal creeper in the area opposite to and east of the National Park.
9. Encourage and coordinate feral animal control along the river and within the catchment.
10. Undertake a programme of bridal creeper control from Kevill Rd to the coast, involving extensive spreading of biological control agents.

Ecology

11. Instigate and support research on the effects of water level on the ecology of river pools with the objective of determining environmentally acceptable water useage during summer and autumn.

12. Encourage restoration of areas of floodplain and backwaters to restore important habitat and ecological functions. Investigate the suitability of Fishcare Funding to be used for this purpose.

13. Support the proposal for a fishway to be constructed at the Apex weir to aid upstream migration of native fish and lampreys. Encourage and support future construction of a fishway on the weir east of Bussell Highway.

14. Investigate water useage from the river from Bussell Highway to Caves Rd and seek advice from the Water and Rivers Commission regarding unlawful water use.

15. Support Department of Fisheriess recovery plan for the 'hairy' marron in the Margaret River.

Water quality

16. Promote management techniques that minimise soil erosion and nutrient loss to waterways, such as: buffer strips, soil testing and appropriate fertiliser regimes, and maximising vegetation cover on the soil.

17. Encourage the Shire of Augusta-Margaret River and the Ministry for Planning to adopt and promote water sensitive urban design guidelines.

18. Continue to support the Shire of Margaret River Clean Drains Program.

CALM and AMR Shire managed land

19. Consult with the Department of Conservation and Land Management (CALM) regarding vehicle access to the river within the National Park. It is recommended that vehicle access to the river be closed to ensure the long term protection of this A grade stretch of river. The road adjacent to the river could be maintained for pedestrian access and fire control purposes.

20. In partnership with CALM undertake an assessment of the Margaret River in State Forest, concentrating on areas used by the community for recreation and marron fishing. Develop recommendations regarding protection and restoration of these areas. Apply for funding to assist with implementation if necessary.

21. Work with the Shire of Augusta-Margaret River to improve weed control and management of foreshore reserves vested in the Shire.

22. Encourage the formation of Friends of the Margaret River groups to work with the Shire on management of foreshore reserves. Assist the groups to develop and implement management plans to protect and restore native vegetation along the river and control weeds.

Community education

23. Work with Ribbons of Blue to increase community knowledge and awareness of the Margaret River and the pressures on it.

7. River foreshore condition and recommendation for management

Maps 1 to 10 show the Margaret River and adjoining land titles from Challis Rd to the coast. The maps show the foreshore condition of the river as assessed using the Pen-Scott method (see Section 4 of this report for details of the method of assessment). Also shown on the maps are fencing status, weeds and management issues. A fold-out legend is provided.

The notes accompanying each map contain background information and management recommendations.

Figure 11 provides an index for the individual maps.


Legend
Section Break
A3
Foreshore Condition
blackberry
Weed
rabbits
Comment
203
Cadastre & Lot No
Fence (diagrammatic)

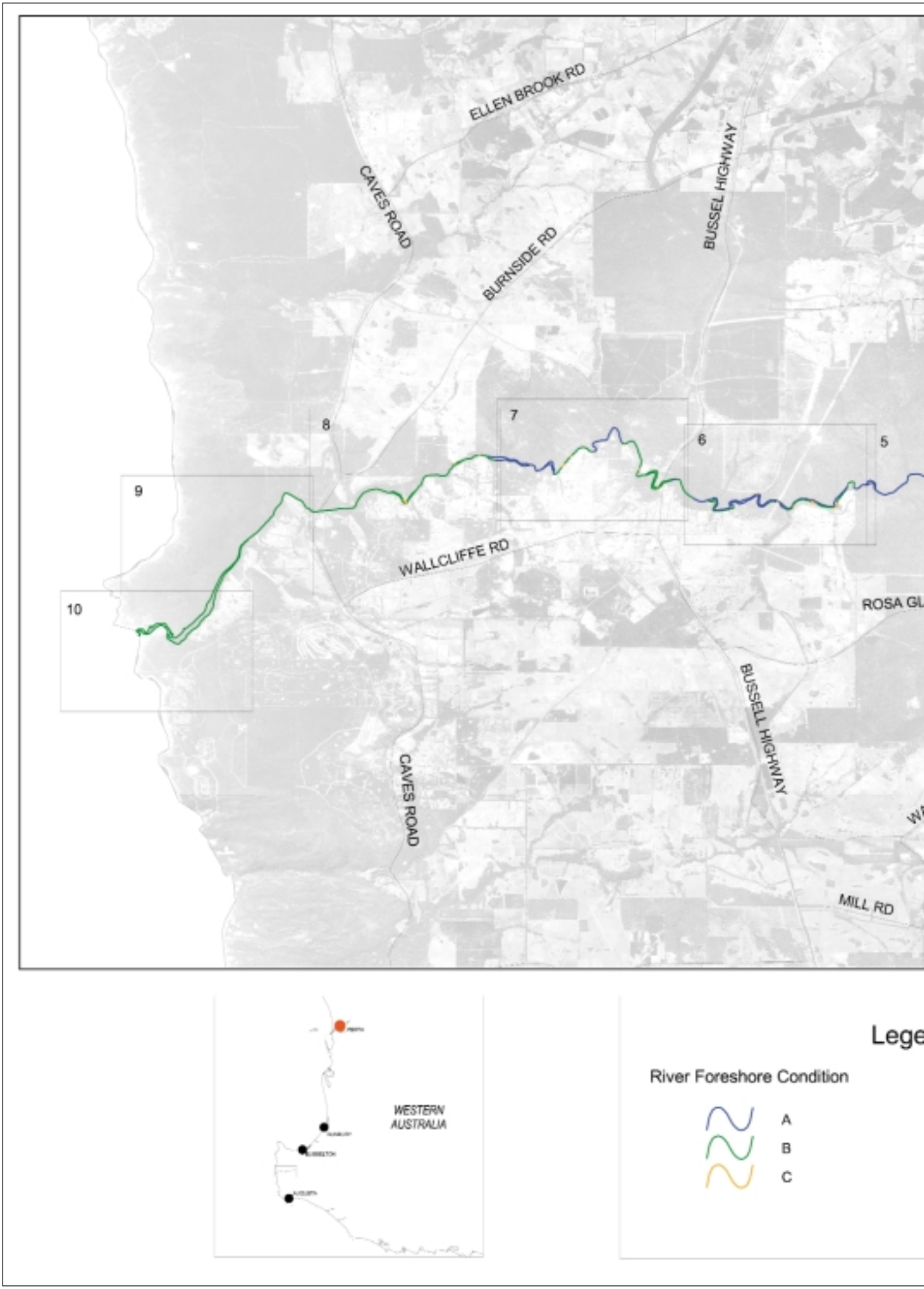


Figure 11: Index map

end

Map Extent

Major Road

1 0 1 2 3 Km

Map 1

The Margaret River leaves State Forest at Challis Rd and enters farmland. On the southern side of the river are large farming enterprises, including potato growing and grazing. On the northern side of the river there are small lots, many with vineyards and orchards. A narrow band of native fringing vegetation remains along most of the river in this section. A number of large pools exist in this area.

Issues	Comments
Fencing	Through locations 2911 and 2909 stock have access to the river though grazing is controlled in some areas through the use of a single electric wire. Regeneration of trees and tea trees within the river reserve is evident and indicates that the single electric wire is working to reduce stock pressure on the riparian zone. On location 2911 stock have access to the river for water. On location 2896 permanent fencing was constructed with some funding assistance from the Water Corporation. On location 2891, lot1 the river is fenced. On location 2889, lot 4 only a few stock are currently run and the river is in part protected through a single electric wire. Stock have access to the river for water. Locations 2300 and 2299, lot A are not fenced and have not been grazed for more than ten years.
Landform and soils	The river is located within the Treeton Fertile Flats land unit. These valley flats and floodplains have well drained red-brown and grey loamy soils. Less well drained floodplain and valley flats also exist in areas along the river. Banks are generally stable though low level erosion was evident in areas where stock have historically accessed the river.
Vegetation	Native fringing vegetation remains along most of this section of river though it is mostly in a very narrow band. Dominant species are marri (*Corymbia calophylla*), blackbutt (*E. patens*), tea trees (*Agonis linearfolia* & *Astartea fascicularis*), bullich (E. megacarpa), *Hakea lasianthoides* and numerous species of rushes and sedges.
Weeds	Blackberry is present throughout and some control is undertaken by landholders and contractors. Kikuyu is a problem on the northern bank since grazing has been controlled and is limiting regeneration of native flora. Bridal creeper is present and may be coming from the garden of the old house on location 2895. The level of infestation is currently low and some control has been undertaken by landholders. Paspalum, yorkshire fog and guildford grass are some of the other weeds in this area. The many fruit trees and vines, garden plants and non-local trees on the northern side of the river are of concern. There is the potential for some of these species to become weed problems on the river in the future.
Special features and landholder concerns	Adjacent to location 2891, lot 1 the vegetation along the river is primarily tea tree with very few trees. It is not known if this is a function of the landscape or past management practices though local knowledge indicates that fringing vegetation may have been mainly cleared here in the past. Concern was expressed regarding the difficulty of maintaining fences in areas where tea tree regenerates and grows up to and through fences. Concern was also expressed about water use from pools during summer and the effect on aquatic flora and fauna and the river ecosystem.

Map 1: Management recommendations

1. In areas where grazing is occurring fence the river to allow control of stock. See Section 6 regarding fence location.
2. Provide stock watering away from the river to minimise damage to the river and protect water quality.
3. Continue weed control.
4. Liaise with the Cape to Cape Catchments Group regarding coordinated blackberry control.
5. Monitor the river for new weed invasion and undertake control as required.
6. Assist regeneration of native vegetation and extend the riparian zone through planting of local native species. See Appendix 1 for a list of local species suitable for planting in this area. Where old stock watering points are not regenerating naturally assist regeneration with the techniques outlined in Section 6.
7. Undertake planting on the eroding creekline on location 2909 to minimise the amount of sediment being washed into the river. Sediment within the river can cause scouring and erosion and may fill river pools.

Margaret River Map 1

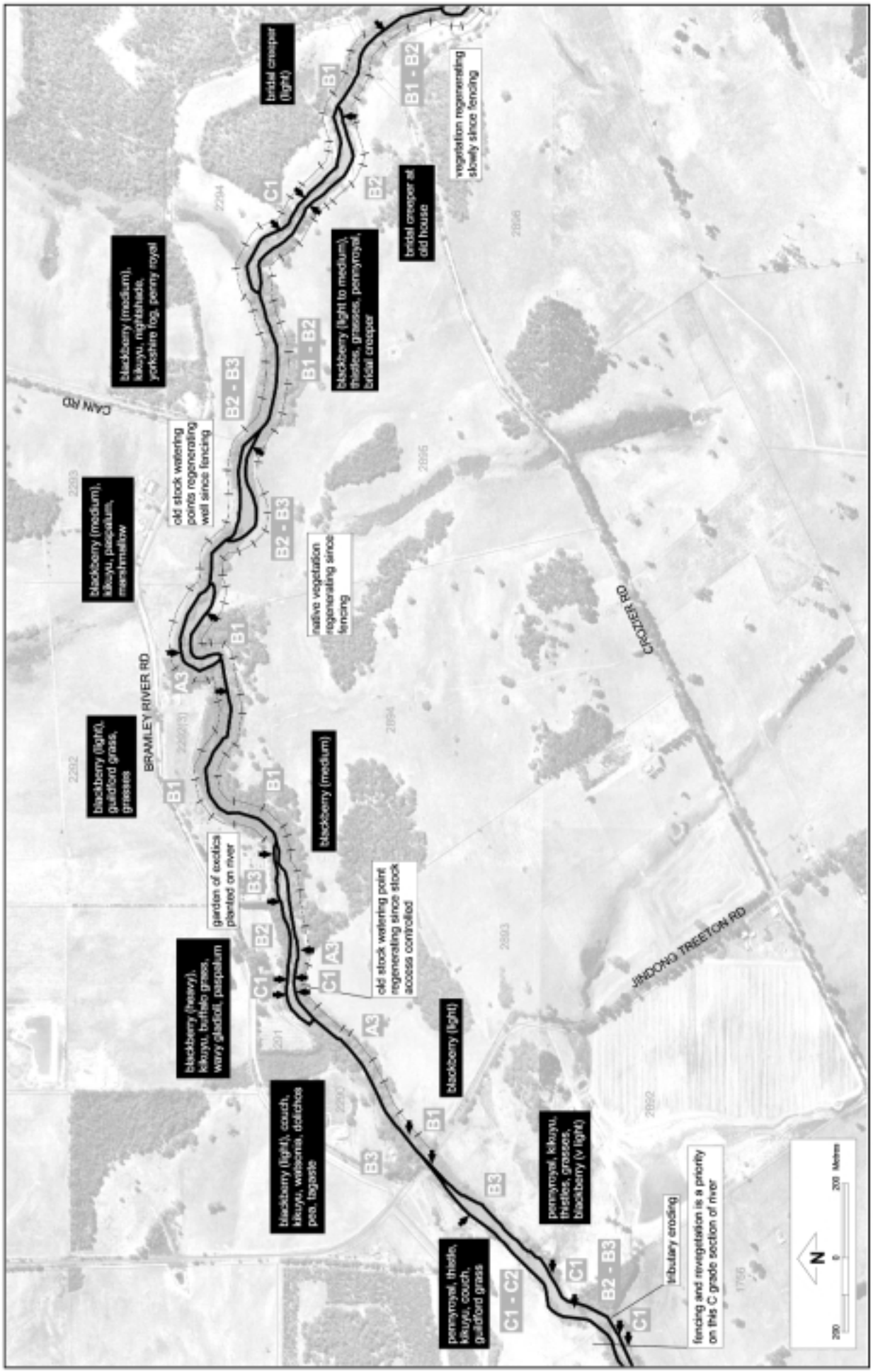
Map 2

The river continues through farmland within a narrow band of native fringing vegetation. Grazing is occurring within much of the area and vineyards and olive groves have been established on a few locations. Location 2893 has been fenced for about seventy years and contains more diversity of native vegetation than in other areas along this section of river. A number of pools exist in this area.

Issues	Comments
Fencing	Locations 2895, 2894, 2294 and 2293 have been fenced with assistance from Water Corporation funds. Location 2893 has been fenced for about seventy years, much of the fence will soon need replacing. Part of location 2292, lot 3 is fenced. Locations 2291and 2290 are both unfenced and ungrazed. Location 2892 is unfenced and ungrazed. Location 2279 is unfenced and grazed and stock have access to the river for water.
Landform and soils	The river is located within the Treeton Fertile Flats land unit. These valley flats and floodplains have well drained red-brown and grey loamy soils. Less well drained floodplain and valley flats also exist in areas along the river. Banks are generally stable though low level erosion was evident in areas where stock have historically accessed the river.
Vegetation	Native fringing vegetation remains along most of this section of river though it is mostly in a very narrow band. Dominant species are marri (*Corymbia calophylla*), blackbutt (*E. patens*), tea trees (*Agonis linearfolia* & *Astartea fascicularis*), bullich (*E. megacarpa*), *Hakea lasianthoides* and numerous species of rushes and sedges. The fringing vegetation becomes very narrow and degraded on location 2279 and 2892. On location 2292, lot 3 a small area of riparian vegetation has been cleared and a garden of exotic plants established.
Weeds	Blackberry, kikuyu, paspalum, yorkshire fog, deadly nightshade, marshmallow, wavy leaf gladioli, guildford grass, pennyroyal and couch. Watsonia, dolichos pea and tagasaste are present only on location 2290 and are being controlled by the landholder. Bridal creeper is present though the infestation is currently light.
Special features and landholder concerns	Landholders expressed concerns regarding: diminishing numbers and size of marron in the river; the problem of escaped cattle being able to access and damage unfenced vines and orchards; changes to hydrology through dam construction; water use from the river; and the difficulty of maintaining fences in areas where tea tree regenerates and grows up to and through fences.

Map 2: Management recommendations

1. In areas where grazing is occurring fence the river to allow control of stock. See Section 6 regarding fence location. Fencing to control stock access is a priority on location 2279 where the only extended area of C grade foreshore on the river exists.
2. Provide stock watering away from the river to minimise damage to the river and protect water quality.
3. Continue weed control.
4. Liaise with the Cape to Cape Catchments Group regarding coordinated blackberry control.
5. Monitor the river for new weed invasion and undertake control as required.
6. Seek advice regarding exotic plants in the riverside garden on location 2292, lot 3 to determine which ones may become future weed problems on the river. Replace potential weeds with less weedy species.
7. Assist regeneration of native vegetation and extend the riparian zone through planting of local native species. See Appendix 1 for a list of local species suitable for planting in this area. Where old stock watering points are not regenerating naturally assist regeneration with the techniques outlined in Section 6. The area between locations 2892 and 2279 is a priority for revegetation.
8. Undertake planting on the eroding creekline on location 2892 to minimise the amount of sediment being washed into the river. Sediment within the river can cause scouring and erosion and may fill river pools.



Margaret River Map 2

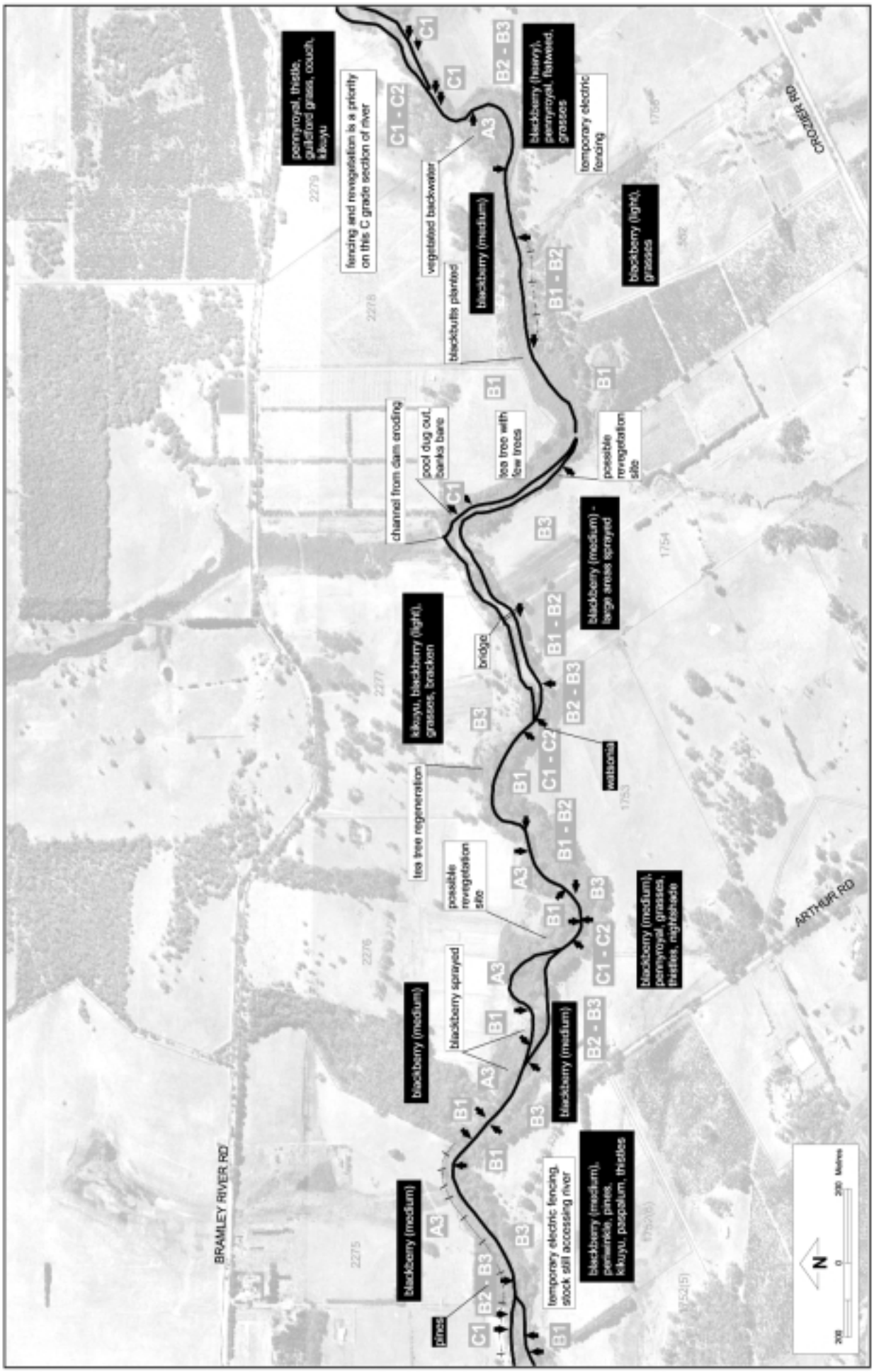
Map 3

The river continues within a broad flat valley with a wide floodplain on the southern side. There are a number of pools between long stretches of shallow, densely vegetated river channel. Native vegetation remains along most of this section although it is often very narrow. Much of the river is unfenced and continued stock access is leading to further degradation of the native fringing vegetation.

Issues	Comments
Fencing	Only locations 2275 and 552 are fenced in this section. All other locations are unfenced and grazed. In some areas stock access is controlled by temporary electric fencing. The boundary between the foreshore reserve and private land is within the floodplain, particularly on the southern side of the river. This makes fencing more difficult although it was noted that similar areas are successfully fenced further along the river.
Landform and soils	The river is located within the Treeton Fertile Flats land unit. These valley flats and floodplains have well drained red-brown and grey loamy soils. Less well drained floodplain and valley flats also exist in areas along the river. Banks are generally stable though low level erosion was evident in areas where stock have historically accessed the river. A pool has been dug out on the river on location 2278, lot 1 and the banks are bare and susceptible to erosion.
Vegetation	Native fringing vegetation remains along most of this section of river. Although a narrow band in places there are areas where the fringing vegetation including both sides of the river is 100 – 200 metres wide. Dominant species are marri (*Corymbia calophylla*), blackbutt (*E. patens*), tea trees (*Agonis linearfolia* & *Astartea fascicularis*), bullich (*E. megacarpa*), *Hakea lasianthoides* and numerous species of rushes and sedges. The fringing vegetation is very narrow on location 2279 with little or no understorey in places.
Weeds	Blackberry is a serious problem throughout much of this section. Spraying of large infestations in some areas has resulted in much damage to native vegetation and the potential for new weeds to invade before natives can regenerate to fill the space. In other areas such as locations 1753 and 1752, lot 6 no blackberry control is undertaken. Other weeds include couch, kikuyu and other grasses, thistles, nightshade and pennyroyal. An infestation of periwinkle has taken off on location 1752, lot 6 and is a priority for eradication. A few watsonia plants were sighted on location 1753.
Special features and landholder concerns	Two potential revegetation sites have been identified by the landholders of location 2276, 2277 and 1754. Concerns were expressed regarding water use and the impact on the river ecosystem.

Map 3: Management recommendations

1. In areas where grazing is occurring fence the river to allow control of stock, including horses. It is acknowledged that fencing on the floodplain is prone to damage. However it was noted during the foreshore surveys that the river was successfully protected from stock access through fencing on the floodplain on locations 1749 and 1751. See Section 6 regarding fence location.
2. Provide stock watering away from the river to minimise damage to the river and protect water quality.
3. Seek Water and Rivers Commission advice about the pool that has been dug out on the river on location 2278 (1). The banks are bare and susceptible to erosion and should be revegetated.
4. Control, as a priority, the periwinkle on location 1752, lot 6 and the watsonia on location 1753. Control now will prevent a much bigger problem developing.
5. Liaise with the Cape to Cape Catchments Group regarding coordinated blackberry control. No blackberry control is undertaken on some locations such as 1753 and 1752, lot 6 and it is important these areas are included in the blackberry control program.
6. Monitor the river for new weed invasion and undertake control as required.
7. Assist regeneration of native vegetation and extend the riparian zone through planting of local native species. See Appendix 1 for a list of local species suitable for planting in this area. Where old stock watering points are not regenerating naturally assist regeneration with the techniques outlined in Section 6.



Margaret River Map 3

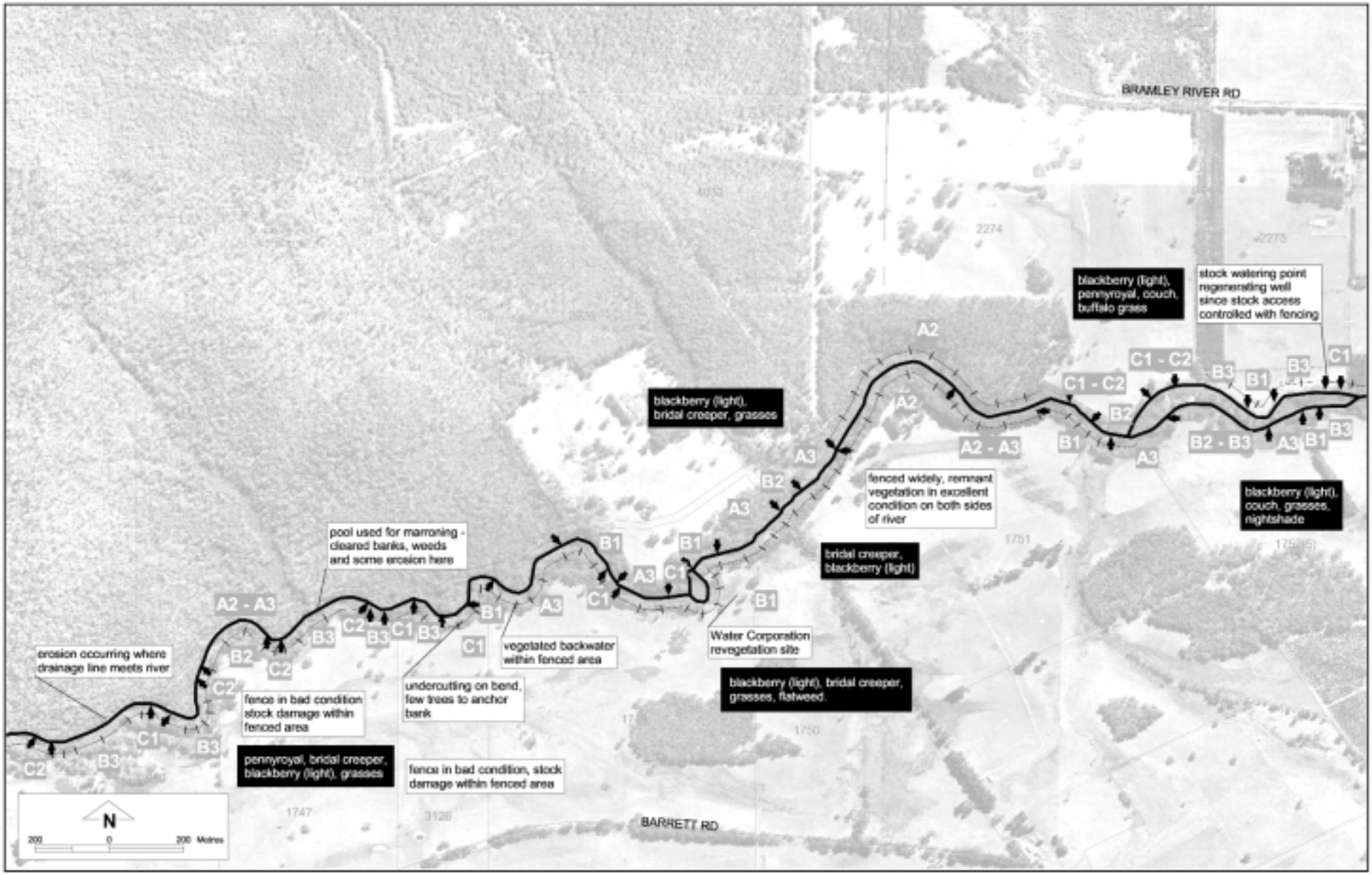
Map 4

The river continues within a broad flat valley with a wide floodplain on the southern side and hills on the north. The river enters National Park on the northern side of the river. Farming land is used for grazing. Part of this section is vegetated river channel and has therefore been protected by the fencing that was required to ensure stock didn't escape through the dry river channel in summer. In places this vegetation is in excellent condition and wide enough to provide a buffer from weeds.

Issues	Comments
Fencing	Locations 2275, 1751, 1750, 1749 and most of location 2274, lot 2 are fenced. Location 1752, lot 5 is unfenced and currently grazed. Location 2926 is unfenced and ungrazed. Locations 3126, 1747 and 950 are fenced though the fence is in bad condition and stock damage is evident within the fenced foreshore area.
Landform and soils	The river moves from the Treeton Fertile Flats land unit to the Wilyabrup Fertile Flats land unit in this section. The river is contained within well drained valley flats and floodplains with deep alluvial soils, often red-brown loams, or less well drained floodplain and valley flats. Banks are generally stable though low level erosion was evident in areas where stock have historically accessed the river.
Vegetation	Through the National Park and locations 1751, and much of 2274, lot 2 native fringing vegetation remains in excellent condition. In other locations stock has damaged the native vegetation though regeneration is occurring in areas where stock access is controlled. Continued stock access on locations 3126, 1747 and 950 is leading to further degradation of the native fringing vegetation. Dominant species are marri (*Corymbia calophylla*), blackbutt (*E. patens*), tea trees (*Agonis linearfolia* & *Astartea fascicularis*), bullich (*E. megacarpa*), *Hakea lasianthoides* and numerous species of rushes and sedges.
Weeds	Blackberry is much less of a problem in this area although still present. There was some evidence of early bridal creeper infestations on locations 1751, 1749, 1747 and 2926. Control of these small infestations is a priority before a much bigger problem develops, particularly as the area is adjacent to the National Park.

Map 4: Management recommendations

1. In areas where grazing is occurring fence the river to allow control of stock. See Section 6 regarding fence location. On locations 3126, 1747 and 950 undertake fence maintenance and exclude stock from the riparian zone.
2. Provide stock watering away from the river to minimise damage to the river and protect water quality.
3. Liaise with the Cape to Cape Catchments Group regarding coordinated blackberry control. Blackberry control in this area is a priority due to the proximity to the National Park and the fact that most infestations are still at a manageable size.
4. Control bridal creeper before the infestations become too large to deal with. Control of bridal creeper in this area is a priority.
5. Monitor the river for new weed invasion and undertake control as required.
6. Assist regeneration of native vegetation and extend the riparian zone through planting of local native species. See Appendix 1 for a list of local species suitable for planting in this area. Where old stock watering points are not regenerating naturally assist regeneration with the techniques outlined in Section 6.
7. Seek advice from Water and Rivers Commission engineers regarding the erosion within the National Park, marked on the map.



Margaret River Map 4

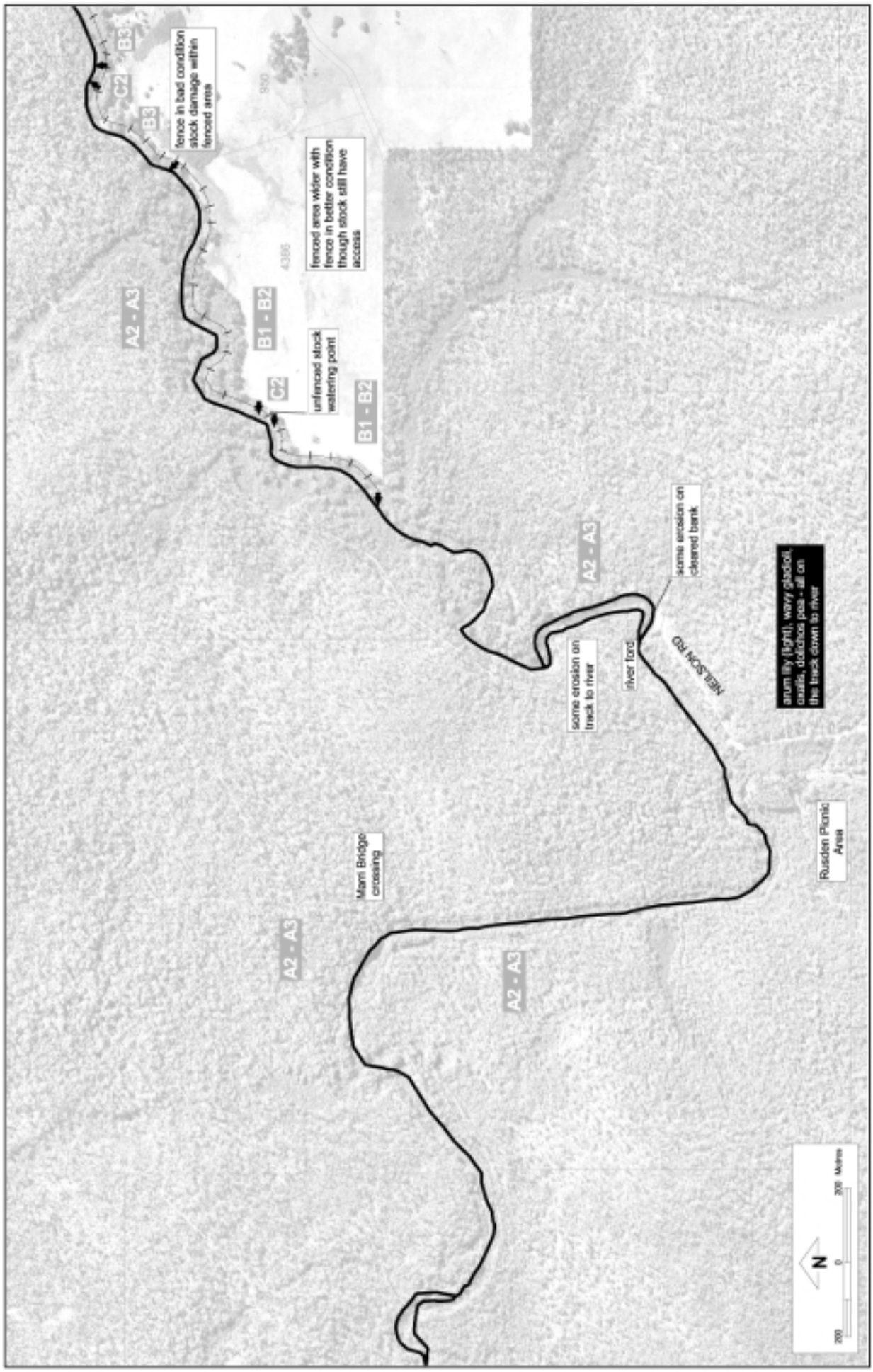
Map 5

The river is within National Park for most of this section. Healthy and diverse native vegetation is found here with minimal weed infestation. Part of the southern side of the river is within farmland and stock access in this area is resulting in on-going degradation to the riparian vegetation.

Issues	Comments
Fencing	Locations 950 and 4386 are fenced. However, the fence is in poor condition and there is stock damage within the riparian zone. A stock watering point remains unfenced on location 4386.
Landform and soils	The river is located within the Wilyabrup Fertile Flats land unit in the Wilyabrup Valleys land system. These well drained valley flats and floodplains have deep alluvial soils, often red-brown loams. Less well drained floodplain and valley flats also exist in areas along the river. Banks are generally stable though low level erosion was evident in areas where stock have historically accessed the river. A creek feeding into the river on location 950 is eroding.
Vegetation	The band of fringing vegetation is very narrow in places on locations 950 and 4386. The vegetation along the remainder of the river in this section is diverse and healthy. Dominant species are marri (*Corymbia calophylla*), blackbutt (*E. patens*), tea trees (*Agonis linearfolia* & *Astartea fascicularis*), bullich (*E. megacarpa*), *Hakea lasianthoides* and numerous species of rushes and sedges.
Weeds	There are light infestations of blackberry and bridal creeper in this area. Pennyroyal is also present. Near Rusden Picnic Site there is arum lily, wavy gladioli and dolichos pea.
Special features	There is a walking bridge and a ford across the river in this section linked up with walking tracks through the National Park.

Map 5: Management recommendations

1. On locations 950 and 4386 undertake fence maintenance and exclude stock from the riparian zone.
2. Provide stock watering away from the river to minimise damage to the river and protect water quality.
3. Liaise with the Cape to Cape Catchments Group regarding coordinated blackberry control. Blackberry control in this area is a priority due to the proximity to the National Park and the fact that most infestations are still at a manageable size.
4. Control bridal creeper before the infestations become too large to deal with. Control of bridal creeper in this area is a priority.
5. Monitor the river for new weed invasion and undertake control as required.
6. Assist regeneration of native vegetation and extend the riparian zone through planting of local native species. See Appendix 1 for a list of local species suitable for planting in this area. Where old stock watering points are not regenerating naturally assist regeneration with the techniques outlined in Section 6



Margaret River Map 5

Map 6

The river continues through National Park on the northern side. On the southern bank it re-enters farmland and then a residential area. Darch Brook joins the river in this section. Subdivision development is currently occurring west of Darch Brook adjacent to the river. Two weirs in this area created dams to provide the town water supply before the construction of Ten Mile Dam. West of Darch Brook the river is contained within a narrow v-shaped valley rather than the broad valley flats and floodplains to the east.

Issues	Comments
Fencing	Locations 2144 and 2143 are unfenced and stock have access to the river. The remainder of this section is unfenced and ungrazed.
Landform and soils	In this section the river moves from the Wilyabrup Fertile Flats land unit to the Wilyabrup Valleys. The Wilyabrup Fertile Flats are valley flats and floodplains with deep alluvial soils, often red-brown loams. The Wilyabrup Valleys are narrow v-shaped drainage depressions. Banks are generally stable throughout this section. Low level erosion is evident at a pool on the north bank and on a track on the south bank off Barret Street.
Vegetation	Native vegetation has become degraded on locations 2144 and 2143. Protection of remaining vegetation from stock grazing and trampling would allow natural regeneration to occur. Healthy and diverse native vegetation occurs in the remainder of this section, except on the southern bank between the eastern weir and the caravan park.
Weeds	Kikuyu, thistles and some blackberry at locations 2143 and 2144. Kikuyu, arum lily, wavy gladioli, lovegrass and nasturtium are found on the southern bank, west of the second weir.
Special features and points of interest	The raising of the weir to increase the water level resulted in tree deaths and the loss of agricultural land on locations 2144 and 2143. A small section of river at the caravan park is totally cleared and planted with lawn. There are two weirs in this area. The western weir presents an obstacle to native fish and lamprey migrating upstream.

Map 6: Management recommendations

1. Fence the river on locations 2144 and 2143 to control stock access to this area. Exclusion of stock will allow natural regeneration. Further grazing will significantly reduce the chances of successful natural regeneration in the future.
2. Provide stock watering away from the river to minimise damage to the river and protect water quality.
3. Liaise with the Cape to Cape Catchments Group regarding coordinated blackberry control.
4. Monitor the river for new weed invasion and undertake control as required.
5. Assist regeneration of native vegetation and extend the riparian zone through planting of local native species and other techniques outlined in Section 6. See Appendix 1 for a list of local species suitable for planting in this area. Where old stock watering points are not regenerating naturally assist regeneration with the techniques outlined in Section 6.
6. Liaise with the AMR Shire and local residents regarding weed control and revegetation on the south bank west of the eastern weir (CCCG).
7. Encourage the Shire of Augusta-Margaret River and the Ministry for Planning to adopt and promote water sensitive urban design guidelines (CCCG).
8. Continue with support for the implementation of the Clean Drains Program (CCCG).
9. Support the proposal for a fishway to be constructed at the western weir to aid upstream migration of native fish and lampreys (CCCG).

Margaret River Map 6

Map 7

Land use adjoining the river changes from agricultural to residential and Special Rural. National Park continues on the northern bank and the river is also within Shire reserves either side of Bussell Highway. Most of this section of river retains a diverse and reasonably wide band of native fringing vegetation. Weeds are a problem within the town where there are many different garden escapees growing along the river.

Issues	Comments
Fencing	Unfenced and ungrazed. Horse riding occurs along the river in the area that already has a degraded, narrow band of riparian vegetation.
Landform and soils	Most of the river through this section is contained within a narrow v-shaped valley with deep alluvial soils, often red-brown loams. In the area between Bussell Highway and lot 43 there is an area of broader valley flats. Throughout this section there are areas of shallow rocky soils with some granitic outcrops. Banks are generally stable.
Vegetation	Much of the river retains a diverse and reasonably wide band of riparian vegetation in this section. An area of very narrow fringing vegetation does exist on the southern bank and can be seen clearly on the map. Karri (*Eucalpytus diversicolor*) is present in the eastern half. Vegetation is generally jarrah (E*ucalyptus marginata*), marri (*Corymbia calophylla*) and peppermint (*Agonis flexuosa*) forest. Heathland dominated by *Darwinia citriodora, Hakea trifurcata* and *Kunzea* spp. is found in the areas of shallow rocky soil with granitic outcrops.
Weeds	A large variety of garden escapees are present either side of Bussell Highway. They include watsonia, dolichos pea, bridal creeper, pittosporum, nasturiums, periwinkle, arum lily, pines and roses. In front of the lot to the east of lot 43 there are a number of weeds, including figs, lillypilly, gooseberry and blackberry. In the area where the fringing vegetation is very narrow there is blackberry, wavy gladioli, kikuyu, guildford grass and a number of garden escapees. A garden very close to the river within this area is of concern in relation to future garden escapees.
Special features and points of interest	The Margaret River Regional Environment Centre (MRREC) is currently working with the Shire to manage A class reserve A18720 on the corner of Bussell Highway and Carters Rd. Weed control and planting is being undertaken. The Apex weir is located on the river within reserve A18720. This weir presents an obstacle to native fish and lamprey migrating upstream. A proposal for a fishway is currently being considered by WRC, AMR Shire and the MRREC. Rapids and cascades are present in this section of river. A couple of tributaries join the river from the south in this section. In front of lot 43 Illawarra Avenue an area of foreshore reserve has been cleared.

Map 7: Management recommendations

1. Support the MRREC in the management of reserve A18720 and encourage extending this work to the east of Bussell Highway (CCCG).
2. Liaise with the landholder on the lot east of lot 43 regarding control of weeds on the foreshore in this area (CCCG).
3. Encourage the AMR Shire and the Ministry for Planning to adopt and promote water sensitive urban design guidelines(CCCG).
4. Continue with support for the implementation of the Clean Drains Program (CCCG).
5. Support the proposal for a fishway to be constructed at the Apex weir to aid upstream migration of native fish and lampreys (CCCG).
6. Coordinate planting of local native plants and weed control in the area where the fringing vegetation is degraded and narrow. Points to consider include consultation with adjoining landholders and access for horse riders (CCCG).
7. Consult with the AMR Shire and landholders of lot 43 Illawarra Rd regarding clearing within the foreshore reserve (CCCG).

Margaret River Map 7

Map 8

The river leaves the National Park and continues through land mainly zoned Special Rural. The narrow river valley is deep with steep sided slopes in places. Rapids and cascades are a feature of this section of river. Weeds, particularly arum lily and bridal creeper, become an increasingly dominant component of the vegetation west of the old horse ford.

Issues	Comments
Fencing	Grazing does not occur throughout this section, some parts of the river are fenced.
Landform and soils	The river is contained within a narrow v-shaped valley with deep alluvial soils, often red-brown loams. The narrow river valley is deep with steep slopes in places. Throughout this section there are areas of shallow rocky soils with some granitic outcrops. Banks are generally stable. Some erosion is occurring at a stock watering point at the waterfall.
Vegetation	Native fringing vegetation is more degraded in this section. Some areas have little understorey and weeds become more dominant. Vegetation is generally jarrah (*Eucalyptus marginata*), marri (*Corymbia calophylla*) and peppermint (*Agonis flexuosa*) forest. Heathland dominated by *Darwinia citriodora*, *Hakea trifurcata* and *Kunzea* spp. is found in the areas of shallow rocky soil with granitic outcrops.
Weeds	Light blackberry infestations, guildford grass, wavy gladioli, thistles, apple of Sodom and grasses. There is watsonia in a couple of areas, including in front of the vineyard on Kevill Rd. Arum lily is light until the old horse ford and from there on arum lily and bridal creeper become very dense in places. There is a very heavy bridal creeper infestation on the north of the river. Just to the east of Caves Rd the foreshore is dominated by a variety of weeds that have come from the adjacent garden.
Special features and points of interest	Rapids and cascades are present in this section of river. An information session was held on this section of river on October 26th 2002. Special rural landholders in the area were invited. It was agreed at the meeting that a 'Friends of' group could be formed to work with the Shire to undertake revegetation and weed control in this area. Concern has been expressed about water use from the river in this area. There are many pumps along this section of river. No licences are allocated in this area and although adjacent properties have riparian rights to water it is illegal to use water for anything other than domestic use, stock water and garden.

Map 8: Management recommendations

1. Weed control and revegetation need to be undertaken to protect and restore this section of river. A revegetation and weed control strategy should be developed with the community and the AMR Shire. The objective should be to increase the width and diversity of local native vegetation. Priority should be given to protecting areas of A grade foreshore and dealing firstly with areas that are lightly infested with weeds. Horse riding should be taken into consideration when planning revegetation as the area is popular with riders (CCCG).
2. Biological control agents for bridal creeper to be introduced and spread widely throughout this section on both sides of the river (CCCG).
3. Revegetation on the northern bank at the old horse ford is required to protect the banks from erosion. Horse riders using the area, and community members living in the area should be involved in planning and implementing this work if possible (CCCG).
4. Fence the remainder of the river on location 412 to control stock access to this area. Provide alternative stock watering to minimise damage to the river and protect water quality.
5. Control weeds (garden escapees) and undertake revegetation on the foreshore directly east of Caves Rd (CCCG with landholders).

Margaret River Map 8

Map 9

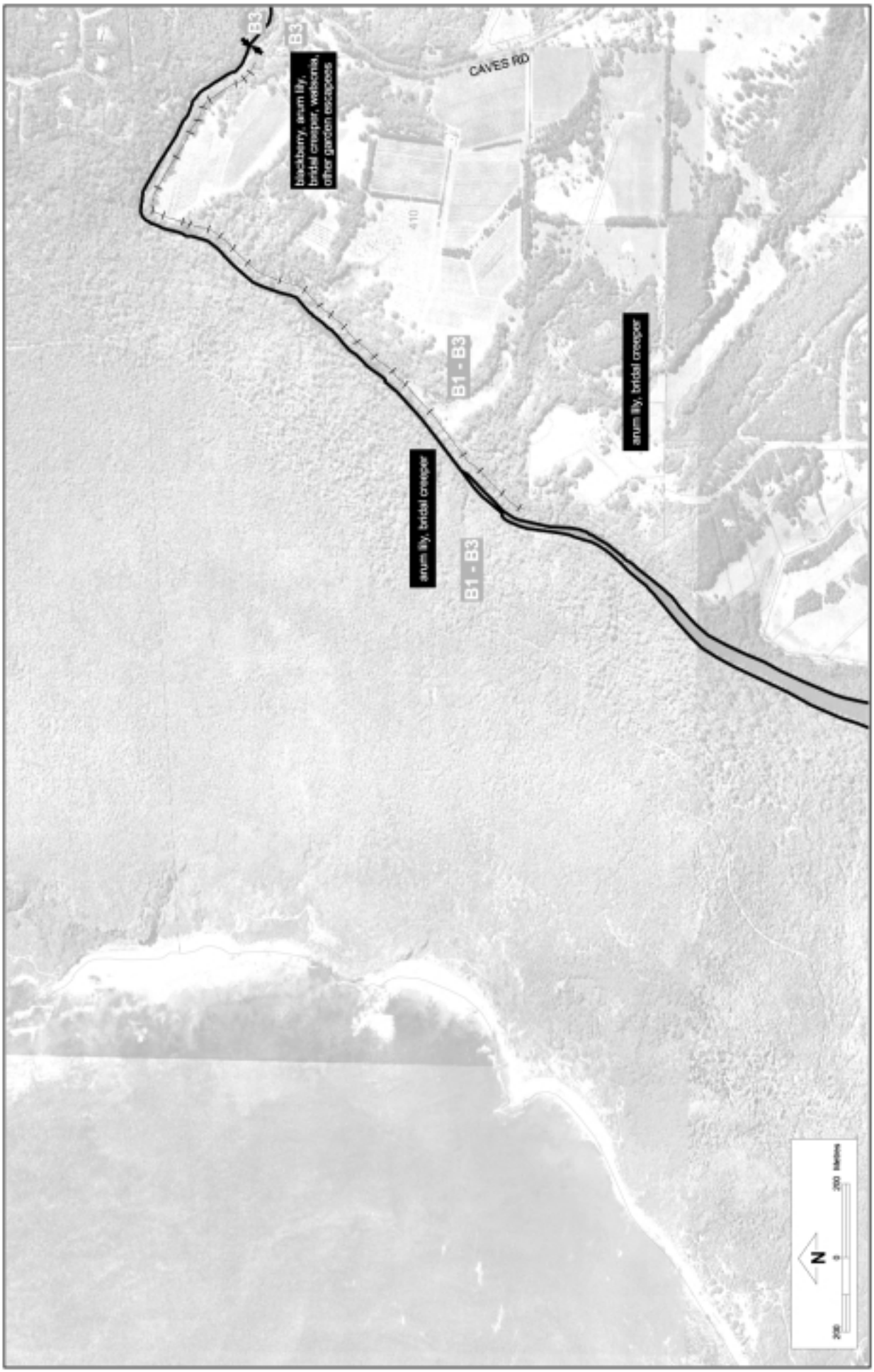
West of Caves Road the river channel becomes quite narrow and heavily vegetated. It meanders sharply south-west and gradually broadens out into a river form estuary[6]. The river enters the Leeuwin-Naturaliste Ridge on the north-western side whilst still within the Wilyabrup Valleys land system on the south-east. Moderate slopes exist on the north-west within an area of public bushland. The other side of the river is mainly cleared but the river itself retains a buffer of wetland and riparian vegetation along most of its length. Arum lily and bridal creeper are a problem throughout this area.

Issues	Comments
Fencing	The river is ungrazed throughout this section. Location 410 is fenced.
Landform and soils	The river continues within the Wilyabrup Valleys land system with alluvial soils, yellow-brown duplex soils and red-brown gravelly gradational soils. North-west of the river is within the Gracetown Ridge land system (yellow-brown siliceous sands over limestone).
Vegetation	*Melaleuca* spp. dominant the fringing vegetation throughout this section.
Weeds	Blackberry, watsonia and other garden escapees exist west of Caves Rd. Further along arum lily and bridal creeper are widespread and very dense in places.

Map 9: Management recommendations

1. Biological control agents for bridal creeper to be introduced and spread widely throughout this section on both sides of the river (CCCG).
2. Weed control and revegetation need to be undertaken to protect and restore this section of river. A revegetation and weed control strategy should be developed with the community and the AMR Shire. The objective should be to increase the width and diversity of local native vegetation. Priority should be given to protecting areas of good quality foreshore and dealing firstly with areas that are lightly infested with weeds (CCCG).

[6] Estuaries occur at the mouth of rivers where they broaden into the sea and within which the tide ebbs and flows, leading to an intermixing of saline and fresh water. River form estuaries have no sizeable lagoons and more or less discharge directly to the ocean.



Margaret River Map 9

Map 10

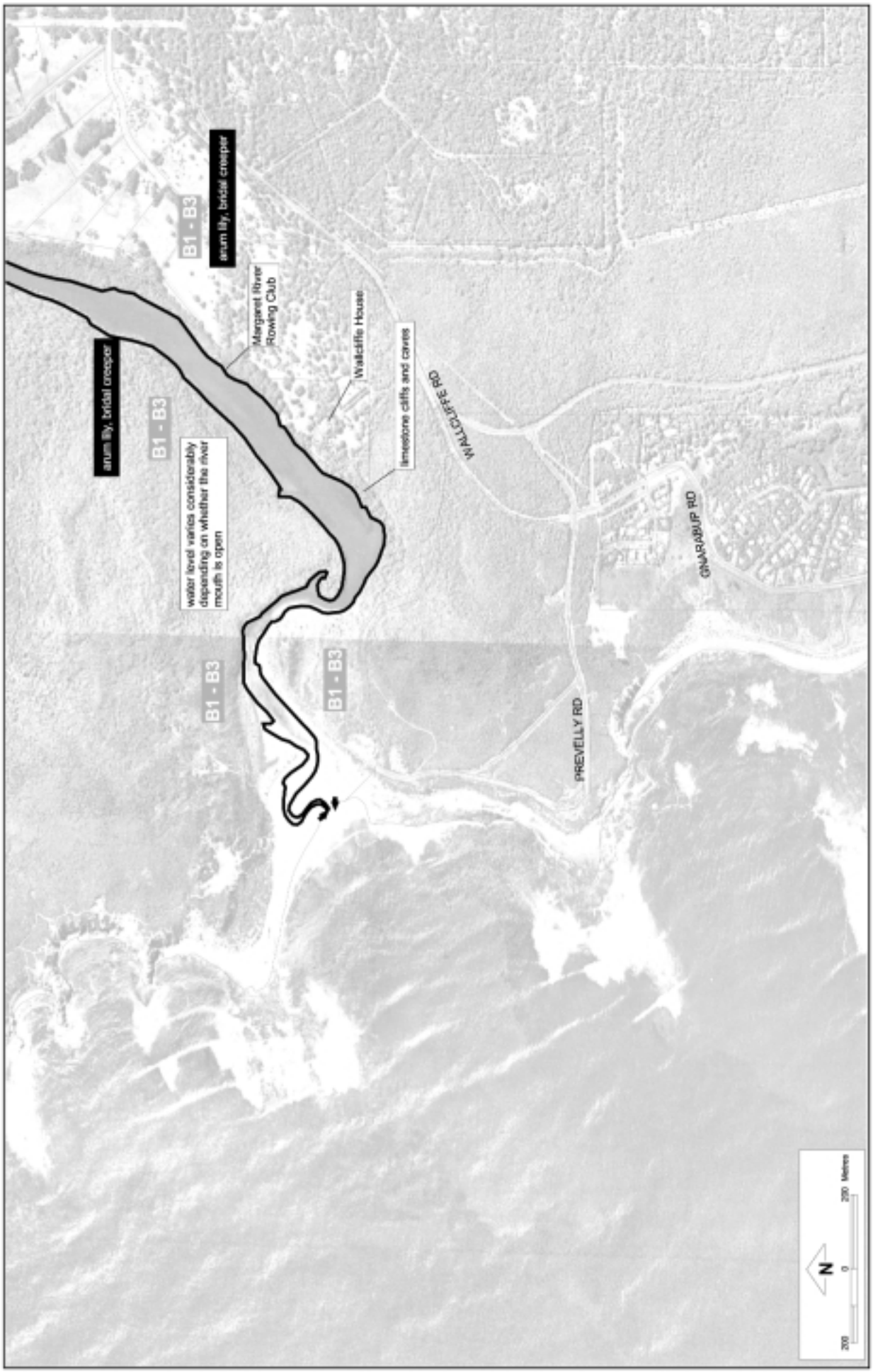
The river broadens out into a small lagoon and is quite shallow throughout most of this section. It then twists around a headland to connect to the ocean. On the north-west is public bushland. On the south-east is a Special Rural development, the historic Wallcliffe House and the Margaret River Rowing Club. Arum lily and bridal creeper continue to be a problem throughout this section.

Issues	Comments
Fencing	Unfenced and ungrazed.
Landform and soils	The last part of the river through the Leeuwin-Naturaliste Coast is within the Gracetown Ridge land system and the Kilcarnup Dunes land system. Soils are brownish-yellow siliceous sands and calcareous sands.
Vegetation	*Melaleuca* spp., marri (*Corymbia calophylla*), peppermints (*Agonis flexuosa*) with a variety of rushes and sedges.
Weeds	Arum lily and bridal creeper throughout this section.
Special features and points of interest	The water level in the estuary varies considerably depending on whether the mouth of the river is open. Opening of the river mouth by people digging a channel in the sand bar is a problem. Limestone cliffs west of Wallcliffe House are a feature in this section.

Map 10: Management recommendations

1. Biological control agents for bridal creeper to be introduced and spread widely throughout this section on both sides of the river (CCCG).

2. Weed control and revegetation need to be undertaken to protect and restore this section of river. A revegetation and weed control strategy should be developed with the community and the AMR Shire. The objective should be to increase the width and diversity of local native vegetation. Priority should be given to protecting areas of good quality foreshore and dealing firstly with areas that are lightly infested with weeds (CCCG).



Margaret River Map 10

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Appendix 1: Species lists for the Margaret River

			Location				
Habit	Species	Common name	1	2	3	4	5
Shrub	*Acacia alata ssp. alata*	Winged Wattle	✗		✗		
Shrub	*Acacia divergens*		✗		✗		
Shrub	*Acacia extensa*	Wiry Wattle	✗		✗		
Shrub	*Acacia gilbertii*		✗		✗		
Shrub	*Acacia latericola*		✗		✗		
Shrub	*Acacia myrtifolia*		✗		✗		
Shrub	*Acacia pulchella*	Prickly Moses	✗	✗	✗	✗	✗
Shrub	*Acacia uliginosa*	Tail-leaved Acacia	✗		✗		
Shrub	*Acacia urophylla*	Net-leaved Wattle	✗	✗	✗		
Shrub	*Adenanthos barbigera*				✗		
Tree	*Agonis flexuosa*	Peppermint	✗	✗	✗	✗	✗
Tall shrub	*Agonis linearifolia*	Swamp Peppermint	✗		✗		
Tall shrub	*Agonis parviceps*	Fine Tea tree	✗				
Herb	*Agrostocrinum stypandroides*	False Blind Grass	✗		✗		
Shrub	*Allocasuarina humilis*	Dwarf Sheoak					✗
Rush	*Anarthria prolifera*		✗				
Herb	*Anigozanthus flavidus (red form)*	Tall Kangaroo Paw, Evergreen Kangaroo Paw	✗		✗		
Shrub	*Astartea fascicularis*		✗				
Tree	*Banksia grandis*	Bull Banksia	✗		✗		
Tree	*Banksia littoralis*	Swamp Banksia			✗		
Climber	*Billardiera candicans*		✗		✗		
Climber	*Billardiera floribunda*		✗		✗		
Climber	*Billardiera variifolia*		✗		✗		
Shrub	*Boronia fastigiata*	Bushy Boronia	✗		✗		
Shrub	*Boronia gracilipes*	Karri Boronia		✗			
	Bossiaea eriocarpa		✗		✗		
Shrub	*Bossiaea linophylla*		✗	✗	✗		✗
Shrub	*Bossiaea ornata*	Broadleaved Brown Pea	✗		✗		
Shrub	*Bossiaea rufa*		✗		✗		
	Brachysema celsiana		✗		✗		
Herb	*Burchardia umbellata*	Milkmaids			✗		
Tall shrub	*Callistachys lanceolata*	Native Willow	✗	✗	✗	✗	
Parasitic herb and climber	*Cassytha racemosa*	Dodder Laurel	✗	✗	✗		
Herb	*Chamaescilla corymbosa*	Blue Squill	✗		✗		
Shrub	*Chorizema nanum*						✗
Climber	*Clematis pubescens*	Common Clematis, Old Man's Beard	✗	✗			
Shrub	*Comesperma confertum*				✗		

			Location				
Habit	Species	Common name	1	2	3	4	5
Tree	*Corymbia calophylla*	Marri	✗	✗	✗		✗
Herb	*Dampiera hederacea*	Karri Dampiera, Ivy-leaved Dampiera	✗	✗			
Herb	*Dampiera trigona*	Angle-stemmed Dampiera	✗		✗		
Shrub	*Darwinia citriodora*	Lemon-scented Darwinia			✗	✗	
Tree-like perennial	*Dasypogon hookeri*	Pineapple Bush	✗		✗		
Herb	*Dichondra repens*	Kidney Weed					✗
Herb	*Drosera macrantha*	Bridal Rainbow					
Tree	*Eucalyptus diversicolor*	Karri		✗			
Tree	*Eucalyptus marginata*	Jarrah	✗		✗		
Tree	*Eucalyptus megacarpa*	Bullich	✗				
Tree	*Eucalyptus patens*	Blackbutt	✗				
Herb	Gompholobium *polymorphum*				✗		
Shrub	*Grevillea brachystylis*		✗				
Shrub	*Grevillea diversifolia*		✗		✗		
Shrub	*Grevillea manglesiodes*		✗		✗		
Shrub	*Grevillea trifida*		✗		✗		
Shrub	*Hakea amplexicaulis*	Prickly Hakea	✗		✗		
Small tree	*Hakea lasianthoides*	Woolly-flowered Hakea	✗				
Shrub	*Hakea linearis*		✗		✗		
Shrub	*Hakea lissocarpha*	Honeybush	✗		✗	✗	
Shrub	*Hakea ruscifolia*	Candle-spike Hakea	✗		✗		
Shrub	*Hakea trifurcata*	Two-leaf Hakea	✗		✗	✗	
Climber	*Hardenbergia comptoniana*	Native Wisteria	✗	✗			✗
Shrub	*Hibbertia cuneiformis*	Cutleaf Hibbertia	✗	✗			✗
Shrub	*Hibbertia cunninghamii*		✗		✗		
Shrub	*Hibbertia hypericoides*	Yellow Buttercups	✗		✗		✗
Shrub	*Hovea chorizemifolia*	Holly-leaved Hovea	✗		✗		
Shrub	*Hovea elliptica*	Tree Hovea	✗	✗	✗		✗
Shrub	*Hypocalymma cordifolium*		✗				
Herb	*Johnsonia lupulina*	Hooded Lily	✗		✗		
Rush	*Juncus kraussii*	Sea Rush					✗
Climber	*Kennedia coccinea*	Coral Vine	✗		✗		✗
Shrub	*Kennedia prostrata*	Scarlet Runner, Running Postman	✗		✗		
Grass tree	*Kingia australis*		✗				
Shrub	*Kunzea recurva*					✗	
Sedge	*Lepidosperma effusum*	Spreading Sword Sedge	✗	✗	✗		✗
Sedge	*Lepidosperma squamatum*		✗	✗	✗		
Sedge	*Lepidosperma tetraquetrum*	Square Sedge	✗	✗	✗		
Shrub	*Leucopogon australis*	Spiked Beard-heath	✗	✗	✗		
Shrub	*Leucopogon capitellatus*		✗		✗		

			Location				
Habit	Species	Common name	1	2	3	4	5
Shrub	*Leucopogon propinquus*		✗		✗		✗
Shrub	*Leucopogon verticillatus*	Tassel Flower	✗	✗	✗		✗
Herb	*Lobelia alata*	Angled Lobelia					✗
Shrub	*Logania vaginalis*	White Spray	✗		✗		✗
Herb	*Lomandra drummondii*		✗		✗		
Herb	*Lomandra pauciflora*			✗	✗		
	Macrozamia reidlei	Zamia Palm	✗	✗	✗		✗
Rush	*Meeboldina* spp.	Velvet Rush	✗	✗	✗		
Shrub	*Melaleuca incana*		✗				
Tree	*Melaleuca rhaphiophylla*	Swamp Paperbark					✗
Sedge	*Mesomelaena tetragona*	Semaphore Sedge	✗		✗		
Shrub	*Mirbelia dilatata*	Holly-leaved Mirbelia	✗	✗	✗		
Herb	*Opercularia hispidula*		✗	✗	✗		✗
Herb	*Patersonia occidentalis*	Purple Flags	✗		✗		✗
Herb	*Patersonia umbrosa*	Yellow Flags	✗		✗		
Small tree	*Persoonia elliptica*	Spreading Snottygobble	✗		✗		
Small tree	*Persoonia longifolia*	Snottygobble	✗		✗		
Shrub	*Petrophile diversifolia*		✗		✗		
Shrub	*Philotheca spicata*	Pepper and Salt	✗		✗		
Shrub	*Phyllanthus calycinus*	False Boronia	✗	✗	✗		
Shrub	*Pimelea rosea*				✗		✗
Shrub	*Pimelea spectabilis*	Bunjong	✗		✗		
Shrub	*Podocarpus drouynianus*	Emu Plum, Wild Plum, Koolah	✗				
Shrub	*Ricinocarpos glaucus*	Wedding Bush			✗		
Herb	*Scaevola microphylla*	Small-leaved Scaevola	✗	✗	✗		✗
Herb	*Scaevola calliptera*			✗	✗		
Shrub	*Sollya heterophylla*	Australian Bluebell		✗	✗		✗
Herb	*Sowerbaea laxiflora*	Purple Tassels, Vanilla Lily					✗
Shrub	*Spyridium globulosum*	Basket Bush					✗
Herb	*Stylidium breviscapum*		✗	✗	✗		
Herb	*Stylidium spathulatum*	Creamy Trigger Plant	✗	✗	✗		
Rush	*Taraxis grossa*		✗	✗	✗		
Shrub	*Thomasia paniculata*		✗		✗		
Shrub	*Thomasia pauciflora*		✗		✗		
Herb	*Thysanotus patersonii/ manglesianus*	Twining Fringe Lily	✗		✗		
Herb	*Tremandra diffusa*			✗	✗		
Shrub	*Tremandra stelligera*			✗	✗		
Herb	*Trichlocline spathulata*	Native Gerbera	✗		✗		
	Trymalium floribundum ssp. *floribundum*			✗	✗		
Shrub	*Trymalium floribundum* ssp. *trifidum*	Karri Hazel, Soapbush		✗	✗		

			Location				
Habit	Species	Common name	1	2	3	4	5
Shrub	*Trymalium ledifolium*			✗	✗		
Shrub	*Viminaria juncea*	Swish Bush	✗		✗		
	Xanthorrhoea gracilis		✗		✗		✗
Grasstree	*Xanthorrhoea preissii*	Grasstree, Balga	✗		✗		✗

Key to locations

1. Jarrah-marri forest east of town with blackbutt, bullich and *Hakea lasianthoides*.
2. Karri forest within town.
3. Marri-jarrah forest with peppermint between town and Caves Rd.
4. Heathlands on shallow rocky soils and granite outcrops with *Kunzea* spp., *Darwinia citriodora* and *Hakea trifurcata* – mainly between Bussell Highway and the coast.
5. Melaleuca woodland towards the coast.

Appendix 2: Planning advice from the Vasse River Action Plan

The following planning advice is taken from the Vasse River Action Plan and was prepared by Marg Scott and Jenny Dewing.

Planning a project

Write down your objectives:

- What work will be done?
- Who will do the work?
- What will the work achieve?
- Who and what will benefit from the work?

A written list of objectives:

- helps planners to stay within the goals,
- encourages recruitment of volunteers,
- helps volunteers to understand their roles,
- provide benchmarks of progress and success.

Site selection:

- Choose a workable-sized site, small enough to complete the job.
- Select a site within easy travelling distance for volunteers.
- Favour a site which enables the volunteers, and if possible the general public, to view their achievements.

Organising a planning committee:

- Select a diverse group of people with various skills and interests.
- Choose leaders in the community.
- Draw on different groups of people within the community.
- Identify those people with supervising and planning skills.
- Enlist the local media to contribute their support.

Planning creek rehabilitation

Planning a revegetation project should commence in the year preceding the proposed planting or seeding and include researching the best revegetation approach.

Issues to be addressed include:

- the design of remedial work on the banks;
- the selection of suitable plant species;
- how to propagate (by green stock or direct seeding);
- where to obtain seed;
- who to get to propagate the seed;
- the position and design of fencing;
- identifying likely weed problems, developing a weed action plan;
- where to access funds if you intend applying for a grant.

It is essential to study the project site thoroughly. A thorough site survey will provide an inventory of assets such as:

- existing indigenous vegetation;
- plants that are naturally regenerating;
- seed sources;
- potential problems – rabbit activity, weed infestations, eroding banks, areas of sedimentation.

The survey may result in the decision to manage the area to encourage natural regeneration rather than to restore the native vegetation by planting or direct seeding.

A survey can also be used for monitoring the effectiveness of a particular management activity over time.

Bank erosion may require remedial action prior to revegetation. Advice should be sought from the Water and Rivers Commission.

When to survey

Late autumn to early winter is a good time to survey when weed problems are apparent. Impacts of river activity can be easily seen – sections of eroding or slumping banks, and areas where sediment is being deposited. Later in winter, a survey of the river or stream in full flow is more likely to reveal the behaviour of the river rather than its impact.

What's growing on the creek or river bank

A list of existing native vegetation is useful for identifying suitable plant species for revegetation and potential populations of plants for obtaining seed. It is important to establish the position on the stream bank that each plant occupies and the type of soil in which it grows – sand, clay, loam etc.

Native plants are easier to identify when flowering. While different species flower in different seasons throughout the year, the peak season is spring. Fringing species flower later to coincide with falling water levels. They flower and produce seed after winter flooding, to complete their cycle before the next winter rains. It may take several visits from winter onwards to identify all plants.

In summer, flowering suites of plants go mostly unnoticed as they flower when few people are walking and looking. Some of these include *Astartea fasicularis* (a tea tree), *Agonis linearfolia* (swamp peppermint) and *Banksia littoralis* (swamp banksia).

There is a slightly different community of plants growing along the banks of each local creek. These variations reflect the topographical features of the landscape and the soil types unique to that site.

It is not difficult to compile a list of plants specific to a site. The revegetation is then tailored to suit local insects, reptiles, frogs, birds and small mammals, and looks similar to existing remnant vegetation.

Identifying plants

Native rushes and sedges are difficult for untrained people to identify, and are often excluded from revegetation plant lists. The easiest way to identify them is to collect samples, including the base of the plant, and compare them with specimens in the regional or State herbarium. Generally perennial grasses, including spear, wallaby and kangaroo grasses, flower from late spring to summer. Rushes flower at the same time, while sedges flower from late spring through to autumn, depending on the species.

These are important plants that help to hold the bank together, acting as 'foot soldiers' to the trees.

Where most understorey plants have been lost through clearing and grazing, selecting a vegetated site nearby with similar soil type and topography will assist in compiling a species list to use.

CALM's publication How to Create a Local Herbarium is recommended for landholders who wish to collect and preserve their own set of field specimens.

Appendix 3: Useful contacts for catchment management

CALM, Busselton
14 Queen St, Busselton 6280
Tel: 9752 1677

CALM, Margaret River
Tel: 9757 2322

Cape to Cape Catchments Group
Chair - Keith Scott
Tel: 9757 4599

Department of Agriculture, Busselton
1 Queen St, Busselton, 6280
Tel: 9752 1688

Department of Agriculture, Margaret River
Tel: 9757 2181

Fishcare WA Coordinator
Department of Fisheries
3rd Floor SGIO Atrium
168 St Georges Terrace
Perth, 6000
Tel: 9482 7333

GeoCatch
Unit 2 Palm Court Arcade
Busselton 6280
Tel: 9754 4331

Land for Wildlife
Off Reserve Conservation Officer
Tel: 9752 1677

Marron Research
Department of Fisheries
PO Box 20 North Beach 6920
Tel: 92468461

Ribbons of Blue
GeoCatch
Unit 2 Palm Court Arcade
Busselton 6280
Tel: 9754 4331

Water and Rivers Commission
PO Box 261 Bunbury 6231
Tel: 9721 0666

Water Corporation
PO Box 305 Bunbury 6231
Tel: 9791 0400

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