JERDACUTTUP RIVER ACTION PLAN

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Jerdacuttup River Action Plan

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Cover photograph: Community walk along the Jerdacuttup River 2002 [taken by Kaylene Parker]

Jerdacuttup River (photograph Kaylene Parker)

"...I must tell you about this Jerdacuttup River. We understand this to be an aboriginal name. Well it smacks of aboriginality, but it is not aboriginal. 'Jerda' is. The proper name of that river or the proper Aboriginal name of the river is 'Jerda Carte'. It was a name made of two words: 'Jerda', for a great big bird, let us say a black swan with a long neck and 'Carte' being the Aboriginal name for 'head' so it means 'a bird to its head'.

Now to get a proper appreciation of this river, its name and meaning, you should leave Hopetoun and go for a drive to the '12-mile' along the new road. As you get to about the '5-mile' you will see ahead of you, this great, huge long lake into which the Jerdacuttup pours. This is the body of the bird. The Jerdacuttup does not pour into the sea – that would take a lot of rain and floods. It would take the flood of Noah's time to reach the sea. Anything less would only extend that lake onward, eastward. Now, as you come out from the '12-mile' you can see the eastern end of that lake, and it's a great long, narrow lake. It's very much like the body of a black swan, you'll say long and not wide. As you come to Mr Arnold Daniel's property there, you come to the breast of the bird, with the neck taking off up through Mr Daniel's property, with Springdale on the other side. Then it comes in a slight curve, right round the back of the Ravensthorpe Range until it gets to the 'Carte' or head.

That is 'Jerda Carte'. We'll call it 'Jerdacuttup' – which is the correct name for us – and we'll let 'Jerda Carte' go back to the dreamtime."

as told in *'Stories from the past – some recollections of WA's pioneers'*.
William Peter Coleman (1900-1982)
Bill Coleman was part Aboriginal and was born at Geordie Soak on the Jerdacuttup River.

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Purpose of this plan

The purpose of this Action Plan is to provide information on the condition of the Jerdacuttup River. The report describes the condition of the river, its vegetation, water quality, channel features, and then provides specific management advice for further works needed to protect the river. In summary, the River Action Plan provides:

- a summary of waterways information – including Jerdacuttup River and Jerdacuttup Lakes;
- a record of river condition;
- a summary of on-ground works completed on waterways in the catchment;
- an indication of problem areas;
- management guidance and technical advice;
- a mechanism to increase community knowledge of waterways management issues;
- a mechanism for recording and prioritising on-ground work; and
- a tool to apply for funding opportunities.

How to use this plan

The Jerdacuttup River Action Plan was prepared for the Ravensthorpe LCDC, the Department of Environment and landholders in the Jerdacuttup River catchment.

Section 1 provides the background to the project and outlines the study area and methods used.

Section 2 describes catchment information including the natural resources, heritage, flora and fauna in the catchment.

Section 3 provides information on the Jerdacuttup River, some of its tributaries and the Jerdacuttup Lakes. This includes general information on the waterways, water quality monitoring results, macroinvertebrates, native fish populations and aquatic flora that rely on the river system.

Section 4 reports on the state of waterways in the catchment. This includes vegetation, water quality and other major issues in the catchment.

Section 5 includes general management recommendations and future actions to protect waterways in the catchment.

Section 6 includes the results of the foreshore survey of the main channel of the Jerdacuttup River.

Executive summary

The Jerdacuttup River catchment has an area of 232 000 ha on the central south coast of Western Australia. It has several important attributes; including 70 000 ha of cleared farmland, the town of Ravensthorpe, the Ravensthorpe Range and it terminates in the Jerdacuttup Lakes, an important coastal wetland.

The catchment is also part of the Fitzgerald Biosphere Reserve and is an integral part of the Bandalup corridor - a substantial linkage of high value vegetation between the coast and the interior.

The results of the river survey indicate that the Jerdacuttup River is in excellent condition, with 81% of the foreshore vegetation in A grade condition, 14% in B grade and 5% in C grade. The survey does however, indicate a river in the early stages of hydrological change, particularly with respect to the duration of the wetting cycle – possibly caused by an increase in flow volume and duration due to land clearing. There are localized areas of degradation where land clearing, secondary salinisation and stock grazing have impacted on the riparian vegetation.

The Jerdacuttup River and its catchment are of considerable interest to the local community. This is evident from the level of on-ground works completed in the Yallobup and Woodenup-Moolyall subcatchments. There is scope for further management initiatives on the Jerdacuttup itself and these are detailed as recommendations. A significant impediment to effective management is the lack of consistent reservation status and vesting for the riparian corridor.

Attributes of the Jerdacuttup River and some of its tributaries are described – in particular its considerable geological diversity, heritage and conservation values.

Jerdacuttup River (photograph Kaylene Parker)

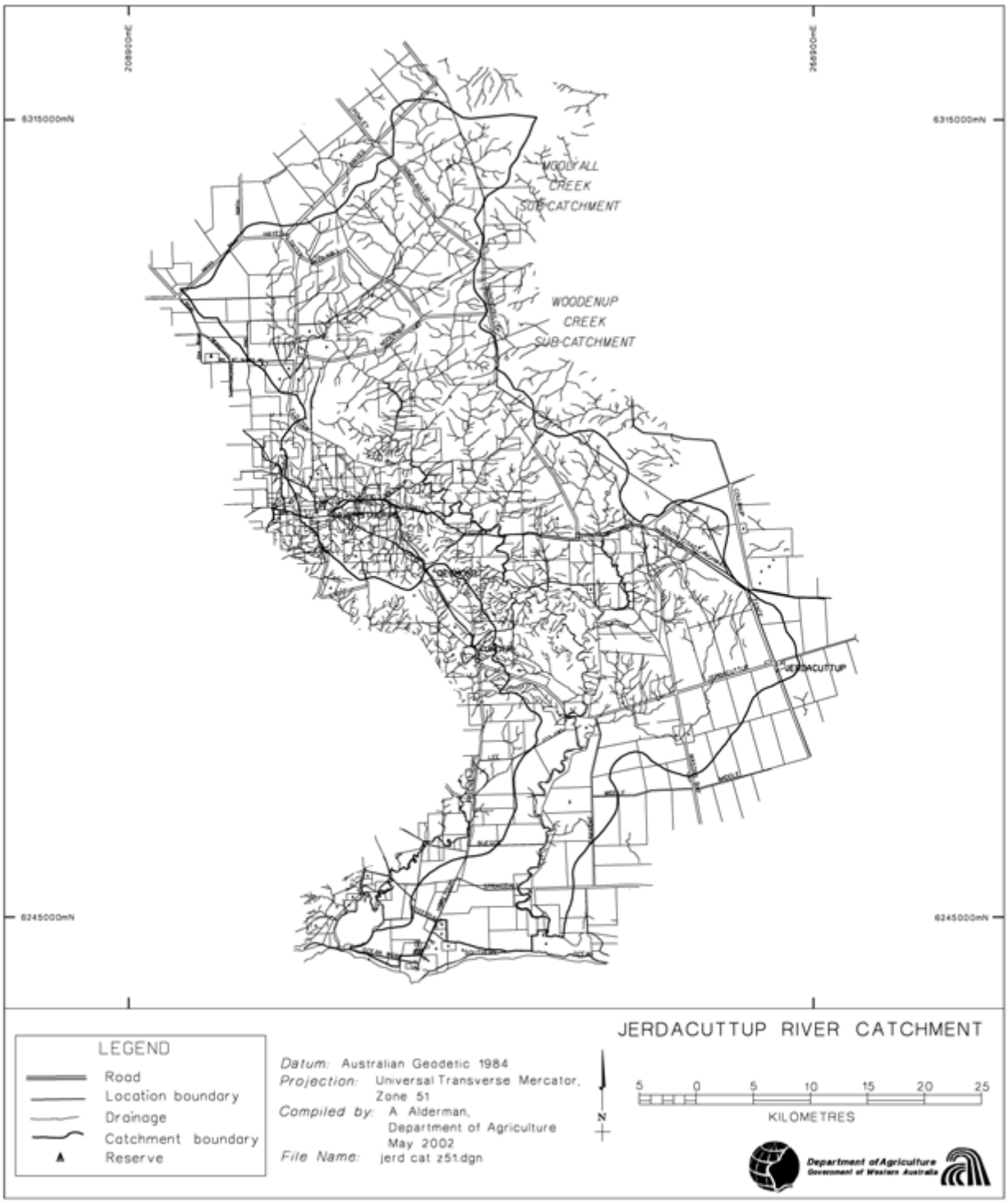

Figure 1. Location of the Jerdacuttup River catchment

1 Introduction

1.1 The issue

Many Western Australian rivers are becoming degraded as a result of human activity along waterways, and through the off-site effects of catchment land uses. The erosion of foreshores and invasion of weeds and feral animals are some of the more pressing issues. 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 (Water and Rivers Commission, 1999).

The Ravensthorpe LCDC decided in early 2001 to support an Action Plan for the Jerdacuttup River. This decision was particularly appropriate as the LCDC had been successful in gaining NHT funding for fencing and revegetation projects in the Yallobup and Moolyall subcatchments and on-ground works have been completed on many properties.

1.2 The study area

The study area for this action plan includes the Jerdacuttup River, its tributaries and catchment on the central south coast of Western Australia in the Shire of Ravensthorpe. The catchment has an area of 2 320 km^2 of which 30% is cleared (Pen 1999). Agricultural clearing occurred in four relatively well-defined nodes which correspond with four separate agricultural land releases between 1900 and the 1980s. The catchment includes the southern edge of the Yilgarn Plateau, the hills of the Ravensthorpe Range, an extensive marine plain as well as the town of Ravensthorpe.

1.3 Methods and approach to survey

The Jerdacuttup River Foreshore Survey was conducted using the Stream Foreshore Assessment and Survey Technique developed by Pen and Scott as a guide (WRC, 1999). The approach to the survey was determined in part by the functional definition of a riparian zone being '*any land which adjoins, directly influences, or is influenced by a body of water'*. This is the definition adopted by the River Restoration Program (Boulton and Brock 1999).

Pen and Scott's Foreshore Assessment technique (Pen & Scott, 1995) classifies the condition of the foreshore as being in A, B, C or D grade which represent respectively a pristine foreshore to a completely degraded foreshore. These grades can be further broken down, fore example A1, A2, A3, B1, B2 and so on, to provide a more detailed assessment.

Before fieldwork was completed black and white aerial photography at a scale of 1: 50 000 and satellite imagery map products were examined to identify sections of the river which could be readily walked in available time, adjacent landuses and if possible the general condition and nature of the riparian vegetation. For recording purposes, the river was divided into 2 km sections; occasionally sections were lengthened or shortened to accommodate features such as road crossings or changes in landuse. Field data was entered onto a foreshore condition assessment form. Assessments are displayed in table 5, and individual section descriptions are summarised in section 6. The survey also recorded:

- waterfowl present in pools;
- land birds and other fauna using the riparian vegetation;
- water quality parameters – particularly electrical conductivity and dissolved oxygen were measured *in situ* with a WTW Multiline P4 meter; and
- presence/absence of fishes – the spotted minnow *(Galaxias maculatus)* and the Swan River Goby *(Pseudogobius olorum).*

The river was walked between Floater Road and the south boundary of 'Maydon' in 5 days in October 2001. The sections between 'Maydon' and North Jerdacuttup Road were assessed at three sample points accessed by vehicle – due to its remoteness and relatively undisturbed condition. Sections between North Jerdacuttup Road and Springdale Road were walked in 3 days in November 2001. The sections between Springdale Road and Jerdacuttup Lakes were assessed by boat. The sections between Carlingup Road crossing and Cordingup Creek confluence were walked with community members and concluded with a social barbecue. Further consultation with specific land

managers occurred over January 2002 to discuss remediation options for sections requiring restoration. Fencing grants were offered to two land managers, part funded by the NHT and the Department of Environment.

A 'snapshot sample' of river water quality was conducted twice, in 2001 and 2002. Eight sites were selected (table 2) and the following was recorded at each site by a Multiline WTW P4 meter; electrical conductivity, dissolved oxygen, pH, temperature and turbidity on the 21 September 2001 and the 9 April 2002. On the latter water samples were also collected for total nitrogen and phosphorus analysis. This data is summarised in section 3.

1.4 Values of the Jerdacuttup River

- The catchment is entirely within the Fitzgerald Biosphere Reserve – a part tenured land management concept supported by both State and Commonwealth Governments and UNESCO.
- The Jerdacuttup Lakes System is contained within Nature Reserve no. 40156. The reserve totals an area of 6 620 ha which is vested in the Conservation Commission. The lakes are frequented by many bird species including four trans equatorial migrants (protected by international treaty, the Japan–Australia Migratory Bird Agreement), as well as two threatened species; Hooded Plover and Freckled Duck. Ninety-five bird species have been recorded using the Jerdacuttup River and Lake System.
- The Jerdacuttup Lake Nature Reserve has been recommended for inclusion on the Register of the National Estate.
- The Jerdacuttup River forms part of the Bandalup Corridor – an important vegetative corridor between the coastal reserve, the Ravensthorpe Range and the Kundip Nature Reserve and a large extent of Unallocated Crown land in the upper catchment.
- The Jerdacuttup River rates as a priority river system due to the pristine condition of the foreshore vegetation, 81% of which is graded as almost pristine (A grade condition).
- The Heritage Council of WA lists the following sites in the catchment on the municipal register; Springdale homestead, Woodenup Pool, Moolyall Rocks, River View farm, Jerdacuttup Springs, Carlingup homestead and spring and the site of the former Jerdacuttup fish cannery. The Jerdacuttup River komatiites near Kundip are on the Register of the National Estate.
- The Jerdacuttup River has important recreational values as locals and tourists enjoy boating and recreational fishing in many river pools.
- There are three registered Aboriginal sites including Bandalup Creek, a gnamma hole on the river at the Carlingup Road crossing and an occupation (camp) site on low sand dunes on the west side of the river north of Jerdacuttup Lakes.

2 Catchment information

2.1 Hydrogeology

The Jerdacuttup River catchment is underlain by fractured and weathered Archaen and Proterozoic granite, gneiss and greenstone (Johnston 1998). These basement rocks provide minor localised aquifers and provide for a watertable that is continuously present throughout except in isolated elevated areas. The depth to watertable varies due to rock type, topography, groundwater recharge and discharge and more recently due to agricultural clearing. In the absence of clearing it varies between 5 m in valleys but may reach 30 m along topographic divides. Groundwater salinity is fairly even in the north of the catchment at 14 000 mg/l. On the marine plain south of Jerdacuttup North Road it varies between 1 000–3 000 mg/l except for a minor occurrence in Cainozoic alluvial and colluvial deposits south of Springdale Road and east of the river which has been developed as the Hopetoun water supply where the salinity is < 1 000 mg/l (Johnston 1998).

2.2 Hydrology

The Jerdacuttup River catchment is in the Southwest Coast drainage division where, on average, only 1.7% of precipitation occurs as run-off (Boulton and Brock 1999). This means that over 98% of rainfall received must be returned to the hydrologic cycle by other means. A small proportion enters groundwater but by far the greater majority is normally returned to the atmosphere by evapo-transpiration from plants. With the replacement of deep rooted, native, perennial plants by annual crops this requirement is no longer met and rising water tables and salinisation and/or waterlogging is a consequence. At present 11.2% of cleared land is affected, this is expected to increase to 18.3% by 2010-2020 and to 22.7% when equilibrium is later reached (Ferdowsian *et al.* 1996).

2.3 Climate and rainfall

The climate of the catchment is Dry Mediterranean according to the system of Bagnouls & Gaussen (1957). Mediterranean recognises that the maximum rainfall is in winter and 'dry' is contributed to there being 5-6 months per year when precipitation is inadequate to sustain plant growth. At Ravensthorpe, the nearest official recording station, the mean annual rainfall is 424.2 mm and the median is 415.2 mm. The wettest and driest years on record are in 1951 (734.5 mm) and 1940 (234.1 mm) respectively. There are on average 109 rain days per annum. Temperature varies seasonally with warm-hot summers and cool-cold winters. Average summer temperatures range from 14–29^{0}C and average winter temperatures range from 7–17^{0}C. Frosts are recorded in winter though the frequency is diminished by frequent cloud cover. Evaporation ranges from 1500 mm pa in the south to 2 000 mm pa in the north.

Rainfall for 2001 was well above average with 593.7 mm recorded at Ravensthorpe. Except for January – the months to June were below average however the remainder of the year was particularly wet with the months July, August and November receiving 2-3 times their average. The Jerdacuttup River flowed vigorously between July and December 2001.

Wind is an important environmental factor in the catchment because most days are windy and the effects of light rains on plant growth are often negligible due to the evaporative effect of wind. Between May and October strong north-westerly winds are associated with the passage of cold fronts along the south coast; the passage of the front is accompanied by a west-southwest change which, unlike elsewhere in the Wheatbelt, often delivers most winter rain. Summer winds are northerly or easterly and associated with high pressure systems in the Bight and developing low pressure troughs off the west coast. Most of the catchment receives a regular sea breeze in summer which is usually south-easterly.

In spite of being in a winter rainfall area, the most significant rainfall events are over summer and are associated with either decaying tropical cyclones or complex upper atmosphere interactions. Usually these are not forecast and the associated flooding is a significant factor, which influences agriculture, river management, access and communications. A predicted increase in the severity of natural events such as cyclones, bushfires and particularly flooding due to enhanced greenhouse effect may have significant local implications (DEP 1998).

2.4 Vegetation

The vegetation of the catchment falls entirely within the Eyre botanical district of Beard (1990); 52% of which has been cleared for agriculture. Beard (1976) mapped four vegetation systems over the Jerdacuttup River catchment:

2.4.1 Chidnup system

This system occupies the watershed between the southerly flowing coastal rivers and the Swan-Avon drainage. The dominant vegetation types are *Eucalyptus eremophila – E. oleosa* mallee on lateritic soils and *E. redunca – E. uncinata* mallee on sandier soils lower in the landscape. Mallee heaths and woodlands with swamp yate (*E. occidentalis*) are also present.

2.4.2 Oldfield system

This system occupies the southern edge of the ancient land surface of Australia called the Yilgarn Plateau. This system includes the Moolyall and Woodenup Creek subcatchments. Granite rock outcropping is abundant; soils are skeletal and vegetation here is mallee (*Eucalyptus pleurocarpa*) and *Allocasuarina campestris / Calothamnus quadrifidus* thicket.

2.4.3 Ravensthorpe system

This system occupies the greenstone derived reddish–brown loams and clay loams of the Ravensthorpe Range and surrounds. The Range vegetation is a mallee and banksia thicket association on crests and upper slopes with *Eucalyptus pleurocarpa* and *E. falcata Banksia lemmaniana.* This association has a complex and very diverse shrub understorey. Low forests occupy slopes with either *Eucalyptus astringens, E. clivicola, E. gardneri,* or *E. megacornuta* with a very open shrub understorey. Small patches of woodland are present on deeper loams in valleys, species include: *Eucalyptus extensa, E. cylindroidea* and *E. salmonophloia.*

2.4.4 Esperance system

This system occupies the marine plain south of North Jerdacuttup Road and east of the river. The vegetation is dominated by mallee and banksia species including: *Eucalyptus pleurocarpa, E. tetraptera* and *E. preissiana* as well as *Banksia media, B. speciosa* and the ground level species *Banksia repens* and *B. blechnifolia.* Cauliflower hakea (*Hakea coryombosa)* is a very prominent shrub in the area. The plain is interspersed with abundant swamps with *Eucalyptus occidentalis* and *Banksia preissiana*.

2.5 Vertebrate fauna

The vertebrate fauna of the catchment is relatively well known from studies in the Ravensthorpe Range (Chapman & Newbey, 1995) and environmental impact assessments associated with the Ravensthorpe Nickel

Jerdacuttup River, showing characteristic vegetation of the Ravensthorpe system (photograph Kaylene Parker)

Operations project (Craig & Chapman, 1999; Chapman, 2000 and Biota Environmental Science, 2000). Together these studies reveal a fauna of approximately 110 species of birds, 35 species of reptiles, 16 species of native mammals, 8 species of frogs and 4 species of inland fishes. For a relatively small area this is a very high degree of faunal richness, due largely to its heterogeneity and the substantial proportion (70%) of the catchment that is relatively undisturbed. The fauna includes the threatened species: mallee fowl, western whipbird, Carnaby's cockatoo, hooded plover, heath rat, tammar wallaby and carpet python.

Appendix 1 is a list of the 95 bird species recorded in riparian vegetation and on river pools during this survey as well as waterfowl recorded on Jerdacuttup Lakes from Jaensch *et al.* (1988).

2.6 Heritage and land use

There is little doubt that the Jerdacuttup River featured prominantly in the lives and economy of local Aborigines before European settlement. Indeed the word 'Jerdacuttup' is the anglicized version of 'Jerda Carte' that according to William Coleman means 'a bird to its head' (see foreword).

A comprehensive ethnographic survey of the river has not been done, however there are three registered Aboriginal sites on Bandalup Creek as well as a gnamma hole on the river at the Carlingup Road crossing and an occupation (camp) site on low sandunes on the west side of the river north of Jerdacuttup Lakes. As happened elsewhere, European settlement of the catchment was determined, in part, by the relatively productive soils offered by river flats as well as the availability of fresh water from springs. William Moir arrived from Fanny Cove in 1900 and established a homestead and orchard at Getenmellup on Carlingup Creek on what was to become Oldfield Location 1. Mary Daniels (*nee* Wellstead) purchased 800 acres of river flat south of Springdale Road in 1914 and the well known, but now abandoned, mud brick homestead 'River View' was built in 1924 by Arnold Daniels and his brother, the property still remains in the family today.

The next node of agricultural development was in the 1920s when the river flats north of Highway One were developed as small farms. These were relinquished in the depression and purchased by Tommy Daw who amalgamated them into the Daw family farming business, the Jerdacuttup Pastoral Company.

Two land releases have occurred in the catchment; the first in the mid 1960s between North Jerdacuttup Road and Springdale Road on the east side of the river. The last release of land for agriculture in WA also occurred in the upper catchment when in 1979, 15 locations were released around Moolyall and Woodenup creeks. Thus the settlement of the Jerdacuttup River catchment is

Gnamma hole on the river at the Carlingup Road crossing (photograph Kaylene Parker)

an integral part of the agricultural and social development of the local community.

At present the Heritage Council of WA lists the following sites in the catchment on the municipal register: Springdale homestead, Woodenup Pool, Moolyall Rocks, River View farm, Jerdacuttup Springs, Carlingup homestead and spring and the site of the former Jerdacuttup fish cannery. The Jerdacuttup River komatiites (volcanically-formed rocks with spinifex type texture) near Kundip are on the Register of the National Estate.

2.7 Land tenure

The catchment has an area of 232 000 ha; of this approximately 77 000 ha or 33% of the catchment is held as private freehold. In the uncleared upper parts of the catchment there is a large area of native bush in the Ravensthorpe mineral field that includes the Kundip Nature Reserve and a large tract of Unallocated Crown Land (155 000 ha). It is currently proposed that the Ravensthorpe Range and the uncleared land to its north be vested as nature reserves.

The Jerdacuttup River is entirely in public ownership (table 1) and includes areas of reserves, but the majority is Unallocated Crown Land. There are some limitations in the reserve size, with some sections not adequate to protect the riparian vegetation. For example, reserve no. 31760 located between North Jerdacuttup and Springdale roads, is not adequate to protect the west side of the river and there is serious erosion and vegetation loss in this reserve.

Addressing the issue of the width of the riparian corridor is the principal recommendation arising from this plan; all other recommendations are contingent upon its implementation (section 5). Land tenure along the Jerdacuttup River is indicated in table 1.

Table 1. Land tenure along the Jerdacuttup River

Section	Distance (km)	Tenure
1-2	4.4	Reserve No. 32047 'Parklands'
3-10	16.0	UCL – undisturbed bushland (proposed nature reserve)
11-13	5.8	UCL corridor with adjacent farmland
14-17	9.2	UCL corridor with adjacent farmland
18-20	6.5	UCL corridor with adjacent farmland
21-31	22.0	UCL – undisturbed bushland (proposed nature reserve)
32	2.0	UCL corridor with adjacent farmland – west bank only
33-43	22.0	Reserve No. 31760 'Park and Protection of river and foreshore'
45-46	6.0	UCL corridor with adjacent farmland
47	1.5	Reserve No. 28286 'Preservation of natural vegetation' west bank

Note: UCL denotes Unallocated Crown Land.

River View 2002. The property was built in 1924 by Arnold Daniels (photograph Kaylene Parker)

3 Waterways information

3.1 Jerdacuttup River

The Jerdacuttup River has its headwaters north of Ravensthorpe in cleared agricultural land. The river follows a spectacular course along the eastern face of the Ravensthorpe Range. It arises in Archaean granite (<300 m), 60 km north of where it discharges to the Jerdacuttup Lakes. Although the river arises 60 km north, the river itself is 105 km in length due to its meandering nature – particularly in the lower catchment as it flows through alluvial sediments.

There are many pools in the river bed, some over a kilometre long and 5 m in depth. The river drains through four different nodes of land that have been cleared for agriculture and are separated by vast tracts of undisturbed bushland. The estimated mean flow is 4400 Ml per annum (SCRIPT, 1997).

The river drains into the Jerdacuttup Lakes, which is a coastal lagoon, permanently closed to the ocean. The last 8 km of the river is navigable by small boats from Springdale Road to where it disappears into a dense paperbark and samphire swamp that blocks passage from the river to the lake for about 500 metres. This section of the river retains water all year round, even if the Jerdacuttup Lakes dry up.

3.1.1 Geology of the river

To understand a river and its hydrology it is necessary to understand something of the geology and landscape processes that have formed it. This can be done at both the regional and local scale. The former is the big picture and includes the geological time component. This has been described elegantly by Mary White in her recent book 'Running Down – water in a changing land' (White, 1999). Prior to Australia's separation from Antarctica *circa* 80 million years before present (mybp), the rivers of WA's central south coast originated in the mountains of Antarctica and flowed northward. Following separation, in the Eocene Period *circa* 40 mybp, a warm, shallow sea covered much of the south coast and penetrated inland in these river valleys. Marine sediments were deposited which today are revealed as the well known spongolite cliffs, mesas and buttes of Fitzgerald River National Park and elsewhere.

As the Eocene sea retreated there were major changes to local drainage; a divide called the Jarrahwood Axis developed parallel to the coast approximately 60–70 km inland. North of the divide the land was uplifted, south of it the land tilted away to the coast causing the local rivers, including the Jerdacuttup, to reverse their flow with increased energy. This process is called rejuvenation; here it occurred about 30 mybp.

The Jerdacuttup River originates from colluvial and alluvial soils on a gently undulating high plain near the watershed of the Swan-Avon and Jerdacuttup drainage north of Mt Short. From here, the river progresses east and south through Archaean coarse-grained granites and adamellites. The tributaries Moolyall and Woodenup creeks drain this geological type – most of which is uncleared. On the north side of the Ravensthorpe Range the river comes under the influence of Archaean ultramafic and mafic rocks collectively known as 'greenstones'; the valley becomes very steep sided and the riparian vegetation is very different. The tributaries Cordingup and Bandalup creeks drain much of the greenstone country. This situation along with the intrusion of some banded ironstone formation continues until the river crosses Highway One. South of here, where it has developed some maturity as a river, it traverses Quarternary colluvial and alluvial sediments, which have been extensively cleared for agriculture.

South of the property 'Maydon' the river re-enters an extensive greenstone belt that it traverses almost to North Jerdacuttup Road. South of this road it traverses an extensive marine plain on which Eocene marine sediments that were deposited during the marine incursion and since been eroded by the river. At approximately the latitude of Middle Road the sediments have been stripped back to bedrock in the river valley and Proterozoic migmatites exposed. Here some of the largest, deepest and most permanent river pools are present. Much of the marine plain has been cleared for agriculture but the river is protected here by a wide reserve on the eastern side (section 2.7). In spite of the river pools the river is essentially 'upland' in character until it crosses Springdale Road, in other words it exists as a chain of pools separated by extensive portions of vegetated river bed.

South of Springdale Road, the river is 'riverine' in character in that it always retains water until it enters Jerdacuttup Lakes. For this section the river is mature and it traverses an extensive alluvial plain. This was the first land cleared for agriculture in the catchment.

3.1.2 Water quality

There has been no long term water quality monitoring undertaken on the Jerdacuttup River. The Department of Environment conducted snapshot sampling in 2000 and 2001 to examine the variation of salinity levels throughout the catchment, and to give a preliminary indication of nutrient levels. Water quality data for the Jerdacuttup River are shown in table 2 and figures 2 and 3.

The snapshot data indicates that salinity (as electrical conductivity) and flow are the most widely fluctuating environmental variables of the Jerdacuttup River. This is the case with all rivers on the cental south coast of WA. The Jerdacuttup River is naturally saline due to transport of soil stored salts, mainly sodium chloride originating either from previous marine incursion or from salt of marine origin borne by wind and rain.

Salinity levels varied from 7.70 mS/cm at the crossing of Carlingup Road recorded on the 23-11-01, to 117.3 mS/cm recorded on 9-4-02 at Woodenup Road. This is a fifteen-fold increase and is shown in figure 2.

Salinity readings were also shown to be lower in the spring in comparison to autumn. This is consistent with rivers becoming saltier in summer months due to evaporation. Salinity readings are also higher in the upper catchment and decline downstream.

Dissolved oxygen is usually in the range 5–10 mg/l; it is dependent primarily on activity of aquatic plants, less so on temperature and salinity. In the sampling period, the dissolved oxygen levels varied from 2.7 to 9.3. It is reduced by high flow periods, which result in an increase in organic matter.

River water is always alkaline, usually within the pH range 7.5 – 9.0, and the pH of the Jerdacuttup River ranges from 7.4–9.45.

The temperature varies with the time of the day, level of biological activity, time of year and amount of shading. The temperature of the Jerdacuttup River varied from 10.0 degrees to 27.7 degrees.

Table 2. Jerdacuttup River catchment water quality results (snapshot)

SITE	SITE No.	DATE	EC(25) mS/cm	DO mg/l	TEMP 0C	PH	TURB (NTU)	TN mg/l	TP mg/l	FLOW l/sec
Woodenup Road	JER100	09.04.02	117.3	2.96	16.9	8.1	10	9.3	0.24	nil
		21.09.01	20	8.48	14	8.1	10	-	-	11.5
		03.11.01	39.7	8.24	27.1	8.40	10			6.25
		16.12.01	19.80	NA	27.7	8.21	20			11.60
		16.01.02	33.80	NA	23.3	8.32	20			NIL
		13.02.02	53.6	NA	19.9	7.68	10			NIL
		13.03.02	81.6	2.86	21.4	7.51	10			NIL
		31.05.02	71.4	9.94	17.6	7.96	15			NIL
		17.06.02	74.6	6.73	11.8	8.15	15			8.4
Carlingup Road	JER102	09.04.02	53.3	5.86	19.8	8.1	10	3.8	0.08	nil
		21.09.01	15.15	8.52	16.1	8.1	10	-	-	54
Highway One	JER103	09.04.02	34.8	2.7	17.7	7.5	10	2	0.11	nil
		21.09.01	17.21	8.51	17.3	8.1	10	-	-	144
North Jerdacuttup Road	JER105	09.04.02	17.83	11.2	21.9	8.7	10	1.3	0.03	nil
		21.09.01	11.67	6.94	20	7.8	10	-	-	160
Springdale Road	JER106	09.04.02	19.88	7.15	19.2	7.4	10	0.72	0.02	Trickle
		21.09.01	8.85	7.8	17.8	7.7	10	-	-	300
Carlingup Crossing	JER107	09.04.02	NA	NA	NA	NA	NA	1.7-	0.02-	NA
		21.09.01	63.3	7.7	17.8	7.4	10	-	-	Trickle
		11/04/01	67.8	8.59	19.7	8.97	30			NIL
		10/05/01	73.2	8.14	17.3	8.41	60			NIL
		24/06/01	70.9	7.58	10.0	7.58	20			NIL
		26/07/01	62.7	9.35	15.4	8.49	20			NIL
		27/08/01	11.09	7.49	13.8	8.22	15			74
		20/09/01	17.15	8.52	16.1	8.09	10			54
		26/10/01	22.2	7.87	18.2	NA	10			50
		23/11/01	7.82	5.31	19.0	8.60	30			600
		20/12/01	15.76	NA	27.1	8.21	10			20
		24/01/02	20.1	NA	27.4	9.33	10			NIL
		21/02/02	24.1	16.28?	24.8	9.45	10			NIL
		22/03/02	27.5	NA	24.4	NA	10			NIL
Moolyall Creek (Moolyall Road)	JER101	09.04.02	46.1	9.26	18.1	7.9	10	2.8	0.1	nil
		21.09.01	15.62	7.19	15.3	7.4	10			9.9
Cordinup Creek (Highway)	JER104	09.04.02	61.5	7.07	18.7	7.7	20	1.2	0.05	nil
		21.09.01	33.9	6.43	15	8.2	15			Undet.
Woodenup Creek (Woodenup Road)		21.09.01	63.3	7.70	17.8	7.44	10	-	-	Trickle
		9.04.02	NA	NA	NA	NA	NA	NA	NA	NA

Note: undet.(undetermined) refers to flow present but not estimated.

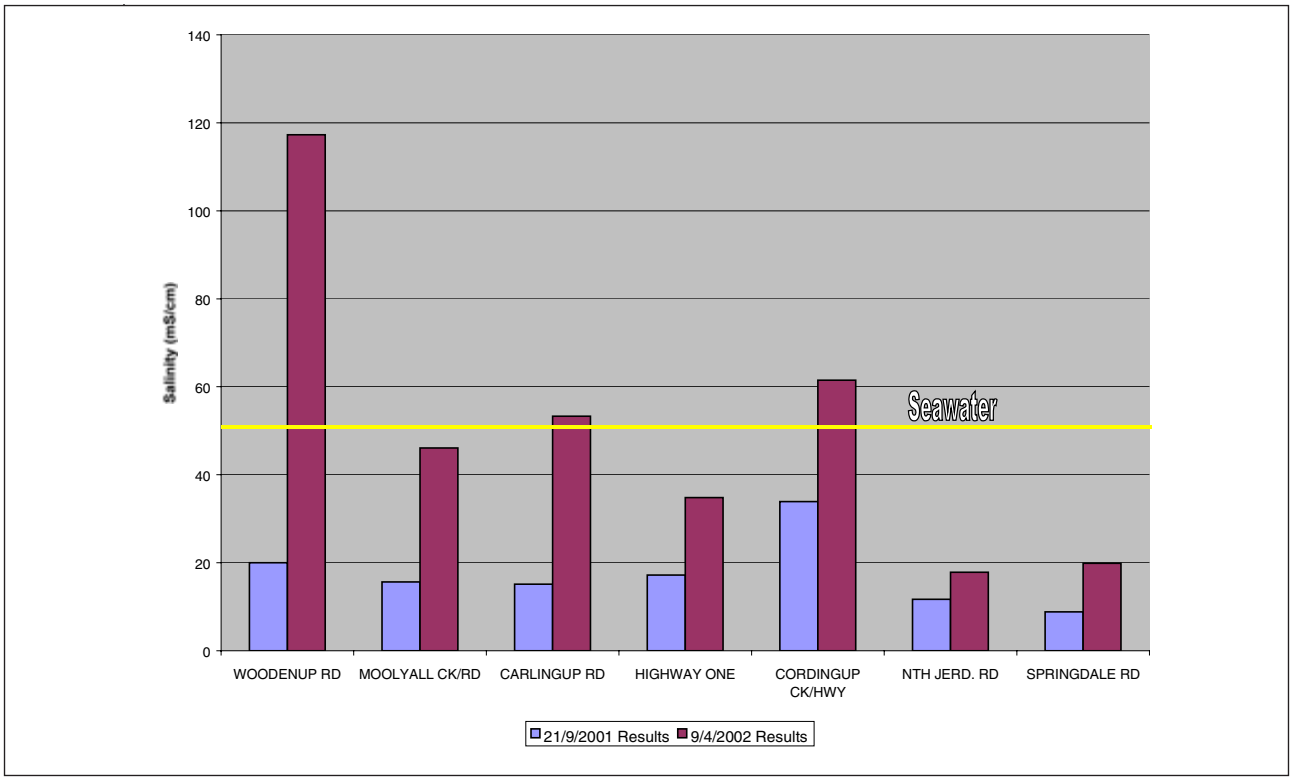

Figure 2. Conductivity levels of the (salinity) Jerdacuttup River and its major tributaries (mS/cm)

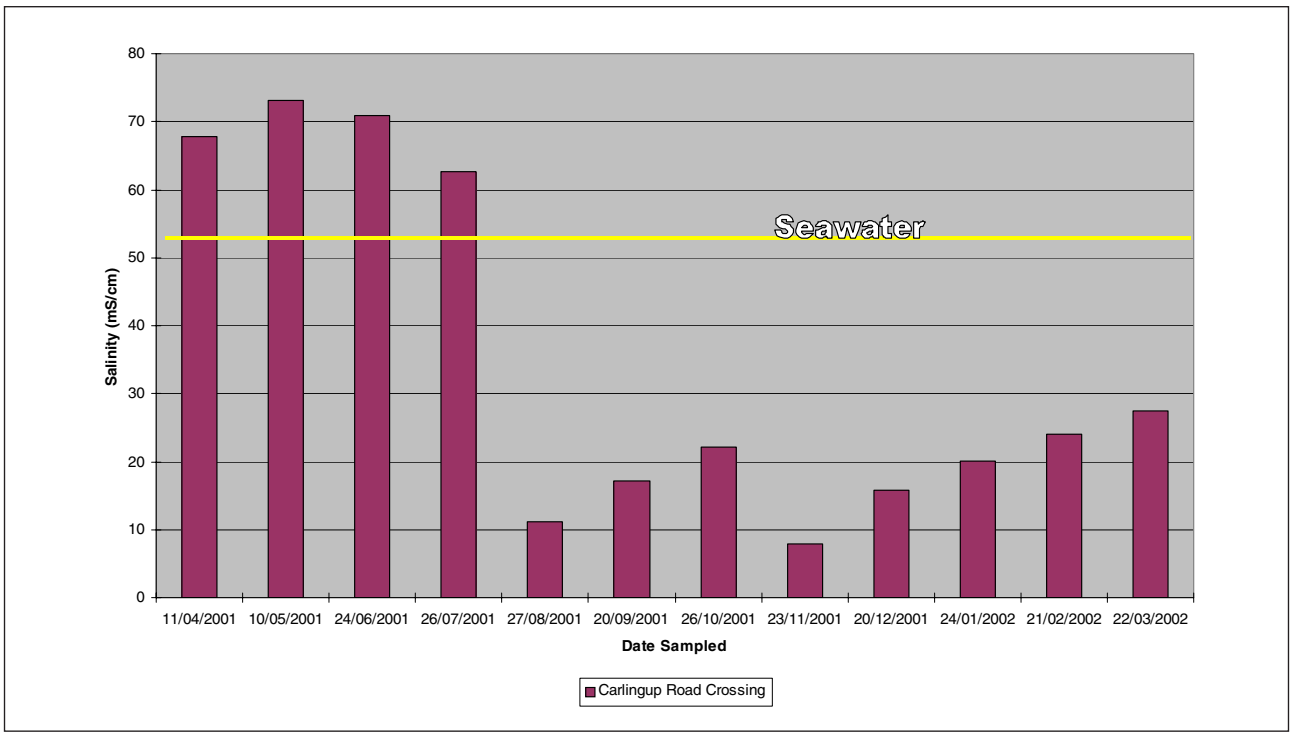

Figure 3. Conductivity levels (salinity) at the Carlingup Road Crossing on the Jerducuttup River over a one year-period (mS/cm)

Turbidity levels were relatively consistent on the Jerdacuttup River – around 10 nephelometric turbidity units (ntu), however measurements varied in two defined periods. Summer periods may show increased algae and phytoplankton growth which can increase the turbidity levels. Also after flow events, organic matter and sediment is visible in the water column which can increase the turbidity level.

The major concern with respect to water quality of the Jerdacuttup River is the high nutrient levels. Total nitrogen levels ranged from 1.2 mg/l – 9.3 mg/l. The ANZECC water quality guidelines recommend nitrogen levels of 1 mg/l for protection of aquatic health. Total phosphorous levels were also high, with levels ranging from 0.02 mg/l – 0.24 mg/l. Some readings were also higher than ANZECC guidelines of 0.1 mg/l.

3.1.3 Macroinvertebrates (aquatic bugs)

Macroinvertebrates or aquatic bugs consist of worms, snails, crustaceans and insects (such as mayflies, stoneflies, beetles, and bugs). Many macroinvertebrate species are found in the waterways throughout the Jerdacuttup River catchment.

Macroinvertebrates play an important role in the ecology of the river system. In the upper catchment, macroinvertebrates are responsible for shredding larger particles including bark, leaves and other detritus that falls into the waterway. Further downstream, macroinvertebrates such as worms take small particles of organic matter from the sediment and digest them further. Algae that grows on the rocks is 'scraped off' by snails and limpets. There are also predator species of macroinvertebrates including dragon fly larvae, adult beetles and stonefly larvae that prey on smaller animals.

The quality of the water is linked to the survival of macroinvertebrates and in turn larger animals such as fish and birds. Macroinvertebrates are sensitive to changes in the physical and chemical conditions including salinity, flow and temperature.

The most important feature in a stream is vegetation – including logs, branches, bark and leaves. This forms the basis of a food web for macroinvertebrates in our waterways. Vegetation removal can impact on food availability, light penetration, water flow, sediment levels, and temperature of the water. Protection of foreshore vegetation is vital to ensure the protection of ecological attributes of our river systems. Removal of riparian vegetation upstream can have serious consequence on downstream macroinvertebrates that rely on the input of organic matter to the system.

Macroinvertebrates were sampled on the Jerdacuttup River as part of the National Rivers Health project (table 3).

Andy Chapman sampling the Jerdacuttup River (photograph Kaylene Parker)

Table 3. Macroinvertebrate data collected as part of the AUSRIV Health Program

SITE NO	SAMPLE DATE	HABITAT	FAMILY NAME	ABUNDANCE (log scale)
Un-named creek	17/09/1997	CHANNEL	Ceratopogonidae	2
(test site only)	17/09/1997	CHANNEL	Chironominae *	3
	17/09/1997	CHANNEL	Corduliidae	1
	17/09/1997	CHANNEL	Corixidae	1
	17/09/1997	CHANNEL	Culicidae	2
	17/09/1997	CHANNEL	Dytiscidae	1
	17/09/1997	CHANNEL	Leptoceridae	1
	17/09/1997	CHANNEL	Libellulidae	1
	17/09/1997	CHANNEL	Notonectidae	1
	17/09/1997	CHANNEL	Paramelitidae	1
	17/09/1997	CHANNEL	Stratiomyidae	1
	17/09/1997	CHANNEL	Tanypodinae *	2
	17/09/1997	CHANNEL	Oligochaete indeterm.	1
Jerdacuttup River	18/09/1997	CHANNEL	Chironominae *	2
(test site only)	18/09/1997	CHANNEL	Corbiculidae	1
	18/09/1997	CHANNEL	Leptoceridae	1
	18/09/1997	CHANNEL	Palaemonidae	1
	18/09/1997	CHANNEL	Paramelitidae	1
	18/09/1997	CHANNEL	Pomatiopsidae	3
	18/09/1997	CHANNEL	Sphaeromatidae	2
	18/09/1997	CHANNEL	Tabanidae	1
	18/09/1997	CHANNEL	Tanypodinae *	1
	18/09/1997	CHANNEL	Nematoda indetermin.	1
	18/09/1997	CHANNEL	Oligochaete indeterm.	2
Moolyall Creek	18/09/1997	CHANNEL	Aeshnidae	1
(Reference site)	18/09/1997	CHANNEL	Ceinidae	3
(Moolyall Road)	18/09/1997	CHANNEL	Ceratopogonidae	2
	18/09/1997	CHANNEL	Chironominae *	3
	18/09/1997	CHANNEL	Corduliidae	1
	18/09/1997	CHANNEL	Corixidae	2
	18/09/1997	CHANNEL	Culicidae	1
	18/09/1997	CHANNEL	Dytiscidae	2
ESP24	18/09/1997	CHANNEL	Haliplidae	1
ESP24	18/09/1997	CHANNEL	Leptoceridae	1
ESP24	18/09/1997	CHANNEL	Lestidae	2
ESP24	18/09/1997	CHANNEL	Notonectidae	2
ESP24	18/09/1997	CHANNEL	Stratiomyidae	1
ESP24	18/09/1997	CHANNEL	Tanypodinae *	2
ESP24	18/09/1997	CHANNEL	Oligochaete indeterm.	2

** Data obtained from CALM, AUSRIV program.*

At the Carlingup Road Crossing sample site, sampling of aquatic invertebrates as well as examination of fish stomach contents indicates that the following macroinvertebrates in decreasing order of abundance are present: chironomid larvae, copepods, coleopteran larva (Dytiscidae), trichopteran larvae, adult chironomids, zygopteran larvae, adult coleopterans (Dytiscidae), amphipods, anisopteran larvae, corixid larvae and ostracods.

This indicates a fairly low level of species richness. Additionally there are wide fluctuations in the seasonal biomass of aquatic invertebrates. There are only very low numbers of species and individuals in high river flows and late summer flow events.

3.1.4 Fish of the Jerdacuttup River

An unpublished study of riverine fish in the South West of WA by David Morgan found three fish existed in the upper reaches of the Jerducuttup River. They included the spotted minnow (*Galaxias maculatus*), Swan River goby (*Pseudogobius olorum*) and Wallace hardyhead (*Atherinosoma wallacei*) (David Morgan, pers. comm., 2000). Black bream (*Acanthopagrus butcheri*) are also present in the river.

Wallace hardyhead (also commonly known as Western Hardyhead) are small, silvery fish that tend to swim around in schools. They are generally an olive-green colour with silvery sheen on its sides and belly. It is normally seen in schools near the surface or around shoreline vegetation and log debris. Spawning occurs during spring and summer months. The diet consists largely of insects and small crustaceans (Allen, 1989).

Spotted minnow *(Galaxias maculatus*) is a small fish that is found in a variety of habitats, but is most common in still or slow-flowing waters, mainly in streams, rivers and lakes within a short distance of the sea.

Swan River gobies are fish with a brown or tan colour with narrow, darker brown blotches. It is a silvery white colour on the belly, and the dorsal fins may have irregular blackish stripes. It is found in many parts of Australia and inhabits streams, ponds and brackish estuaries. It is usually found over mud bottoms, sometimes among weeds or adjacent to rocky areas. Spawning occurs during Spring, and each female deposit up to 150 eggs. The male guards the eggs during the incubation periods. The larvae then often migrate to fresh water however there is evidence that some populations are landlocked. The diet consists mainly of insects, crustaceans and algae (Allen, 1989).

Black Bream (*Acanthopagrus butcheri*) are present in the river at least as far upstream as Buegge Road. There is debate as to whether Black Bream occur naturally in the Jerdacuttup. Elsie Penglase (pers. comm.) is adamant that they were not present until introduced from the Steere River by her mother (Mary Daniels *nee* Wellstead) in 1932. Ernest Hodgkin (pers. comm.) believes they were probably present in the Jerdacuttup prior to then but not detected. It seems unlikely that someone of such pioneering credentials as Mary would have been unaware of Bream in the river for 20 years!

Swan River Goby (photograph Kaylene Parker)

3.2 Jerdacuttup Lakes

The Jerdacuttup Lakes are two coastal lagoons or a 'fossil estuary' that no longer have a connection to the sea. A 10 m-high, stable dune separates the Jerdacuttup Lakes from the sea. The Jerdacuttup Lakes absorb the flow from the Jerdacuttup River but never break open to the sea. The lake system comprises two larger lakes of areas 380 and 150 ha as well as numerous swamps to the east of the lakes. The lake has a muddy bottom, becoming sandier towards the margins. The river has sand in the shallower and mud in the deeper parts.

The open water and paperbark tree swamps of the Lake system extend for 15 km along a shallow depression behind the coastal dunes. The large western lake is separated from the sea by a densely vegetated foredune – 1 km long, 8-10 m high and 50 m wide. The Jerdacuttup River enters the western lake through a swamp, which restricts river flow to the lake, but during floods the water then backs up the river and over Sprindale Road. Two small streams drain to the smaller eastern swamps.

3.2.1 Water characteristics

The lake water is saline - and becomes increasingly saline as the water evaporates. Between 1981 and mid-1985 salinity varied with depth between 50 and greater than 100 ppt (Jaensch *et al.,* 1988).

Samples taken from the lake show that the water can vary from almost fresh when full to brine when it dries out. It only becomes much greater than sea water salinity when the water level falls below the samphire fringe, and there is still 2 m in deeper parts of the lake. Records of flowing river water at Springdale Road are of about 6 ppt with less than 2 ppt in September and October 1989. The few records indicate that the river is seldom more than half the concentration of seawater and often less. It was 15 ppt in April 1977 but in October 1973 it had been about 70 ppt (Department of Fisheries records).

3.2.2 Water depth

Depth of water in the lakes varies from 5 m in flood to nil in drought. When flooded, with water over the Coast Road (ie. 1986, 1987 and 1989), there is about 5 m of water in the centre of the lake, and 2 m over the samphire fringe. In January 1990, the water level in the lake was 3.3 m above Australian Height Datum. All this water may be lost by evaporation after years of low rainfall leaving the lake bed dry. The river however always holds water, with 3–4 m on the bends when flooded and probably only 1–1.5 m at other times.

3.2.3 Geological history of Jerdacuttup Lakes

Hodgkin and Clarke (1990) considered that the lakes have not been an estuarine since the Holocene rise in sea level 6000 years ago; this then is likely to be the last time the Jerdacuttup River had contact with the sea. At first the estuaries were always open to the sea, where tidal water flowed into them. The Jerdacuttup Lakes would have been deeper than they are now, probably with channels through the spongolite to hard rock. Sediment from the catchments and the beaches has progressively shallowed the lagoons and reduced their volume. Growth of the bar reduced exchange with the sea or limited it totally. Coastal dunes were formed during the previous interglacial periods, which has subsequently cemented to form limestone.

3.2.4 The bar

For a kilometre, the coastal dune is only 60–120 m in width and about 12 m in height. It is well vegetated with trees and shrubs, but appears to be unconsolidated sand, unlike the higher and wider dunes to the east and west, which are dune limestone. Limestone reef rock is exposed at water level along the seashore, and along the entire length of the lake system.

3.2.5 Management status

The lakes system is contained within nature reserve no. 40156 of which 6 620 ha is vested in the Conservation Commission. The Department of Conservation and Land Management monitors the lakes for their waterfowl attributes. Twenty-six species have been recorded including four trans-equatorial migrants protected by international treaty (the Japan–Australia Migratory Bird Agreement), as well as two threatened species – the hooded plover and freckled duck.

South coast reserves between Esperance and Fitzgerald River National Park, including the Jerdacuttup Lake Nature Reserve have been recommended for inclusion on the Register of the National Estate.

4 State of the Jerdacuttup River

4.1 Overall state of the Jerdacuttup River

4.1.1 Foreshore vegetation condition

Foreshore vegetation or riparian vegetation is any land, which adjoins directly influences or is influenced by a body of water. This is described as the 'last line of defence' for aquatic ecosystems. Foreshore vegetation is important as it supports a high diversity of plants and animals. Foreshore vegetation also regulates instream primary production as it provides the energy and nutrients essential to aquatic organisms.

Assessing foreshore vegetation is a quick and simple way to determine the condition of a river – as it indicates what level of degradation the system is undergoing or has undergone. Riparian vegetation is primarily affected by the grazing of stock, weed invasion and secondary salinity.

The foreshore vegetation survey of the Jerdacuttup River indicates that 81% is in excellent condition (A grade), 14% is in good condition with some signs of weeds (B grade) and 5% showing erosion and weeds (C grade) according to the Pen and Scott (1995) method. Distributions of these conditions along the river are displayed in table 4.

It is evident that the sections of river that are either B or C class is where it is in close contact with cleared agricultural lands. Here there are signs of degradation including tree deaths, weed invasion, and some erosion and sedimentation of the main channel.

4.1.2 Erosion and sedimentation

Erosion and sedimentation are indications that the river is showing signs of stress. This is often caused when the foreshore vegetation is degraded, and the banks actively erode and deposit the sediment into river pools.

Erosion and sedimentation were recorded in sections of the river designated as B or C class. Although a certain degree of either of these phenomena may be considered a 'natural ' part of river function, erosion in particular was observed where tributary flow from cleared lands entered the main channel. At these points, soil is usually completely lost and plants, if still present, have exposed roots.

The other manifestation of erosion on the river is gullying of tributaries occurring up to 50 m from the channel. This occurs in situations of narrow riparian corridors where the outer riparian vegetation has not arrested the increased volume and velocity of paddock runoff. Fortunately, both topsoil stripping and gullying are restricted to relatively few isolated occurrences at present along the Jerdacuttup River.

Section of river graded as A grade condition (photograph Kaylene Parker)

Table 4. Foreshore assessment results

	SECTION	LENGTH (km)	CONDITION	COMMENTS/LOCATION
Floater Road	1	2.0	A2	
	2	2.4	A2	
Woodenup Road	3	2.0	A2	
	4	2.0	A2	
	5	2.0	A2	
	6	2.0	A2	
	7	2.0	A2	
	8	2.0	A2	
	9	2.0	A2	
	10	2.0	A3	
Carlingup Road	11	2.0	A3	
	12	2.0	A2 & A3	1 km A2, 1 km A3
	13	1.8	A3 & B2	1.4 km A3, 0.4 km B2
Cordingup Creek	14	2.2	A3 to B3	score B2
	15	2.2	A3 to B3	score B2
	16	2.1	A3 to C1	score B2, except 0.2 km C1
	17	2.7	A3 to C1	score B2, except0.3 km C1
Highway One	18	1.5	A3 to C2	score B2, except0.1 km C2
	19	2.0	A3 to C1	score B2, except 0.3 km C1
	20	3.0	A3 to C1	score B2, except 0.4 km C1
Maydon south	21-31	22.0	A1-A2	
	32	2.0	A2	
Jerdacuttup North Road	33	2.0	A3-B1	1.5 km A3, 0.5 km B1
	34	2.0	A2	
	35	2.0	A2	
	36	2.0	A2	
	37	2.0	A2	
	38	2.0	A2	
	39	2.0	A2	
	40	2.0	A2	
	41	2.0	A2 & B3	1.8 km A2, 0.2 km B3
Buegge Road	42	2.0	A2 & B3	1.8 km A2, 0.2 km B3
	43	2.0	B1 & C3	1.9 km B1, 0.1 km C3
	44	2.0	A2	
Springdale RoadCannery Pool	45	3.0	A3-C1	west bank A3-B3, east bank A2-C2
	46	3.0	B1-C3	west bank C3, east bank B1
	47	1.5	A2	

4.1.3 Water quality

There is no long-term data to ascertain the long-term trends of water quality in the Jerdacuttup River. The snapshot data, taken as part of this project, indicated that parametres such as conductivity, temperature and flow show the great variation. The nutrient samples indicated levels greater than ANZECC guidelines, however, further sampling is required.

There is no data to support the contention that the salt content of the River is increasing. Unlike the Phillips River there is no extensive vegetative change from which salinisation can be inferred.

4.1.4 Catchment hydrology changes

Hydrological changes in the catchment are evident from both deaths and stress to vegetation, particularly obvious in swamp yate trees, along tributaries and the main channel. There is however no data to substantiate hydrological change as there is no gauging station or weir on the Jerdacuttup River and monitoring bores and piezometers have only recently been installed. Those installed in the Yallobup subcatchment in 1986 show a short-term response to local rainfall events rather than a rise in the watertable (JPCMS, 1997). Similarly 30 bores and piezometers installed in the Woodenup-Moolyall subcatchment in 1998 have not yet registered any watertable rise (Jenny Chambers, pers. comm.). This may be due, in part, to on ground works particularly 400 ha of lucerne planted in the upper catchment.

BHP Billiton has recently installed bores in the Jerdacuttup catchment as part of their environmental and resource investigations for the Ravensthorpe Nickel Operations Project. These may offer indications of hydrological change in years to come.

In spite of this dearth of hydrogeological data there is anecdotal information that flood and flow frequency and volume may be increasing. Rod Daw, who has had a life long association with the river, says that the flood of January 2000 and the winter-spring flow of 2001 were the greatest summer and winter flows he has experienced (pers. comm., 2001). Unlike the Phillips River, where substantial vegetation change due to salinisation/waterlogging has been documented (Department of Environment, 2003), the death of swamp yate trees may indicate that the Jerdacuttup River is starting to exhibit signs of system stress. In the absence of any past salinity data and given the enormous fluctuations in 'background' salinity it is not possible to say whether salinisation is yet affecting the Jerdacuttup River.

Section of the Jerdacuttup River showing erosion of the bank – caused by cattle access and the resultant loss of foreshore vegetation (photograph Kaylene Parker).

Dead vegetation on Woodenup Creek crossing/Woodenup Road due to waterlogging and possibly secondary salinisation (photograph Kaylene Parker)

5 General management recommendations

5.1 Overall management recommendations

The general conclusion arising from this survey is that the Jerdacuttup River is in very good condition in comparison to other rivers in the South Coast Region. There are however, indications of early stage system stresses – particularly in the duration of the rivers wetting cycle and waterlogging – and there are localised areas of degradation which could benefit from remediation. The following recommendations are made in the light of these conclusions and they recognise that some initiatives require a whole of catchment approach and some can be met at the smaller landholder scale.

A management recommendation that applies to the entire main channel of the river and upon which all specific recommendations are contingent for their success is that the riparian corridor be widened where indicated and that an appropriate land tenure and vesting for the corridor be implemented.

5.1.1 Fencing

Controlling the access of livestock to rivers is a simple management decision that will improve the condition of a river. It is generally recommended that riparian zones are fenced to completely exclude stock l– particularly where the river banks are steep and where the embankments are poor to moderately cohesive. Fencing is recommended in most sections of the river, however in lower order streams, fencing may be used to manage stock to encourage natural regeneration of the bush while minimising weed invasion in heavily degraded systems.

Fencing on the Jerdacuttup River fencing is required over 53 km of the 98 km assessed The broader issue is that in many places when the original farm blocks were surveyed the boundaries were set too close to the river – often only with a 20 m vegetated corridor. This applies in particular to sections 11-20 and 33-43. The former is Unallocated Crown Land (UCL) through Jerdacuttup Pastoral Company and the latter is reserve number 31760 on the west side of the river between North Jerdacuttup and Springdale roads. To maintain the structural integrity of the river and its conservation and amenity value there is a compelling case to initiate whole of government support for extending the riparian corridor, vesting it in an appropriate body and compensating affected farm businesses for the loss of land.

Particular fencing requirements include:

- Section 13 west side of CG 170 c. 1 km;
- Section 18 west side of CG 54 near bend in river c. 400 m; and
- Section 18 south-east side of CG 47 old fence requires replacement c. 1 km.

5.1.2 Crossing construction

Most river crossings on the Jerdacuttup River are for movement of stock and farm machinery. They are already in place and with few exceptions are appropriately located. Any further crossing construction should only be done with reference to the following guidelines:

Crossings should be established where sediment deposition is occurring rather than erosion, and where the bedrock is rocky and hard. The crossing should preferably use the existing base of the channel and lined with small stones rather than the use of culverts, which increase the erosive power of the water downstream. The following are some basic principles for crossing design.

1. *Firm foundations* – choose a site that has stable soil or visible rocks in the river. Sandy bottoms and river pools are the worst locations, with rock sheets and clay soils being the best.

2. *Straight river section and crossing* – choosing a straight section of river is very important if you want your crossing to survive those big storm events and floods. Putting a crossing on a bend means in high flows the erosive force of the river acts mainly on one point of the crossing rather than equally on all points of the crossing if on a straight stretch of river.

Fence line showing the difference between an unfenced and a fenced river corridor. Note the erosion and bank slumping in the unfenced section, in comparison to the well vegetated adjacent foreshore (photograph Andy Chapman)

Inappropriate fence location due to inadequate foreshore reserve width (photograph Kaylene Parker)

Crossings on bends will wash out more often than crossings on straight sections. Also make sure the crossing goes straight across the river and not on an angle or the same principle applies.

3. *Angled approach roads* – roads that head straight down a steep river embankment are more likely to erode. Therefore build an approach road across and angle it down the embankment to minimise erosion of the road.

4. *Crossing materials* – heavy, small rocks are probably the best materials that most farmers have available. Some use concreted meld mesh. Ensure a mixture of sizes rather than all the same size.

5. *Height of crossing* – keep the crossing low and flat so that when high flows occur the water flows over the top of the crossing and not through the crossing. A rocky crossing which follows the stream contour is more likely to survive high flows than a culvert.

Crossing showing good design – following the contour. Small rocks could be placed to minimise the amount of water the vehicle drives through (photograph Kaylene Parker).

For further information on designing river crossings please read Water Note 6: *Livestock Management – Construction of Livestock Crossings* or phone the Department of Environment in Albany on (08) 9842 5760 or visit the web page www.wrc.wa.gov.au.

5.1.3 Revegetation

Riparian vegetation along a river is important because it helps combat erosion, is necessary for the maintenance of habitats, bio-filtering and ecological corridor functions of the river and to preserve the riverine landscape (APACE and Pen, 1995). Apart from 3 km on the west side of the river south of Springdale Road only a few very localised sections of the Jerdacuttup River are devoid of vegetation and would benefit from rehabilitation. An appropriate prescription for rehabilitation for these would include fencing the riparian vegetation, very lightly scarifying bare areas along the contour and applying brushing and bush mulch from adjacent weed-free sites. The latter can be readily achieved by incorporating fruiting berry saltbush (*Atriplex semibaccata*) plants in the mulch mix. Once there is some build up of organic matter, vanilla wattle (*Acacia redolens*) would be an appropriate plant to seed. Both the above are local native species that occur on the Jerdacuttup River.

Recommendation 2. The Department of Environment and the Ravensthorpe LCDC negotiate with the land managers over fencing and revegetation projects for the river frontage of locations 37, 38 and 21.

5.1.4 Weed management

Seventeen weed species were recorded along the Jerdacuttup River during this survey. A comprehensive survey would record many more, particularly introduced grasses. Weed occurrence on the river is sporadic with weeds being the dominant vegetation only in very few situations. However weeds are an issue and their management is very difficult and labour intensive.

The best method of weed control is prevention of establishment by ensuring minimal disturbance of native vegetation (Hussey et al., 1997). Burning can also increase weed invasion, as bare ground is a perfect place for weed seeds to establish – especially after a fire. This can cause an even greater fire risk.

Therefore if resources were available, a weed action plan for the Jerdacuttup River would probably recommend that sporadic occurrences of bridal creeper be identified, and depending on their extent, be biologically or chemically controlled. For this reason the following information is included:

Bridal creeper *(Asparagus asparagoides)* control

This creeper bears small glossy leaves, white flowers, then red berries. It is spread by birds and smothers native vegetation. Underground tubers form a dense mat and control is very difficult. For manual removal stems can be pulled before buds are formed. Chemical control methods include using a sponge or spot spraying larger plants with 1L of Roundup (glyphosate) in 2L of water. Best results are achieved when flowering (August – September). Application needs to be repeated every year to be effective. Currently a leafhopper (*Zygina* sp.) and the rust fungus (*Puccinia myrsiphylli*) are being used for biological control and these may be more effective than chemical control or hand-pulling. Redistribution of the leaf hopper and rust virus around local areas will help speed up their dispersal.

Recommendation 3. The Department of Environment discuss with the Ravensthorpe LCDC and the local weeds action group the feasibility of a Weed Action Plan for the Jerdacuttup River.

5.1.5 Erosion and sedimentation

Widespread erosion and sedimentation are not present on the Jerdacuttup River. There are localised pockets of erosion that have been identified and the degree of sedimentation is probably no more than natural. The treatment of minor erosion is usually conducted at the landholder scale with LCDC or other support. The following information takes this into account.

Eroding stream embankments can be protected and repaired in a number of ways, however, ultimately the bank must be revegetated to be stable. Methods of bank stabilisation will depend on the steepness of the slope, the power of the water flow in a normal year and the cost and availability of materials.

Brushing involves cutting trees, or branches from trees and securing them to the bank to provide erosion protection. This method is most applicable where bank erosion is caused by direct washing action of the water removing material from the face of the bank. The brush needs to be anchored to the top of the bank. This can be achieved by encasing the brush in old ringlock fencing wire. The bank may need to be battered prior to placing the material on the bank (Davey, 2000). Brushing using *Melaleuca cuticularis* or other locally occurring melaleuca species is recommended. The seed can be released from the brushing and can provide natural regeneration with the woody cover providing protection for the seedlings. Brushing is only a temporary stabilisation technique that relies on establishment of vegetation on the bank. This technique is not as stable as harder methods, however, it is one of the cheaper options that encourages natural regeneration.

Vegetative mats can be used to stabilise banks, however the bank will need to be battered prior to laying the mats. Burying the edge and pinning them to the banks can secure mats. Seed can be spread beneath the mats and mats wetted along the bank contours. The mats have a limited life and require vegetation to establish. This is also a relatively inexpensive option.

5.1.6 Salinity and waterlogging

Salinity affects the production capabilities of the land, threatens the economic feasibility of farming systems and degrades our natural environment. A whole catchment approach is needed when tackling salinity and waterlogging issues. This involves changing farm management practices to reduce the amount of recharge.

Recharge is rainfall that soaks deep into the soil and replenishes the groundwater. This causes the watertable to rise and bring the stored salts in the soil with it (Negus, 1991). The current options being used in salinity management in Western Australia are to:

1. Increase water use of annual crops and pastures. Annual crops and pastures allow nearly twice the amount of recharge in comparison to native vegetation.
2. Grow perennial pastures: eg. tall wheat grass, lucerne, kikuyu and fodder crops including tagasaste (*Acacia saligna).*
3. Control surface water: using banks and drainage structures.
4. Grow summer crops: this utilises untapped summer rain eg. forage sorghum, grain sorghum, sunflowers – when the season permits.
5. Use perennial forage plants on salt-affected land as this provides surface mulch to reduce salt accumulation on the soil surface and the plants use groundwater.

Taken from Negus (1991)

5.1.7 Water quality and eutrophication

The main management actions employed to reduce the risk of nutrient enrichment of waterways include:

- conducting soil tests to ensure that your fertilizer regime is appropriate and that there is minimal run-off into the waterways.
- ensuring that sewerage systems in the catchment do not transport run-off into the downstream waterways, in particular that they have an adequate depth to groundwater and are situated where the effluent is not able to run-off to nearby waterways.
- ensuring an adequate buffer of vegetation exists along waterways to trap nutrients that run-off, and also to ensure that the banks do not erode and transport nutrients into the system.

5.1.8 Feral animal control

Feral animals recorded on the Jerdacuttup River include foxes, rabbits and goats. The latter were not evident at the time of survey. In addition dingoes are occasionally reported along the river and sheep and cattle from managed flocks find their way into the riparian corridor when fences are damaged or non-existent.

Rabbits present the greatest feral animal threat to the river. Although they were only occasionally recorded during the survey, they can be present in very high numbers as evidenced by disused warrens. Rabbits in this area favour sandy soils on slopes. These soils are inherently fragile to wind and water erosion and the effects of vegetation removal, and are among the first soils to be colonised by weeds.

The threat that foxes pose to native fauna is well documented e.g. Kinnear (1989) and several of the threatened species known from the catchment, particularly mallee fowl and tammar wallaby, are vulnerable to fox predation. Dingoes, because of their lower numbers in the catchment, are perceived more of a threat to sheep farming than native fauna. Foxes and dingoes are controlled by the Department of Conservation and Land Management.

Rabbits are not subject to any integrated control; they are poisoned, shot or their warrens ripped on an individual landholder basis. The requirement for rabbit control in the riparian corridor can only be met if there is control on adjacent farmland and *vice versa.* There is a compelling requirement for control in situations where revegetation or rehabilitation is prescribed. Goat control by shooting must be a high priority if further animals are located, as they cause considerable damage to foreshore vegetation.

5.1.9 Fire management

Fire is a natural part of the Australian environment and riparian corridor vegetation is no exception. Fires along the river may be due to lightning strike, clearing or hazard reduction burn. The former is by far the most common cause of fire. In the Jerdacuttup River catchment there is a lightning ignition most summers and every 3-4 years there is a fire along the river. Areas burnt extend from a few to hundreds of hectares.

Management of fire in riparian corridors is particularly difficult because of dense vegetation and high fuel loads, steep slopes and difficulty of access in many cases. In addition the bare soil exposed by fire is particularly prone to weed invasion due to the tendency of seed and plant material to progress down slope.

Fire management on Unallocated Crown Lands in the catchment is under the control of local brigades under the direction of a Chief Bushfire Control Officer. The Department of Conservation and Land Management provide some resources and management input on lands that are proposed for management by them. The Fire and Emergency Services Authority provides financial, advisory, communications and extension support.

One area of riparian vegetation causing some concern is un-vested reserve number 31760 on the east side of the river between North Jerdacuttup Road and Springdale Road where the vegetation is dense mallee and shrubland which has not been burnt since 1962. Much of the quality and character of the river here is due to this vegetation and there is a requirement to manage it actively rather than by neglect.

Recommendation 4. Develop a fire management plan for the reserves along the Jerdacuttup River, under direction of the Chief Bushfire Officer with advice from local brigades, local landholders, Department of Conservation and Land Management and the Department of Environment.

5.1.10 Land use and development (mining)

It is possible that the Ravensthorpe district is on the cusp of a new wave of mining development, which has the potential to impact directly or indirectly on the Jerdacuttup River and its catchment – particularly with population growth. A study has been commissioned to address these issues in general but not their particular catchment impacts. There is any opportunity to evaluate catchment impacts of proposed developments, which might present options to better manage the river.
Four mining proposals, one of which is at the near completion stage, have the potential to impact on the river and its catchment.

1. The Tectonic Resources NL Rav 8 Nickel Mine situated on Bandalup Creek is nearing completion.
2. The proposed BHP - Billiton, Ravensthorpe Nickel Operations project at Bandalup Hill is at the advanced planning and design stage. If this project proceeds there will be new residential sub-division of the Ravensthorpe townsite.
3. The proposed Tectonic Resources Trilogy open-pit gold mine.
4. The proposed Tantalite mine on Cattlin Creek.

Any future land use changes or cadastral changes that could also affect the health of the river should be assessed and options to improve the river examined. For example, a subdivision on land adjacent to the river reserve, could request widening of the riparian corridor. For example, the Lakes Entrance housing sub-division south of Springdale Road and west of the river is a good example of how riparian vegetation could have been protected through the development process. A foreshore management plan could have been requested as a condition of subdivision.

Recommendation 5. Any future land use changes or cadastral changes that could potentially impact on the health of the riparian vegetation – include scheme amendments and conditions to help ensure the long-term protection of the river. In particular, any future subdivision along the river should request the extension of the foreshore reserve to an adequate width.

Stormwater is also a concern for the health of the Jerdacuttup River. The majority of the town's stormwater flows to the Jerdacuttup River. Stormwater detention ponds and gross pollutant traps are examples of management options.

Recommendation 6. The Department of Environment recommend that the Shire of Ravensthorpe complete a Stormwater Protection Plan to minimise the impact of stormwater on the health of the Cordingup Creek and the Jerdacuttup River.

The Jerdacuttup River is a relatively unknown river. Many local residents have special spots that they visit for annual barbeques and picnics. These sites are currently adequately managed however any further increased recreation or tourism on the river is likely to lead to degradation of its natural assets. If tourism continues to increase, it is recommended that the Shire of Ravensthorpe develop a specific tourism management plan to ensure the appropriate provision of facilities and management of any potentially damaging activities. For example, boat access on Springdale Road occurs down the edge of the river bank. This site is too steep and considerable track damage will result if too many people start to use this site. The Shire of Ravensthorpe should assess options to install a proper boat access facility if this is deemed suitable through the tourism management plan.

In addition to this, there is relatively little known about the Jerdacuttup River. To increase community awareness of the river, and how they could protect it - an interpretive strategy could be developed. This would ensure there is appropriate signage with key messages. This also could tie in with the tourism management plan developed by the Shire of Ravensthorpe.

Recommendation 7. Encourage the development of an interpretive strategy for the river system. This is to include signage, pamphlets and walk trails to raise awareness of the values of the Jerdacuttup River and how the community can protect the river.

6 Foreshore survey: results relevant to river section

This section describes the river corridor sections that were surveyed. It includes vegetation type and condition, management issues such as weed invasion, fencing and crossing design and specific management recommendations for each section.

6.1 Sections 1–2 Floater Road to Woodenup Road (4.4 km)

Foreshore vegetation condition

The foreshore vegetation conditions in these sections of the river is almost pristine. The presence of the odd weed species and rabbit damage resulted in grading the river channel as A2 condition.

FLOATER ROAD

Section	Length (km)	Condition
1	2.0	A2
2	2.4	A2

Riparian vegetation and river characteristics

Granite rocks that are completely exposed, or only covered by very shallow soil, dominate the character of the river along this portion. Much of the river bed here is bare granite. There are numerous seasonal fresh water seepages into the river partly due to the abundant hallow rocks. The outer riparian vegetation is typically mallee with *Melaleuca uncinata* and *Leptospermum erubescens* shrubs on coarse red brown loamy sand. Understorey species include *Borya nitida* and *Lepidobolus chaetocephalus.*

In-stream vegetation, where it occurs, consists of *Melaleuca cuticularis* shrubs to 3 m, with occasional *Callistemon phoeniceus* over succulent groundcovers *Sarcocornia* sp. and *Disphyma crassifolium.* Towards Woodenup Road, on deeper soils, is a small patch of rock sheoak (*Allocasuarina huegeliana*) and swamp yate (*Eucalyptus occidentalis*) woodland.

The most upstream point at which spotted minnows (*Galaxias maculatus*) were recorded during this survey was at 33^0 26.433' S, 120^0 02.399' E in this portion.

Weeds and feral animals

Weeds along this portion were very few and far between and included: Pimpernel (*Anagallis arvensis*), milk thistle and black nightshade (*Solanum nigrum*). These plus the occasional sign of rabbits are the only disturbance to the river.

Management recommendations:

- **There are no specific management recommendations for this section of the river.**

Moolyall Floater Road (photograph Andy Chapman)

6.2 Sections 3–10 Woodenup Road to Carlingup Road (16 km)

Foreshore vegetation condition

The foreshore vegetation in these sections of the river is almost pristine. The presence of a few weed species resulted in the grading of the river corridor as A2 condition.

WOODENUP ROAD

Section	Length (km)	Condition
3	2.0	A2
4	2.0	A2
5	2.0	A2
6	2.0	A2
7	2.0	A2
8	2.0	A2
9	2.0	A2
10	2.0	A3

Riparian vegetation and river characteristics

For sections 3–7 granite rocks further dominate the character of the river; soils are shallow and loamier than further upstream. The outer riparian vegetation is quite variable with shrublands of *Melaleuca uncinata, Callitris roei* interspersed with low woodland of jam (*Acacia acuminata*) or rock sheoak with a tea tree (*Leptospermum* sp.) understorey. Swamp yate woodlands are restricted to areas of deeper sandy loams where they usually have a dense sedge understorey. In-stream vegetation is dominated by either *Melaleuca cuticularis* or *M. viminea* shrubs to 3 m with *M. elliptica* and *Callistemon phoeniceus.* In section 4 on the west side of the river a small lightning ignited wildfire burnt in summer 1998/99.

In sections 8 and 9 the river comes under the influence of the topography and greenstone rock of the Ravensthorpe Range. The valley has much steeper sides and the vegetation is very different; there are open woodlands of *Eucalyptus cylindroidea* and complex dense shrublands with *Hakea verrucosa, Hybanthus floribundus, Acacia erinacea* and *Oxylobium parviflorum.*

In section 10 the river follows a greenstone/granite discontinuity with *Eucalyptus extensa* mallee on greenstone on the west side and quandong (*Santalum acuminatum*) shrubs over sedges on granite on the east side.

Weeds and feral animals

Weeds in this section include: pimpernel, cape weed (*Arctotheca calendula*), milk thistle, and bridal creeper (*Asparagus asparagoides*). Weed infestations are few. Tracks of goats and dogs (probably dingoes) were present. Rabbits were abundant in section 10.

Management recommendations:

- **Control a local infestation of bridal creeper in section 9.**
- **Monitor and control rabbit numbers in section 10.**

6.3 Sections 11–13 Carlingup Road to the Cordingup Creek confluence (5.8 km)

Foreshore vegetation condition

In section 12, the vegetation is A3 condition at the beginning of the section, and then towards the end it is in slightly better at A2 condition.

Condition in section 13 is A3 – B2 dependent upon the degree of weed infestation and the decline in vegetation due to stock access. Where the vegetation is not fenced there is a noticeable loss of understorey.

CARLINGUP ROAD

Section	Length	Condition	Comments/Location
11	2.0	A3	
12	2.0	A2 and A3	1 km A2, 1 km A3
13	1.8	A3 and B2	1.4 km A3, 0.4 km B2

Riparian vegetation and river characteristics

Sections 11 and 12 traverse the greenstone of the Ravensthorpe Range, this has a pronounced effect on the vegetation and slope of the river valley. Where the valley is steep-sided the outer riparian vegetation is tall mallee, *Eucalyptus myriadena* and *E. extensa* over chenopod shrubs *Maireana brevifolia* and *M.georgei* with *Atriplex nummularia*.

The In-stream vegetation is *Melaleuca cuticularis* and *M. viminea* shrubs to 3 m over samphire (*Sarcocornia* sp.) and *Disphyma crassifolium.* Where the valley is wider and less steep swamp yate woodland over *Callitris roei* and *Acacia redolens* form the outer riparian vegetation. Large river pools, with *Ruppia* sp. are present in this area.

In section 12 there was a prescribed hazard reduction burn in June 2001 on the east side of the river. There are also some recent deaths of swamp yate along this section of river. There are yates on the upper slopes, jams and *Malaleuca* follow the flow of the channel. There are also patches of hakea in places. The width of the fringing vegetation is helping to protect the river in this section.

In Section 13, the vegetation traverses a banded ironstone formation of the Ravensthorpe Range and the valley is very steep. Low woodland of *Eucalyptus astringens* and rock sheoak occupies the ironstone. *Halosarcia* is present along the rivers edge, with some understorey. There are jam trees, patches of salmon gums and weeping sheoak. The instream vegetation is swamp yate woodland over *Acacia saligna.* The river in this section has large river pools, surrounded by spectacular cliffs.

Erosion and sedimentation

In section 12, the river is deepening. Past the crossing, a braided section is present followed by a V-sided valley. Some sedimentation is apparent prior to the river bends. There is a floodplain in this section of the river that needs to be fenced 75–100 m wide, or managed as a floodplain. Bank erosion is visible where the banks are not fenced and a large stabilised sediment plume is obvious.

Jerdacuttup River at Carlingup Road Crossing (Photograph Kaylene Parker)

Weeds and feral animals

Weeds in section 12 include box thorn, patches of bridal creeper and grasses. Weeds in section 13 include milk thistle, barley grass (*Hordeum* sp.), saffron thistle (*Carthamus lanatus*), mallow (*Malva parviflora*), turnip weed (*Rapistrum rugosum*), Maltese cockspur (*Centaurea melitensis*), cape weed, pimpernel, common peppercress (*Lepidium africanum*), wild oat (*Avena barbata*) and bridal creeper.

Management issues

Section 12:

- Not all of section 12 is fenced, and in many sections the fencing is too close to the river on the left hand side.
- Section 12: crossing one is located on a bend at the confluence of the Jerdacuttup River and the Cordingup Creek. This is the most erosive area of a creek, hence is badly eroded. It needs to be either relocated to a more stable location of the river, or redesigned to ensure it survives future flood events. The existing crossing needs to be covered with more small rocks as the gravel is likely to wash away. There is also evidence of erosion from the culvert.
- Section 12: crossing two is located in a good position and the crossing design follows the contours of land. There is an active headcut forming on the access track, which is likely to continue to erode if not stabilized. This will threaten the paddock upstream. Rocks have been placed on the crossing, however, the water has flowed around the rocks. These may need moving to form a more 'v'-styled crossing to encourage the water to flow through the middle of the waterway.
- Section 12: crossing three is not in a good location as it is on a corner – the most active section of a river. The access tracks are steep and likely to erode. Crossing design is relatively stable.

Section 13:

- The right hand side of the river is fenced, however there is a 90-degree bend in the river that is not fenced, with evidence of an old fence that was well situated but requires replacing. The left-hand side is a reserve. Location 174 is not fenced in the second half of the property. Location 607 and 103 are poorly fenced on the left-hand side with only 15 m fenced.
- The crossing in section 13 is in a good location with a natural riffle zone. The access route has the potential to erode, however the grasses have helped to stabilise the crossing.

Many areas of these sections of the river are not fenced, however discussions with the land manager have indicated support for fencing the remaining unfenced sections of the river. The Department of Environment funded a small component of the overall fencing project.

The major issue in these sections is the width and location of the foreshore reserve. In many places the foreshore reserve is inadequate to ensure the long-term protection of the river. The Department of Environment and the land manager are currently seeking options to buy back the land so that it can be part of the foreshore reserve.

Management recommendations:

- **The Department of Environment in cooperation with the land manager examine options to increase the foreshore reserve to an adequate buffer width. This may include a 'buy back' option.**
- **The Department of Environment and the Ravensthorpe LCDC seek funding to help the land manager continue to fence the remaining unfenced sections of the river.**
- **Formulate a weed action plan to address bridal creeper and saffron thistle in particular.**

6.4 Sections 14–17 Cordingup Creek confluence to Highway One (9.2 km)

Foreshore vegetation condition

In section 14 and 15, the vegetation condition ranged from B3–A3, with an overall rating of B2. South of the Highway, the reserve is inadequate to protect the foreshore vegetation resulting in natural attrition and weed invasion. There is evidence of stock damage resulting in a loss of understorey species, and there is a considerable number of dead and dying yate trees.

The vegetation in Section 15 is in C1 condition at the beginning. The low flow channel is well vegetated, although weeds have invaded the upper section. The weed burden is extensive although on the left hand side there is a well-developed understorey. At the ninety-degree bend in the river there is healthy casuarina dominated vegetation although it is fenced too close to the river on the left. Scouring is noticable on the right, ruby saltbush is established and weeds have invaded. Sheep may have access to this area.

In section 16 there are two small locations with degradation, both where small un-named creeks enter the river. Here topsoil has been lost due to the combined effects of sheep grazing and increased water flow at the point of confluence.

A small length of river of approximately 200 m was burnt by lightning ignited fire in summer 1989–90; here there have been some swamp yate deaths due to fire and there is a vigorous understorey of *Acacia saligna*. In sections 16 and 17 there are also signs of stress to swamp yates due to waterlogging and/or salinisation. The buffer width is adequate in this region – though it could be wider on the right hand side. No regeneration is apparent in the first part of the section and yate trees are dying. Trees need to be established to shade out the weed species. The vegetation improves in the next part of the section, with more understorey and a higher abundance of acacias. Mid way along the section the vegetation then declines rapidly, the fence is lost and the weed burden high. There are dead and dying yates and melaleucas. In the end of the section the vegetation is of C2–C3 condition. Melaleucas occur on the edge of the river. Yate trees are dying on the rivers edge and there is no understorey. There is a nice pool riffle sequence at the beginning of this section. Further down is a defined secondary channel, which may be the original river channel that has since moved. At the end of the section where the condition is C2–C3 the river is eroded and the banks are subsiding. The river then deepens and headcuts are beginning.

In section 17 there has been recent mineral exploration by drilling in the riverbed. Condition varies between A3–B3 'averaging' B2 dependent upon degree of weed infestation. Two small sections of 200 m and 300 m at Tributary Creek confluences where there has been erosion, these areas are C1 condition. The banks are steep on the left hand side and gentle on the right.

The vegetation is in B2 condition on the right hand side, where there is a grassy understorey the condition worsens to B3. Past the point where sand has been extracted on the left hand side the vegetation is of A3–B1 condition. On the right hand side at this point there is evidence of wind erosion blowing topsoil into the river corridor. Weeds are established heavily in this section. The sand extraction requires stabilising.

CORDINGUP CREEK

Section	Length (km)	Condition	Comments/Location
14	2.2	A3–B3	score B2
15	2.2	A3–B3	score B2
16	2.1	A3–C1	score B2 0.2 km C1
17	2.7	A3–C1	score B2 0.3 km C1

Riparian vegetation and river characteristics

This portion of the river has a well-developed sequence of pool-vegetated river bed-pool; some of the pools are quite large (300 x 25 m) and permanent. The river is farmed on either side and this has influenced its character. Swamp yate woodland is well developed along the river both in the outer riparian and riverbed zones.

Headcut north of Highway #1 from an access track. This has deposited considerable amounts of sediment into the river pool (photograph Kaylene Parker)

The instream vegetation has a *Melaleuca cuticularis* shrub layer over samphire, *Threlkeldia diffusa* and *Disphyma crassifolium* are also present. In most places the outer riparian zone consists of swamp yate with a vigorous understorey of *Templetonia retusa, Melaleuca uncinata, Halgania andromedifolia* and *Enchylaena tomentosa*. Where soils are shallower the swamp yate is replaced by jam (*Acacia acuminata*) or *Eucalyptus extensa* low woodlands on granite and greenstone respectively.

Weeds and feral animals

Weeds in this portion include bridal creeper (with several heavy infestations), cape weed, wild oats, African boxthorn (*Lycium ferocissimum*) – which is only very occasionally present, barley grass, saffron thistle, pimpernel, wild turnip, common peppercress, mallow, and black nightshade (*Solanum nigrum*). Rabbits are present along the river and at times can be quite abundant.

Weed invasion in section 16 is extensive and includes wild radish and barley grass. Extensive weed control is needed to combat this problem. It is suspected that more light is entering the understorey as a result of the tree deaths and increasing the weed infestation.

Weeds in section 17 are prolific especially on the valley floor where there are patches of bridal creeper. Rabbits are also found in this area.

Erosion and sedimentation

The river channel is undefined with two main channels having formed. The secondary channel is eroding and deepening. Sedimentation of the second channel is evident and there is lots of erosion and braiding. There is a 90-degree bend in this section of the river with many avulsions. The second channel is stripped back to bedrock. The greenstone belt along the river has changed with some sediment plumes evident from the 82/85 flood, which the river is working around. Many of the river pools appear deep.

Management issues

In section 14, the right hand side is not fenced. The left hand side is fenced, but may need to be moved back further as many sections are too close to the river.

- Section 14: crossing one follows the low flow channel. It is in a good location, however needs more rocks. Headcuts are forming on the far channel.
- Section 14: crossing two is in a good location. The access track has some erosion and needs more rocks to help stabilise this. There are dead yate trees at this crossing. The fence on the right hand side is very dilapidated; the fencing on the left hand side is wide and in good condition.
- Section 14: crossing three is located at the end of the section, is not used and eroded. This site is not used because the river is too active here.
- The fencing on the left hand side of section 17 is an old remnant fence and on the right is in good condition. A new fence has recently been erected.
- Section 17: crossing one is unstable at one point on the bend as the river is becoming more braided in this section. Additional rocks are required for stabilisation. Access tracks at this point have headcuts and African love grass is growing at this crossing.
- Section 17: crossing two requires more rocks. The fence on the left at this crossing is old and dilapidated.

Specific recommendations are to:

- **formulate a weed action plan to control African boxthorn and bridal creeper.**
- **The Department of Environment, the LCDC and the landholder discuss means of localised erosion remediation, especially for actively eroding crossings and the headcuts.**
- **The Department of Environment and the Ravensthorpe LCDC discuss with the landholder options to fence unfenced sections of the river and revegetate sections where the yate trees are suffering.**

Weed invasion where the foreshore vegetation has been grazed. Revegetation is required in this section of the river (photograph Kaylene Parker)

6.5 Sections 18–20 Highway One to Maydon south firebreak (6.5 km)

Foreshore vegetation condition

In places, the native, perennial understorey vegetation has been replaced by introduced grasses or weedy brassicas – particularly wild turnip. In a small, localised situation, reduced vegetation cover has led to bank instability, erosion and loss of topsoil. The latter is due to sheep access to the river. More widespread is the situation of stress and some deaths of swamp yate due to waterlogging and/or salinisation. Condition is A3–C2, 'averaging' B2, C2 is restricted to three sections of 100 m, 300 m and 400 m where sheep have had access to river pools.

After the bend in the river, the vegetation changes to greenstone country. Halosarcia, riffle zones, melaleucas and yates are present. The condition is A grade. At the end of section 18, the condition is slightly poorer – A2 due to small infestations of bridal creeper. The buffer width is adequate. Section 18 has extensive river pools, however there is evidence that sediment may have blown in from the surrounding farm land.

Section 19 (Reserve to Jerdi Road)

The vegetation is in A2 condition. Broad valleys are vegetated, with little invasion or disturbance by tracks or weeds. The pools are spectacular and the water appears clear.

HIGHWAY ONE

Section	Length (km)	Condition	Comments/Location
18	1.5	A3–C2	score B2, except 0.1 km C2
19	2.0	A3–C1	score B2, except 0.3 km C1
20	3.0	A3 –C1	score B2, except 0.4 km C1

Riparian vegetation and river characteristics

In this portion the river continues its well-developed, pool-vegetated river bed-pool sequence. The pools are particularly large, to 500 m in length, and they provide habitat for waterfowl, including breeding habitat, not seen elsewhere on the river. The river is under the influence of the greenstone landform and there are

Jerdacuttup River near Highway One (photograph Kaylene Parker)

paddocks on either side. The outer riparian vegetation is either swamp yate woodland often with an *Acacia saligna* understorey over sedges or where there is greenstone outcropping a mixed woodland of *Eucalyptus extensa, E. myriadena* over *Melaleuca cucullata.* Where the valley is too steep to support woodland there is mallee with *Melaleuca uncinata* shrubland. The instream vegetation is *Melaleuca cuticularis* shrubland over samphire or the succulent shrubs *Threlkeldia diffusa* or *Disphyma crassifolium*.

Weeds and feral animals

Weeds present in this portion include: wild oats, rye grass (*Hordeum* sp.), Maltese cockspur, pimpernel, barley grass, milk thistle, wild turnip, cape weed, veldt grass, bridal creeper, African love grass and common peppercress. To the west of Maydon homestead the clay loam soils are replaced by reddish brown loamy sands which have supported large numbers of rabbits; there has been recent rabbit warren ripping in this area.

Weeds in section 18 include wild oats, thistle and bridal creeper which is extensive at the end of the section. Weed invasion in section 19 occurs in the low flow channel only.

Management issues

Section 18

- Both sides of the river are fenced in this section. The left is reasonably fenced on top of the valley and the right is wide enough. Further down the section, the fence is too close to the river in some locations, particularly on the right. The tributary on the right requires fencing.
- The access track for the crossing in section 18 is eroding and needs to be stabilised because it is eroding downstream and is likely to detour around the low flow channel as it is very clogged. The crossing is in a good location.

Specific management recommendations:

- **control African love grass and bridal creeper while they are still localised**
- **The Department of Environment and the Ravensthorpe LCDC seek funding to assist the land manager in fencing the unfenced portions of river.**
- **Revegetate section 18, especially using yate trees to shade understorey species and grasses.**

6.6 Sections 21–32 Maydon south firebreak to Jerdacuttup North Road (24 km)

Foreshore condition

MAYDON SOUTH

Section	Length (km)	Condition	Comments/Location
21-31	22.0	A1–A2	
32	2.0	A2	

Riparian vegetation and river characteristics

This portion of river traverses an extensive greenstone belt and the river valley is steeply 'v-sided. A complex shrubland or mallee comprises the outer riparian vegetation, which in most places, extends to the waterline. In-stream vegetation, where present, is *Melaleuca cuticularis* or *Callistemon phoeniceus* shrubland. Swamp yate woodland is restricted to sharp meanders where small, localized floodplains have developed.

Adjacent landuse is occasional mineral exploration which has not impacted on the river except for a large cleared drill pad on Bandalup Creek. In section 29 there is a terminated meander where the former course of the river is indicated by a horseshoe-shaped billabong.

Weeds

The occasional presence of the weeds Maltese cockspur, pimpernel and milk thistle detract from this portion being rated pristine – hence its A2 designation.

Specific management recommendations:

- **maintain a watching brief over mineral exploration impacts, particularly grid line construction, on the riparian corridor.**
- **Support the Department of Conservation and Land Management's proposed nature reserve.**

6.7 Sections 33–41 Jerdacuttup North Road to Buegge Road (18 km)

Foreshore vegetation condition

Condition is A2–B3, the greater majority being A2, B1 is restricted to a small area of section 33 where there has been historical grazing and B3 to a small weed infestation at the end of Buegge Road.

JERDACUTTUP NORTH ROAD

Section	Length (km)	Condition	Comments/Location
33	2.0	A3–B1	1.5 km A3, 0.5 km B1
34	2.0	A2	
35	2.0	A2	
36	2.0	A2	
37	2.0	A2	
38	2.0	A2	
39	2.0	A2	
40	2.0	A2	
41	2.0	A2 and B3	1.8 km A2, 0.2 km B3

Riparian vegetation and stream characteristics

This portion the river has incised a marine plain, eroding relatively soft sediments and creating a steep-sided 'V shaped' valley. In places the sediments have been eroded back to granite bedrock. The shallow soils and the steep valley determine the nature of the vegetation.

Apart from small local occurrences, swamp yate woodland has been replaced by dense mallee and shrubland that has not been burnt since 1962. The eastern side of the river is protected by between 250 – 1000 m of vegetated corridor of reserve no. 31 760 'park and protection of river and foreshore; on the west side of the river the corridor is only 20–50 m wide and there has been some agricultural encroachment.

Section 33 starts on a high cliff of phyllitic schist with moort (*Eucalyptus platypus*) over *Melaleuca coronicarpa* shrub vegetation. Further downstream the vegetation on the west side of the river has previously been grazed although it is currently fenced; here the 'weedy Acacia', *Acacia saligna* is very abundant. Downstream of a disused fence that demarcates the former grazing, the outer riparian vegetation is a dense mallee/shrubland complex with *Eucalyptus conglobata, Melaleuca uncinata* and *Calothamnus quadrifidus.* The latter plant is particularly abundant, tall and dense along this portion of river. This vegetation type, with minor variations including the addition of the mallees *Eucalyptus pleurocarpa* and *E. tetrapleura,* is repeated

between here and Buegge Road. Understorey species include *Petrophile teretifolia, Grevillea concinna, Oxylobium parviflorum, Halgania andromedifolia, Hakea coryombosa, H. nitida* and *Templetonia retusa.*

Distinct vegetation types of minor occurrence are green mallet (*Eucalypyus clivicola*) low woodland on spongolite, *Eucalyptus angulosa* mallee over *Hakea verrucosa* on limestone, *Nuytsia floribunda* woodland on deeper sands and rock sheoak woodland with *Acacia lasiocalyx* on shallow granite-derived soils. In section 41 is a pool approximately 50 x 400 m, this is the widest pool on the river.

In January 1998 a wildfire burnt *c.* 300 m of riparian vegetation at the end of Buegge Road. The early post fire succession includes *Alyogyne hakeifolia, A. huegeliana* and *Muehlenbeckia adpressa* in a dense shrubland.

Weeds and feral animals

At the end of Buegge Road is a small patch of riparian vegetation cleared for a fence line; here the following weeds were recorded: milk thistle, wild rye, wild oats, storksbill, cape weed, black nightshade *(Solanum nigrum)*, canola, mallow, common peppercress, barley grass and an unidentified white-flowering *Brassica*. This small but concentrated infestation shows how vulnerable river valleys that are near agricultural activity are to weed incursion when disturbed. Weeds recorded in relatively undisturbed vegetation in this portion of river were: blowfly grass, veldt grass, wild oats, peppercress and pimpernel.

Management recommendation:

Formulate fire management guidelines for reserve no.31760 which has not been burnt for 40 years.

6.8 Sections 42–44 Buegge Road to Springdale Road (6 km)

Foreshore vegetation condition

The condition of the river corridor is graded as A2–C3. The greater majority is A2. The section graded as B3 is due to a small outbreak of weeds at the end of Buegge Road. The section graded as C3 is due to the eroding gullies near the north-east corner of CG 203.

BUEGGE ROAD

Section	Length (km)	Condition	Comments/Location
42	2.0	A2 and B3	1.8 km A2, 0.2 km B3
43	2.0	B1 and C3	1.9 km B1, 0.1 km C3
44	2.0	A2	

Riparian vegetation conditon and river characteristics

There are two vegetation types abundant along this portion of river: a dense thicket with *Acacia lasiocalyx* and *Calothamnus quadrifidus* where granite rocks are outcropping and a mixed mallee and shrubland with *Eucalyptus pleurocarpa*, Chittick (*Lambertia inermis*) and low *Nuytsia floribunda* over *Dryandra sessilis, Adenanthos cuneatus*, and *Petrophile teretifolia* with *Lepidobolus chaetocephalus* ground cover. In section 44 there is some swamp yate woodland over sedges. In-stream vegetation along these two portions consists of tall *Melaleuca cuticularis* and *M. viminea* shrubland with occasional *Callistemon phoeniceus*.

Erosion and sedimentation

In section 43 near the north-east corner of CG 203 are two deep eroding gullies (3m in depth) caused by run-off from a paddock.

Weeds and feral animals

Weeds are only occasional with pimpernel and bridal creeper present, the latter was only recorded near Springdale Road.

Management recommendations:

- **Slow water run-off from adjacent paddocks through appropriate surface water management or revegetation to reduce the erosive power of the water.**
- **Rehabilitate the gully erosion by revegetating and placing rocks in the actively eroding area.**

6.9 Sections 45–47 Springdale Road to Cannery Pool (7.5 km)

Foreshore vegetation condition

The natural vegetation has been altered considerably by agriculture – particularly the perennial native understorey species which have been replaced by introduced grasses or 'weedy' native pioneer species such as *Acacia saligna*. The upper stratum is a tall woodland of swamp yate and swamp paperbark (*Melaleuca preissiana*).

In section 46 the east bank, which was formerly grazed, has now been fenced to exclude stock, however the west bank is still grazed to the waterline. There are no understorey species, either native or introduced and bank stability is severely at risk. The condition of these sections is quite variable dependent on presence/absence of fencing and grazing pressure. The west bank is rated A3–C3 and the east bank A2–C2.

SPRINGDALE ROAD CANNERY POOL

Section	Length (km)	Condition	Comments/Location
45	3.0	A3–C1	west bank A3-B3, east bank A2-C2
46	3.0	B1–C3	west bank C3, east bank B1
47	1.5	A2	

Riparian vegetation and river characteristics

In this section, the river follows a meandering course south for 8 km from Springdale Road. It widens out at points to about 150 m wide. The first 2 km south of Springdale has high sandy banks on the eastern side and 3.5 km on the west. Then there are river floats on the east and flat grazing land on the west. There the banks are only 2–3 m above water level and are bare due to erosion caused by cattle. From 6 km there are wide areas of swamp on either side with paperbark and yate trees, and the river disappears into the dense woodland swamp.

On the eastern side of the swamp, below a steep granite slope, there is a pool that must have formerly been part of the river and into which water seeps from the river. An old meander joins the east at 6.5 km. There are small outcrops of granite near Springdale Road and at 7 km on the east bank. A sharp bend near 1.5 km has exposed an alluvial deposit with pebbles over rock (spongolite) on the east bank. A spring below the escarpment at the next bend feeds a freshwater swamp with tall rushes.

For this portion the river is riverine in character, it is continuous and permanent from Springdale Road to Cannery Pool. The river does not enter Jerdacuttup Lakes by a channel, rather it drains into a dense wooded swamp which in turn drains into the lakes. The river here flows across a well-developed flood plain which was settled and developed for agriculture in 1914.

Specific management recommendations:

- **negotiate a fencing and revegetation project with the land manager for locations 37, 38 and 21.**
- **encourage completion of a specific management plan for the foreshore reserve adjacent to the Lakes Entrance sub-division. This should address stormwater management, construction of walk trails to stop the proliferation of many trails, manage access points to the river, foreshore reserve demarcation, control and eradication of weed species (especially garden escapees).**

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Appendix

Birds recorded on the Jerdacuttup River and Lakes

SCIENTIFIC NAME	COMMON NAME
CASUARIIDAE	
Dromaius novaehollandiae	Emu
ANATIDAE	
Oxyura australis	Blue-billed Duck
Biziura lobata	Musk Duck
Stictonetta naevosa	Freckled Duck
Cygnus atratus	Black Swan
Tadorna tadornoides	Australian Shelduck
Chenonetta jubata	Australian Wood Duck
Anas gracilis	Grey Teal
Anas castanea	Chestnut Teal
Anas superciliosa	Pacific Black Duck
Anas rhynchotis	Australasian Shoveler
Malacorhynchus membranaceus	Pink-eared Duck
Aythya australis	Hardhead
PODICIPEDIDAE	
Poliocephalus poliocephalus	Hoary-headed Grebe
Podiceps cristatus	Great Crested Grebe
ANHINGIDAE	
Anhinga melanogaster	Darter
Phalacrocorax varius	Pied Cormorant
Phalacrocorax sulcirostris	Little Black Cormorant
Phalacrocorax melanoleucos	Little Pied Cormorant
Pelecanus conspicillatus	Australian Pelican
ARDEIDAE	
Ardea novaehollandiae	White-faced Heron
Ardea alba	Great Egret
THRESKIORNITHIDAE	
Platalea flavipes	Yellow-billed Spoonbill
Hamirostra isura	Square-tailed Kite
Haliastur sphenurus	Whistling Kite
Aquila audax	Wedge-tailed Eagle
Falco berigora	Brown Falcon
Falco cenchroides	Nankeen Kestrel
RALLIDAE	
Gallinula ventralis	Black-tailed Native-hen
Fulica atra	Eurasian Coot
SCOLOPACIDAE	
Tringa nebularia	Common Greenshank
Calidris ruficollis	Red-necked Stint
Calidris acuminata	Sharp-tailed Sandpiper
Calidris ferruginea	Curlew Sandpiper
RECURVIROSTRIDAE	
Himantopus himantopus	Black-winged Stilt

Appendix

Birds recorded on the Jerdacuttup River and Lakes (cont)

SCIENTIFIC NAME	COMMON NAME
CHARADRIIDAE	
Charadrius ruficapillus	Red-capped Plover
Charadrius melanops	Black-fronted Dotterel
Charadrius rubicollis	*Hooded Plover*
LARIDAE	
Larus novaehollandiae	Silver Gull
Sterna nilotica	*Gull-billed Tern*
COLUMBIDAE	
Phaps chalcoptera	Common Bronzewing
Phaps elegans	Brush Bronzewing
Ocyphaps lophotes	Crested Pigeon
PSITTACIDAE	
Calyptorhynchus latirostris	Carnaby's Cockatoo
Cacatua roseicapilla	Galah
Glossopsitta porphyrocephala	Purple-crowned Lorikeet
Platycercus zonarius	Australian Ringneck
Purpureicephalus spurius	Red-capped Parrot
Neophema elegans	Elegant Parrot
CUCULIDAE	
Cacomantis flabelliformis	Fan-tailed Cuckoo
Chrysococcyx basalis	Horsfield's Bronze-Cuckoo
PODARGIDAE	
Podargus strigoides	Tawny Frogmouth
HALCYONIDAE	
Todiramphus sanctus	Sacred Kingfisher
Merops ornatus	Rainbow Bee-eater
MALURIDAE	
Malurus splendens	Splendid Fairy-wren
Malurus pulcherrimus	Blue-breasted Fairy-wren
PARDALOTIDAE	
Pardalotus punctatus	Spotted Pardalote
Pardalotus striatus	Striated Pardalote
ACANTHIZIDAE	
Sericornis frontalis	White-browed Scrubwren
Smicrornis brevirostris	Weebill
Gerygone fusca	Western Gerygone
Acanthiza chrysorrhoa	Yellow-rumped Thornbill
Anthochaera carunculata	Red Wattlebird
Anthochaera lunulata	Western Little Wattlebird
Acanthagenys rufogularis	Spiny-cheeked Honeyeater
Manorina flavigula	Yellow-throated Miner
Lichenostomus virescens	Singing Honeyeater
Lichenostomus leucotis	White-eared Honeyeater
Lichmera indistincta	Brown Honeyeater

Appendix

Birds recorded on the Jerdacuttup River and Lakes (cont)

SCIENTIFIC NAME	COMMON NAME
ACANTHIZIDAE (cont)	
Phylidonyris novaehollandiae	New Holland Honeyeater
Phylidonyris melanops	Tawny-crowned Honeyeater
Acanthorhynchus superciliosus	Western Spinebill
Ephthianura albifrons	White-fronted Chat
PETROICIDAE	
Drymodes brunneopygia	Southern Scrub-robin
POMATOSTOMIDAE	
Pomatostomus superciliosus	*W*hite-browed Babbler
CINCLOSOMATIDAE	
Psophodes nigrogularis	Western Whipbird
PACHYCEPHALIDAE	
Oreoica gutturalis	Crested Bellbird
Pachycephala pectoralis	Golden Whistler
Colluricincla harmonica	Grey Shrike-thrush
DICRURIDAE	
Myiagra inquieta	Restless Flycatcher
Grallina cyanoleuca	Magpie-lark
Rhipidura fuliginosa	Grey Fantail
Rhipidura leucophrys	Willie Wagtail
CAMPEPHAGIDAE	
Coracina novaehollandiae	Black-faced Cuckoo-shrike
ARTAMIDAE	
Artamus cyanopterus	Dusky Woodswallow
CRACTICIDAE	
Cracticus torquatus	Grey Butcherbird
Cracticus tibicen	Australian Magpie
Strepera versicolor	Grey Currawong
CORVIDAE	
Corvus coronoides	Australian Raven
HIRUNDINIDAE	
Hirundo neoxena	Welcome Swallow
Hirundo nigricans	Tree Martin
ZOSTEROPIDAE	
Zosterops lateralis	Silvereye
Acrocephalus australis	Australian Reed-Warbler
Cinclorhamphus cruralis	Brown Songlark
PASSERIDAE	
Stagnopleura oculata	Red-eared Firetail
MOTACILLIDAE	
Anthus australis	Australian Pipit