Goulburn Broken Regional River Health Strategy

Our Catchment – Status of the Riverine System

Regional Overview

GOULBURN BROKEN CATCHMENT MANAGEMENT AUTHORITY

2005

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Abbreviations used in this report

AROT	Australian Rare or Threatened
CAMBA	China-Australia Migratory Birds Agreement
DO	Dissolved Oxygen
DSE	Department of Sustainability and Environment
EC	Electrical Conductivity
EPA	Environment Protection Authority
EPBC	*Environment Protection and Biodiversity Conservation Act* 1999
EPT	Ephemeroptera, Plecoptera and Trichoptera
EVC	Ecological Vegetation Class
FFG	*Flora and Fauna Guarantee Act* 1988
GBCMA	Goulburn Broken Catchment Management Authority
GM	Goulburn Murray
ISC	Index of Stream Condition
JAMBA	Japan-Australia Migratory Birds Agreement
LCC	Land Conservation Council
NRE	Department of Natural Resources and Environment (now DSE)
O/E	Observed (divided by) Expected
RHWQC	River Health and Water Quality Committee
RiVERS	River Values and Environmental Risk System
SEPP	State Environment Protection Policy
SIGNAL	Stream Invertebrate Grade
VRHS	Victorian River Health Strategy (NRE, 2002)
VROT	Victorian Rare or Threatened
VWQMN	Victorian Water Quality Monitoring Network
WQ	Water Quality

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1. Introduction to the Goulburn Broken Catchment

The Goulburn and Broken Basins are situated in northern Victoria and form part of the Murray-Darling Basin. The two basins cover just under 2.4 million hectares, or 10.5% of the area of Victoria, and 2% of the Murray-Darling Basin's land area. Despite this relatively small area, the catchment generates 11% of the basin's water resources.

By far, the major land use in the Goulburn Broken Basins is general dryland agriculture, covering over 1.4 million hectares (62% of the area of both basins). The dryland area generates $1.9 billion in economic activity each year. The basins also support a large food processing industry with production from the irrigation region (covering only 9% of the area) contributing 25% of Victoria's export earnings. Total catchment production value is approximately $7.8 billion per annum (Michael Young and Associates, 2001).

1.1 The Goulburn River Basin

The Goulburn River basin (Figure 1.1) is Victoria's largest, covering over 1.6 million hectares or 7.1% of the state's total area.

The terrain varies significantly across the catchment, from the high ranges and mountains of the Great Dividing Range in the south, to the flat country of the Murray Plain to the north. The high country in the south east experiences cold winters with persistent snow and an average annual rainfall greater than 1,600 mm. Rainfall decreases northward, and in the far north of the catchment is less than 450 mm per year, only one third of the annual evaporation in that area. With the higher rainfall, a number of the Goulburn River's major tributaries rise on the northern slopes of the Great Dividing Range. These include the Big, Delatite, Howqua and Jamieson rivers.

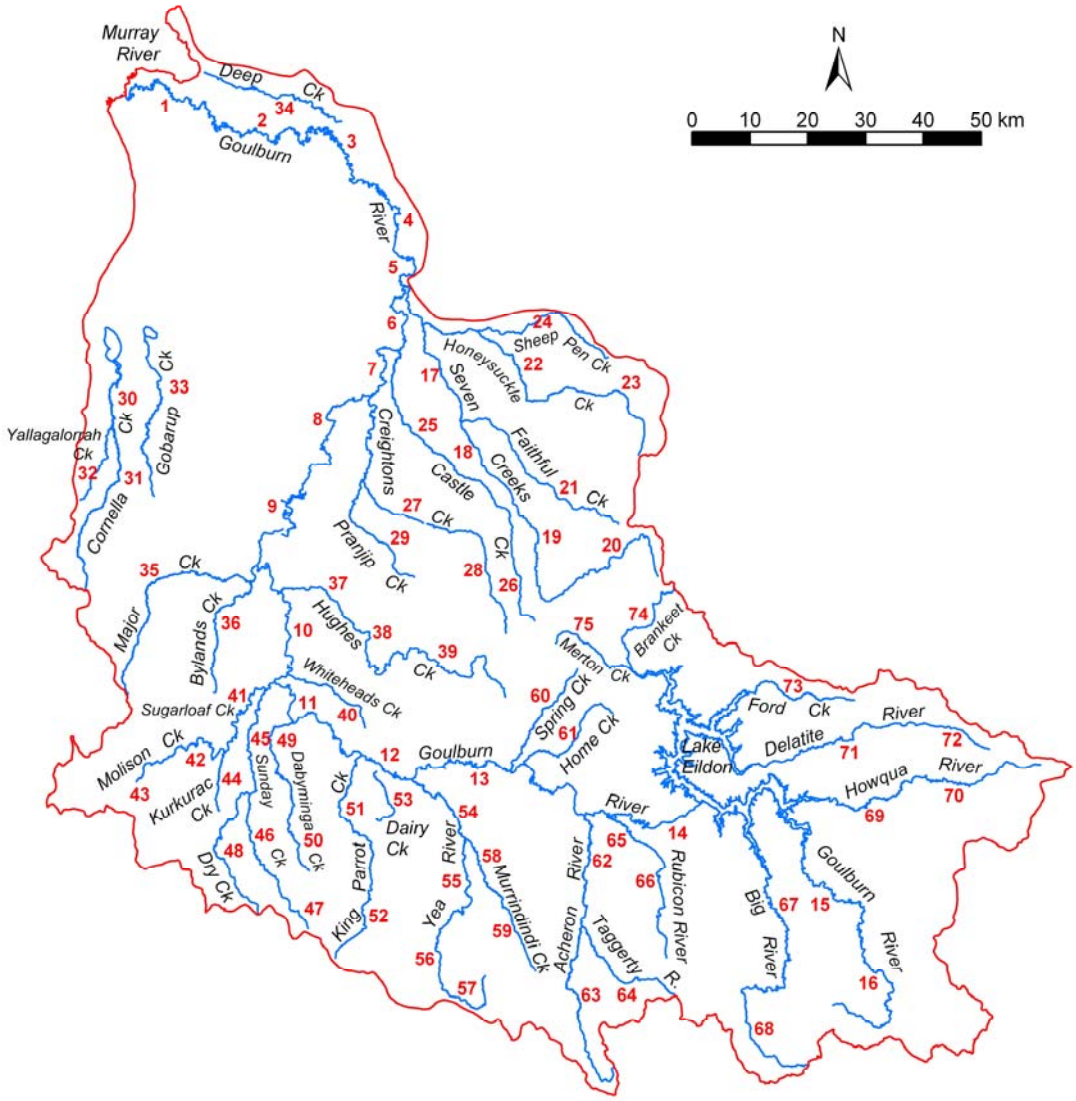
Native vegetation has been retained over much of the mountainous south of the catchment, where slopes are steepest. However clearing for agriculture has been extensive in the valleys and plains.

The Goulburn River itself is 570 km long, flowing from upstream of Woods Point to Echuca. The river has a mean annual water discharge of 3,040 GL (1.8 ML/ha), representing 13.7% of the total state discharge. Streamflow along the Goulburn River has been modified by two major features, Eildon Reservoir and the Goulburn Weir.

Lake Eildon has a capacity of 3,390 GL and supplies more than half of the water used in the Shepparton Irrigation Region. Operation of Eildon Reservoir has reduced winter/spring flows passing Eildon and increased summer/autumn flows so that the flow regime is reversed from the natural regime. The Goulburn Weir near Nagambie and associated diversion channels to the east and west, have reduced the average annual downstream flow there to 1,340 GL, less than half the pre-regulated flow.

There are several major rural towns and cities in the Goulburn Catchment including Shepparton, Mooroopna, Seymour and Kyabram, and a further eight communities with populations greater than 1,500.

Figure 1.1 Goulburn River Basin



1.2 The Broken River Basin

The Broken River basin (Figure), at 772,386 hectares represents 3.4% of Victoria's total area. The Broken River is a tributary of the Goulburn River and joins the Goulburn River at Shepparton. The basin also includes the catchment of the Broken Creek that diverges from the Broken River west of Lake Mokoan and flows north-west to the Murray River.

Climate varies considerably across the Broken River catchment. In the south, average annual rainfall is about 1,270 mm. This decreases to about 700 mm near Benalla, 550 mm at Dookie and 470 mm at Cobram. Across the northern section rainfall generally decreases to the west.

Most of the Broken River catchment has been cleared of native vegetation for agriculture comprising mainly grazing in the south and mixed cereal and dryland grazing in the central region. A large part of the northern section is within the Murray Valley irrigation district where intensive horticultural, dairy and livestock production occurs.

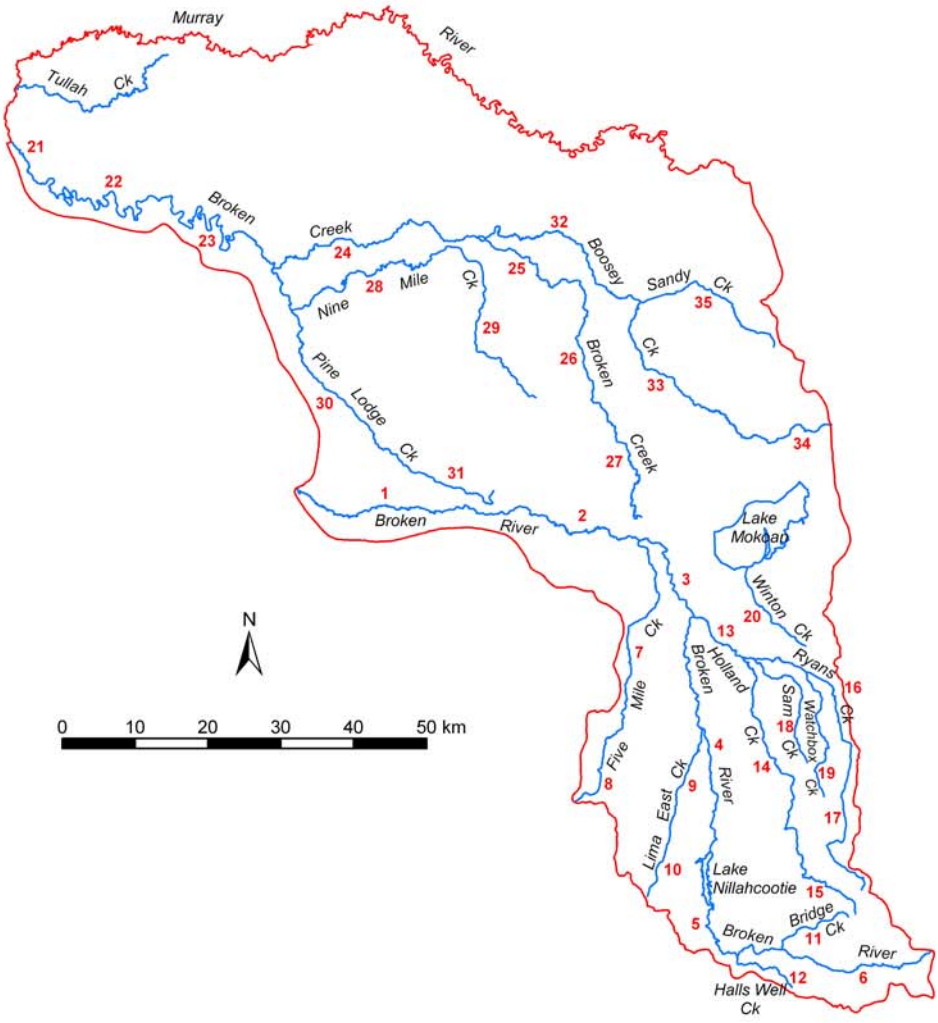
In the north of the basin a unique linear corridor exists, bordering the Broken, Nine Mile and Boosey Creeks. The area spanning 1030 hectares was proclaimed as the Broken-Boosey State Park with the passing of the Box-Ironbark Bill on 30 October, 2002. The park includes streamside reserves and public land water frontages along the Broken and Boosey Creeks south-east of Numurkah and is the only substantial occurrence of high quality native vegetation on the northern plains

Streamflow is extremely variable between seasons and between years. The three months July to September generally account for over half the annual stream flow. The catchment has a mean annual flow of 325,000 ML (0.42 ML/hectares), however annual flow has varied from a minimum of 5,000 ML in the drought year of 1943, to maxima of more than 1,000,000 ML in the flood years of 1917 and 1956.

Two major and two smaller storages have been constructed within the catchment. Lake Nillahcootie was built in 1967 with a capacity of 40,000 ML and Lake Mokoan, constructed in 1971, has a capacity of 365,000 ML. These reservoirs provide water for stock, domestic and irrigation supplies. Two small reservoirs constructed on Ryans Creek, provide water to the town of Benalla.

The city of Benalla is the largest urban community. There are also a number of major towns including Cobram, Nathalia, Yarrawonga and Numurkah.

Figure 1.2. Broken River Basin



2. Condition of the Waterways

The Goulburn Broken Regional Catchment Strategy (GBCMA, 2004) identifies river health and waterway management as priority natural resource management issues. In order for the Goulburn Broken Catchment community to protect and enhance the rivers and streams within the region, there is a need to develop a Regional River Health Strategy. The aim of the Strategy is to produce a range of programs that will protect and enhance the environmental health of the Goulburn Broken River system and its associated floodplain, whilst recognising the economic environmental and social values associated with current and future human activity.

This first supplement to the Goulburn Broken River Health Strategy attempts to support the vision and management approach by identifying and evaluating environmental, social and economic assets across the Goulburn Broken Catchment. In the second supplement a closer examination of the catchment is provided by Management Unit.

2.1 Data Sources

The main source of environmental, social and economic information for the Regional River Health Strategy was derived from the RiVERS database for the Goulburn Broken Basins. RiVERS is a database that integrates environmental, social and economic information from a variety of sources into a single package. For each of the assets and threats listed in Appendix 1 and Appendix 2, an index value between 0-5 has been assigned, with higher values generally representing an increasing "value" of the asset, or a decreasing level of the threat.

Environmental assets are divided into three types of measure, representing rarity, naturalness or representativeness. Rarity measures are those regarded as either threatened (rare or endangered flora, fauna, vegetation communities or wetlands) or they have some special environmental significance (sites of significance such as Heritage Rivers). Naturalness measures assess environmental components in terms of their closeness to natural, or in some cases, acceptable condition. Representativeness is a term used in the VRHS (NRE, 2002) to describe rivers or reaches that have been declared as "typical" of different bioregions across the state.

Social assets are those that have some value to the community. While some may have economic value or benefit to the region (e.g. fishing), the asset is generally assessed in terms of frequency of use. Other social assets have no or little economic value, but represent important heritage values. The main source of social information comes from local knowledge, gathered during workshops to gather specific data for RiVERS.

Economic assets measure the financial return or value of assets to the community. Again, the majority of information in RiVERS comes from local knowledge gathered through specific workshops.

Threats include conditions or activities that have the potential to have an impact on environmental, social or economic assets in the catchment. These include physical conditions (e.g. bed and bank erosion), chemical conditions (e.g. water quality) and biological conditions (e.g. exotic flora and fauna). Much of the information comes from the ISC, but local knowledge and other sources are also used.

RiVERS allows a simple method to assess the condition of assets and threats across the whole catchment, or in specific reaches within the catchment. It also allows risk assessments to be conducted to determine priority actions to be developed, important for the production of the Regional River Health Strategy.

2.2 Environmental Assets

Environmental condition can be assessed using two main types of measures, representing rarity and naturalness. Rarity measures are those regarded as having special environmental significance (e.g. rare or endangered flora, fauna, representativeness[1]). Naturalness measures assess environmental components in terms of their closeness to "natural".

2.2.1 Environmental rarity

The measures of environmental rarity include threatened flora and fauna that are dependent on water or riparian habitats, wetlands and vegetation communities, as well as sites of special significance. The level of environmental rarity can be displayed as the proportion of stream/river length within the basins that have Very High or High levels of significance (Figure 2.1). Only Very High or High ratings are shown as these are the only categories of importance for this rating. Medium, Low and Very Low ratings are not shown for this category, as these lower ratings may imply less value for those regions (which is not true – they simply do not contain assets identified as having special significance).

Rare or threatened fauna and flora

Rare or threatened fauna species with Very High or High significance[2] are found along about 85% of the length of each of the Goulburn and Broken Basins (Figure 2.1)[3]. This includes 60 species, composed of 3 amphibian, 34 bird, 11 fish, 2 invertebrate, 7 mammal and 3 reptile species (Appendix 3). Eleven of the taxa are listed under the Federal *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC) and 36 are listed under the Victorian *Flora and Fauna Guarantee Act* 1988 (FFG). Three species are considered AROTs and 57 are declared VROTs.

Murray Cod

Threatened vegetation communities

Note that this list differs somewhat from that described in the background paper for the Regional River Health Strategy (Howell and McLennan, 2002) due to different selection criteria.

[1] Representativeness refers to the selection of rivers or reaches that have been declared as "typical" of different bioregions across the state (and is here included in the rarity measures).

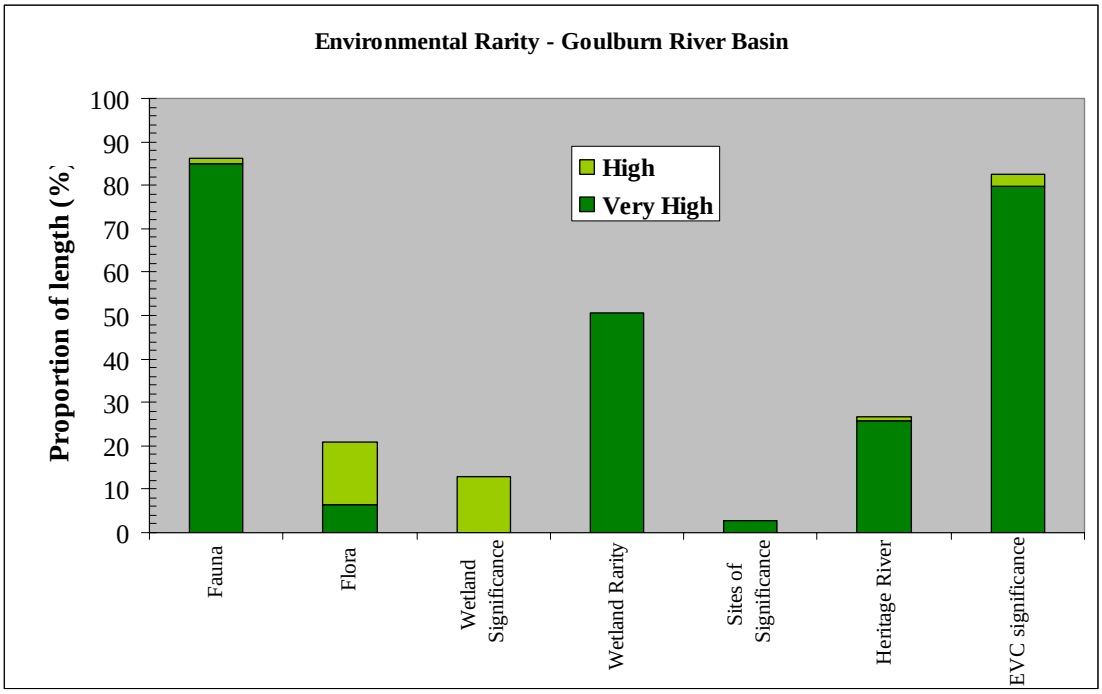
[2] Very High rating refers to federally listed species or the highest category of bioregional significance for Victorian listed species.

[3] Rare or threatened flora and fauna were derived from database records for significant species that occur within 100m of any waterway.

Significant flora species with High or Very High ratings[4] are less widely distributed, found along 14% of waterway length in the Goulburn Basin and 50% of the length of the Broken Basin. Forty-two species have been recorded (Appendix 4). Of these, none are listed under the EPBC Act and 5 are listed under the FFG Act. Five are considered AROTs and all but one are considered VROTs.

Significant Ecological Vegetation Classes

Significant EVCs are found throughout the basins, occurring along most of the length of stream in both catchments (80% and 91% of river length in the Goulburn and Broken respectively). Sixty-six individual EVC with significance are located in the Goulburn Broken catchment (Appendix 5).



[4] Very High rating refers to federally listed species or the highest category of bioregional significance for Victorian listed species; High rating refers to vulnerable or rare species listed in Victoria only, Medium rating refers to Data Deficient taxa (likely to be Rare or Threatened, but with insufficient knowledge).

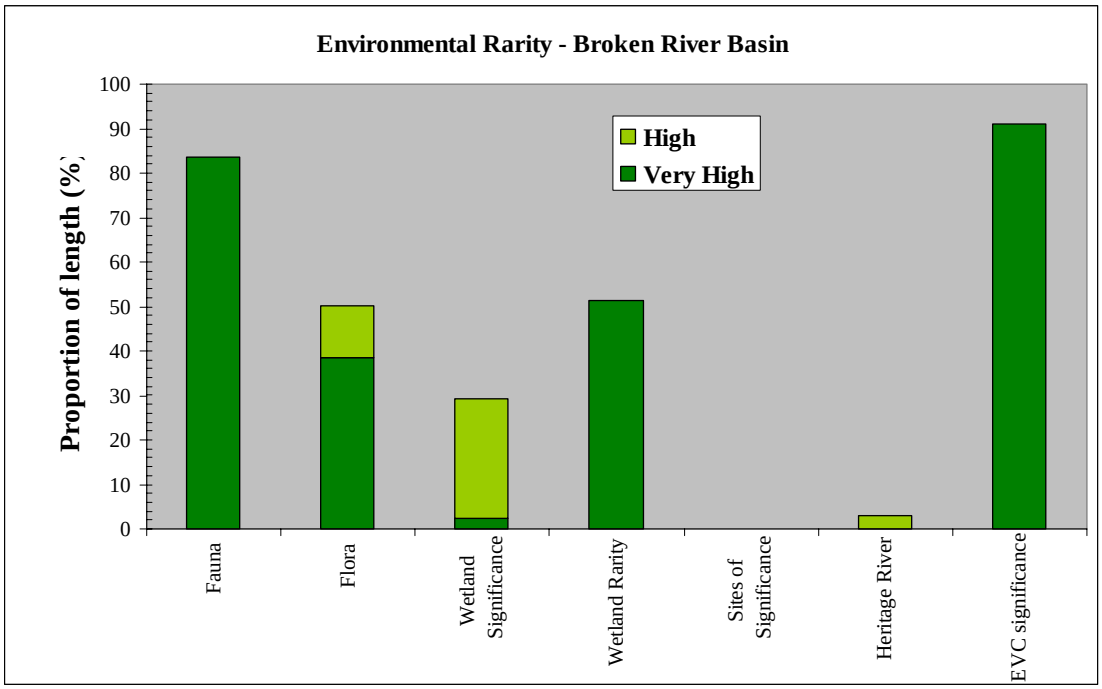


Figure 2.1. **Proportion of stream length in the Goulburn (top) and Broken (bottom) Basins with Very High or High Environmental Rarity ratings for each measure.**

Significant Wetlands

Significant wetlands can be rated on an International or National scale. Within the Goulburn and Broken Basins, wetlands have been rated under the Ramsar classification (International – Very High significance) and the Directory of Important Wetlands in Australia (National – High Significance).

The **Ramsar** classification system covers inland, coastal and marine and man-made wetlands, and focuses on attributes such as the importance of a site for breeding species, its capacity to support native species, its historical and cultural significance. Within the Goulburn Broken, the Barmah-Millewa Forests are listed under the Ramsar Convention as a wetland of international importance, and are also listed in the Register of the National Estate.

The **Directory of Important Wetlands in Australia** (1995–2000) was undertaken to identify nationally important wetlands across Australia. The directory uses similar classification to Ramsar, but is modified slightly to suit Australian conditions. The directory identified 10 wetlands and systems in the Goulburn Broken Catchment as nationally important (Table 2.1). Six of these wetlands also provide habitat for species that are listed under the Japan-Australia Migratory Birds Agreement (JAMBA) and/or the China-Australia Migratory Birds Agreement (CAMBA).

Table 2.1. Significant wetlands in the Goulburn Broken Catchment listed in the Directory of Important Wetlands in Australia

Wetland Name	Location and description	Area (ha)	Ramsar Listed	National Estate	JAMBA CAMBA
Barmah-Millewa Forest	Murray River floodplain between Ulupna Island and Barmah.	29,500	Yes	Yes	Yes
Broken Creek	Between 8 km NNW of Benalla to Barmah Forest.	2,500	No	No	Yes
Kanyapella Basin	13 km ESE of Echuca.	2,581	No	No	Yes
Lower Broken River	Between 8 km NNW of Benalla & Shepparton.	1,268	No	No	No
Lower Goulburn River Floodplain	150 km d/s Goulburn Weir to Murray confluence.	13,000	No	No	Yes
Muckatah Depression	11 km SE of Yarrawonga to 2 km east Numurkah.	2,909	No	No	Yes
Wallenjoe Wetlands	10 km N of Colbinabbin.	303	No	No	Yes
Central Highlands Peatlands	Upper Goulburn Catchment. Includes Oaks, Poley, Snobs, Tom Burns and Storm Creeks.	33	No	No	No
Big River	Upper Goulburn Catchment. Heritage River.	1,465	No	No	No
Howqua River	Upper Goulburn Catchment. Heritage River.	1,520	No	No	No

Heritage Rivers

Three Heritage River corridors are located in the Goulburn Broken Basin (LCC, 1991) and are rated as Very High significance.

The **Goulburn River** heritage river corridor extends 430 km downstream from the Eildon Reservoir to the confluence with the Murray River near Echuca. The heritage status of the corridor was identified due to a number of environmental and social values, particularly:

- Areas with intact understorey in River red gum open forest/woodland, and yellow box and grey box woodland/open forest communities, particularly downstream of Murchison;
- Areas of significant habitat for vulnerable or threatened wildlife including Squirrel gliders, Large-footed myotis, Barking march frogs, Barking owls and Brush-tailed phascogales;
- Native fish diversity and Murray cod habitat below Goulburn Weir;
- Macquarie perch habitat above Goulburn Weir;
- Fishing opportunities – especially for trout from Eildon to Yea River, and native species below Goulburn Weir;
- Canoeing opportunities from Eildon to Goulburn Weir;
- Cultural heritage sites, including the timber Chinamans Bridge, the steel-girder rail bridge at Seymour, Days Flour Mill at Murchison, Goulburn Weir, and the town water supply pump at Murchison; and
- Scenic landscapes – from Molesworth to Seymour, and from below Seymour to Echuca.

The **Big River** heritage river corridor extends 51 km from the junction of Spring and Oaks Creek downstream to the junction with Fryer Creek. The heritage status of the corridor was identified due to both environmental and social values, particularly:

- Habitat for the spotted tree frog;
- Scenic landscapes along the Big River from Oaks Creek to Lake Eildon;
- Fishing opportunities, especially for trout; and
- The canoe resource in a semi-remote setting from Frenchmans Creek to Jamieson Road Bridge.

The **Howqua River** heritage river corridor extends 60 km from the junction of the north and south branches to Lake Eildon. The heritage status of the corridor was identified due to both environmental and social values, particularly:

- Habitat for the spotted tree frog;
- Devonian fish fossil beds;
- Fishing opportunities, especially for trout;
- Cultural heritage sites – Frys Bridge, and early settlement and mining features; and
- The canoe resource from Eight Mile Creek to Frys Hut, and the Sheepyard Flat slalom course.

Representative Rivers

Representative Rivers are selected reaches in ecologically healthy condition (or close to it) that can be used to represent major river classes or types that occur in Victoria

The Goulburn Broken Catchment can be divided into four River Regions, as defined by the VRHS – Alps, North Central uplands, North Central midlands and North Central floodplains. The Goulburn Broken River Health Strategy identified ecologically healthy river reaches for each River Region (Table 2.2). These reaches are accorded High significance under the Heritage River category.

Table 2.2. Representative River reaches in the Goulburn Broken catchment.

River Region	Representative River
Alps	Big River Reach 68
North Central uplands	Taggerty River Reach 64
North Central midlands	Ryans Creek Reach 17
North Central floodplains	None identified

Representative River – Taggerty River

Heritage River – Goulburn River

Sites of significance

Three reaches in the Goulburn Broken Catchment are listed under Sites of Environmental Significance (Very High significance). Two reaches in Seven Creeks (the urban section in Euroa and upstream of Euroa to Polly McQuinn Weir) and the lower reach of the Acheron River.

Sites of Significance – Seven Creeks (Also the preferred habitat for Trout Cod)

2.2.2 Environmental Naturalness

The measures of environmental naturalness are composed of two different components – riparian vegetation condition (expressed as width, continuity and structural intactness) and the condition of the two main instream biological communities (invertebrates and fish). The degree of naturalness can be displayed as the proportion of stream/river length within the basins that have various ratings of naturalness from Excellent to Very Poor (Figure 2.2), including reaches with no data.

Riparian vegetation

The three indicators of riparian vegetation condition are width, continuity and structural intactness.

The width of the streamside zone is important as it determines the ability of the vegetation to filter nutrients and sediment, shade the water surface, provide a source of input to the stream (leaves, twigs and logs) and provide habitat for terrestrial species dependent on the river. Good or Excellent rating for riparian width represent over 30m wide for small streams or over 1.5 times the channel width in large streams (CEAH and ID&A, 1997).

In both basins, 27% of the length of river have Good or Excellent riparian width (Figure 2.2). Over a third of the length of stream in each basin has Poor or Very Poor Riparian width (34% and 39% in the Goulburn and Broken Basin respectively). A Poor or Very Poor rating represents widths of less than 10m on small streams and less than 0.25 times the channel width in large streams (CEAH and ID&A, 1997).

Riparian Continuity is a measure of how continuous streamside vegetation is along the river. Gaps in the vegetation impede the movement of fauna, increase the amount of sun on the stream and reduce terrestrial inputs. For the measure, gaps of greater than 10m of stream bank are considered significant, and Good or Excellent ratings show less than 5 significant gaps for each 1km of stream bank[5].

Riparian Continuity is Good or Excellent over 51% of the Goulburn Basin and 35% of the Broken Basin (Figure 2.2). Riparian Continuity is Poor or Very Poor over 41% of the Goulburn Basin and 49% of the Broken Basin.

Structural Intactness refers to whether the original pre-European vegetation structure, in terms of overstorey, understorey and groundcover, has been retained. Structural Intactness is Medium or Poor over much of the Goulburn Basin (73% - Figure 2.2) and Medium or Poor over most of the Broken Basin.

Goulburn River: The condition of the riparian zone is a good indicator of the health of the stream

[5] Riparian Continuity is also related to the proportion of bank vegetated, with fewer gaps allowed as the proportion of bank vegetated decreases.

Instream Biological Communities

Macroinvertebrates

The measure for aquatic invertebrates comes from the biological monitoring framework developed under the SEPP Waters of Victoria 2003 (EPA, 2001). This approach uses 5 indices, which fall into three categories:

- a measure of diversity – number of families;
- biotic indices – the SIGNAL and EPT indices;
- measures of community composition – numbers of key families and AUSRIVAS predictive models.

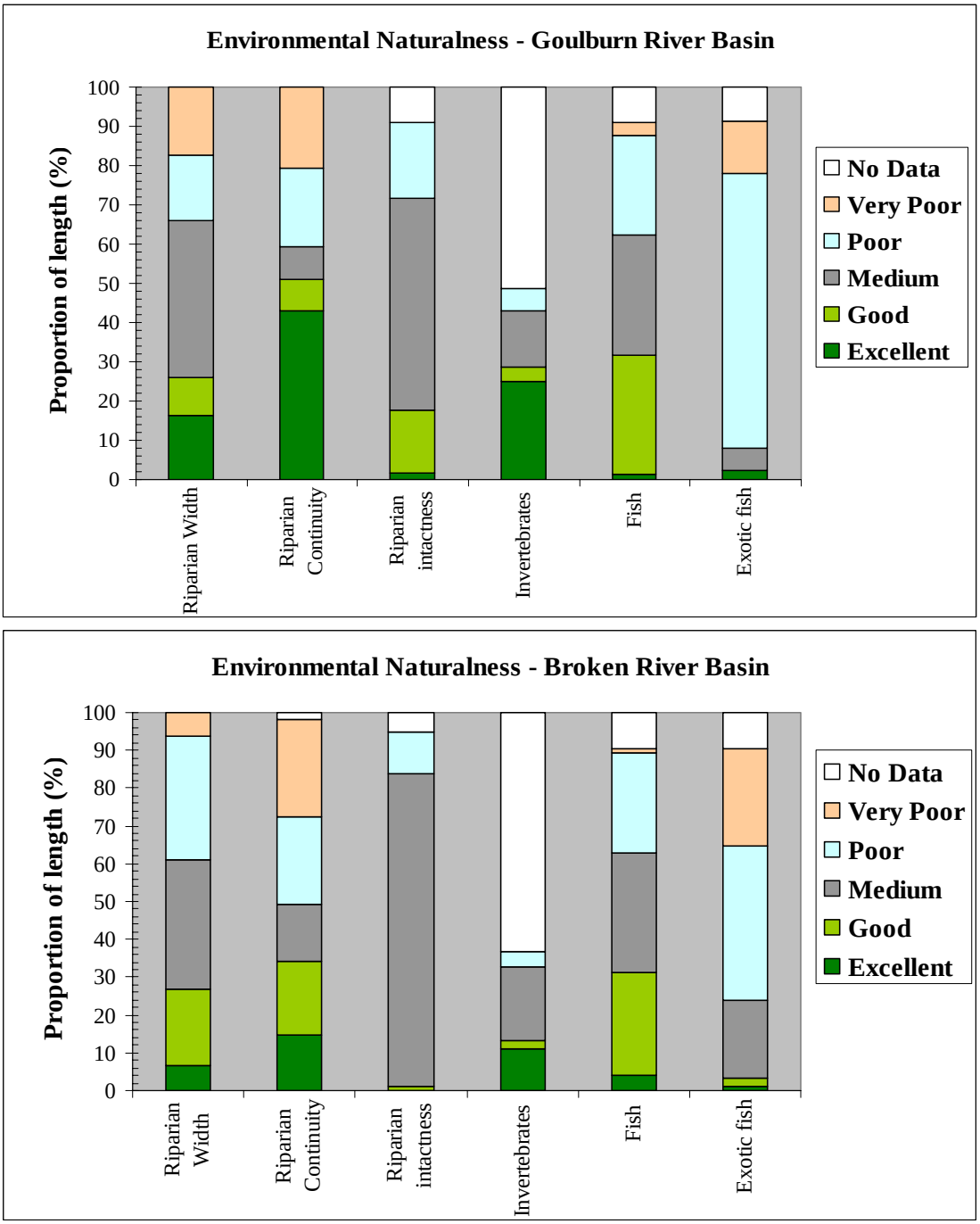


Figure 2.2. **Proportion of stream length in the Goulburn and Broken Basins with "Good" or "Excellent" Environmental Naturalness rating (Hatched = No data).**

The use of a number of macroinvertebrate indicators to measure ecosystem health is desirable as it improves the robustness and reliability of the assessment. When they are in accord, greater confidence may be placed on the outcome, and when there is a discrepancy, this can be used to indicate the type of environmental problem involved.

Number of families

The number of invertebrate families found in streams can give a reasonable representation of the ecological health of a stream - healthy ecosystems generally have more families. However, this is too great a simplification of data to be adequate on its own. Reduction in the expected number of families present can be caused by poor quality habitat and by various pollutants. The presence of toxicants, for example, tends to reduce numbers of families. The number of families indicator is calculated by simply summing the 'families' of invertebrates.

The SIGNAL biotic index

A biotic index is an index of water pollution based on tolerance or intolerance of the biota to pollution. The biotic index SIGNAL (Stream Invertebrate Grade Number - Average Level) has been accepted and used nationally in stream assessments. The output is a single number, between zero and ten, reflecting the degree of water pollution - high quality sites have high SIGNAL scores.

While SIGNAL is particularly good for assessing organic pollution, its usefulness for toxic impacts and other types of disturbance is less certain.

The EPT biotic index

The EPT index is the total number of families within the generally pollution-sensitive insect orders of Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies). Any loss of families in these groups usually indicates disturbance.

AUSRIVAS

One of the main aims of the National River Health Program was the development of predictive models, which could be used to assess river health. AUSRIVAS predicts the macroinvertebrates, which should be present in specific stream habitats under reference conditions. It does this by comparing a test site with a group of reference sites which are as free as possible of environmental impacts but which have similar physical and chemical characteristics to those found at the test site.

By comparing the totalled probabilities of predicted families and the number of families actually found, a ratio can be calculated for each test site. This ratio is expressed as the observed number of families/expected number of families (the O/E index). The value of the O/E index can range from a minimum of zero (none of the expected families were found at the site) to around one (all of the families which were expected were found). It is also possible to derive a score of greater than one, if more families were found at the site than were predicted by the model. A site with a score greater than one might be an unexpectedly diverse location, or the score may indicate mild nutrient enrichment by organic pollution, allowing additional macro invertebrates to colonise.

Key Invertebrate Families

This index focuses mainly on the loss of taxa indicative of good habitat and water quality. The index identifies the number of families which are typically found in the types of stream in that region.

For the majority of reaches in the Goulburn Broken Catchment, no invertebrate data is available (51% of the Goulburn and 63% of the Broken Basin - Figure 2.2). Where data is available, 25% of the Goulburn Basin is rated as Excellent (meets all SEPP Waters of Victoria objectives), with 4%, 14% and 6% rated as Good, Medium and Poor respectively.

In the Broken Basin, 11% of the basin is rated as Excellent, with 2%, 20% and 4% rated as Good, Medium and Poor respectively.

Fish

Similar to one of the macro invertebrate health measures, the native fish composition has been assessed by an observed to expected ratio, comparing the native fish species recorded with what is expected (using expert opinion). For a Good or Excellent rating, >60% of the expected species need to have been recorded.

In both the Goulburn and Broken Basins, 31% of the length of streams has Good or Excellent ratings for fish composition (Figure 2.2), with the same proportion rated as Medium. In the Goulburn Basin, 29% of the length is rated Poor or Very Poor for native fish communities, with 27% of the Broken Basin with Poor or Very Poor ratings.

Very little of the Goulburn Broken Catchment has not been affected by the presence of introduced fish species. Only 2-3% of the length of the Goulburn and Broken Basins are rated as Good or Excellent in terms of introduced fish (i.e. very low abundances - Figure 2.2), with the majority of each basin in Poor or Very Poor condition.

2.3 Social Assets

Nine measures of social assets have been recorded for the Goulburn Broken Catchment, representing active recreation activities (fishing, sports, camping and swimming), cultural values (European Heritage, species of local significance[6] and listed landscapes), and passive recreation. Data for Social values were derived primarily from consultation with the local community of the catchments.

Of the measures, few stand out as being of Very High, High or Medium value throughout the entire Goulburn Broken Catchment (Figure 2.3). This is not surprising as social values often tend to be concentrated in a number of smaller areas within any catchment.

Most widespread is the presence of species of local significance that are found over 86% of the Goulburn Basin and 79% of the Broken Basin. Forty-four taxa of local significance were nominated (Table 2.3). These cover amphibians (1 species), birds (14), fish (12), invertebrates (3), mammals (6), plants (5) and reptiles (3 species).

Passive recreation is popular over 64% of the Goulburn Basin and 32% of the Broken Basin, while fishing is regarded as popular over 35% of the Goulburn Basin and 69% of the Broken Basin (Figure 2.3). Other recreations (sports and camping) are less widespread, but locally important.

Sites of European cultural heritage – those listed under local planning schemes, by Heritage Victoria or on the National Estate – are found in 39% of the Goulburn Basin (with a further 13% of the length with locally identified significant features – rated Medium) and 22% of the Broken Basin. It should be noted that these are mostly individual sites, but are recorded as occurring in a specific reach. Listed landscapes – either in reports on landscape significance or under planning schemes – are found only in the Goulburn Basin.

Table 2.3. Taxa of local significance nominated in the Goulburn Broken Catchment.

Barred Galaxias	Corella	Lyre Bird	Silver Wattle
Billy Buttons	Cray fish or Yabbie	Macquarie Perch	Spiny freshwater crayfish
Black Duck	Freshwater Catfish	Mountain Galaxias	Spotted tree frog
BlackFish	Goanna	Murray Cod	Squirrel Glider
Brolga	Golden Perch	Murray Cray Fish	Strawnecked Ibis
Brown trout	Grey Box	Platypus	Sugar Glider
Brushtail Phascogale	Grey crown babbler	Rainbow trout	Superb Parrot
Bush Stone Curlew	Grey Teal	River Blackfish	Tiger Snake
Buxton gum	King Parrot	River Redgum	Trout Cod
Carpet python	Kingfisher	Sacred Ibis	Water Rat
Cockatoo	Koala	Silver Perch	

[6] Species of local significance are those that are valued by the local community for a variety of reasons. They are not necessarily rare or threatened in some formal sense (although some are), but represent a valued local biological asset.

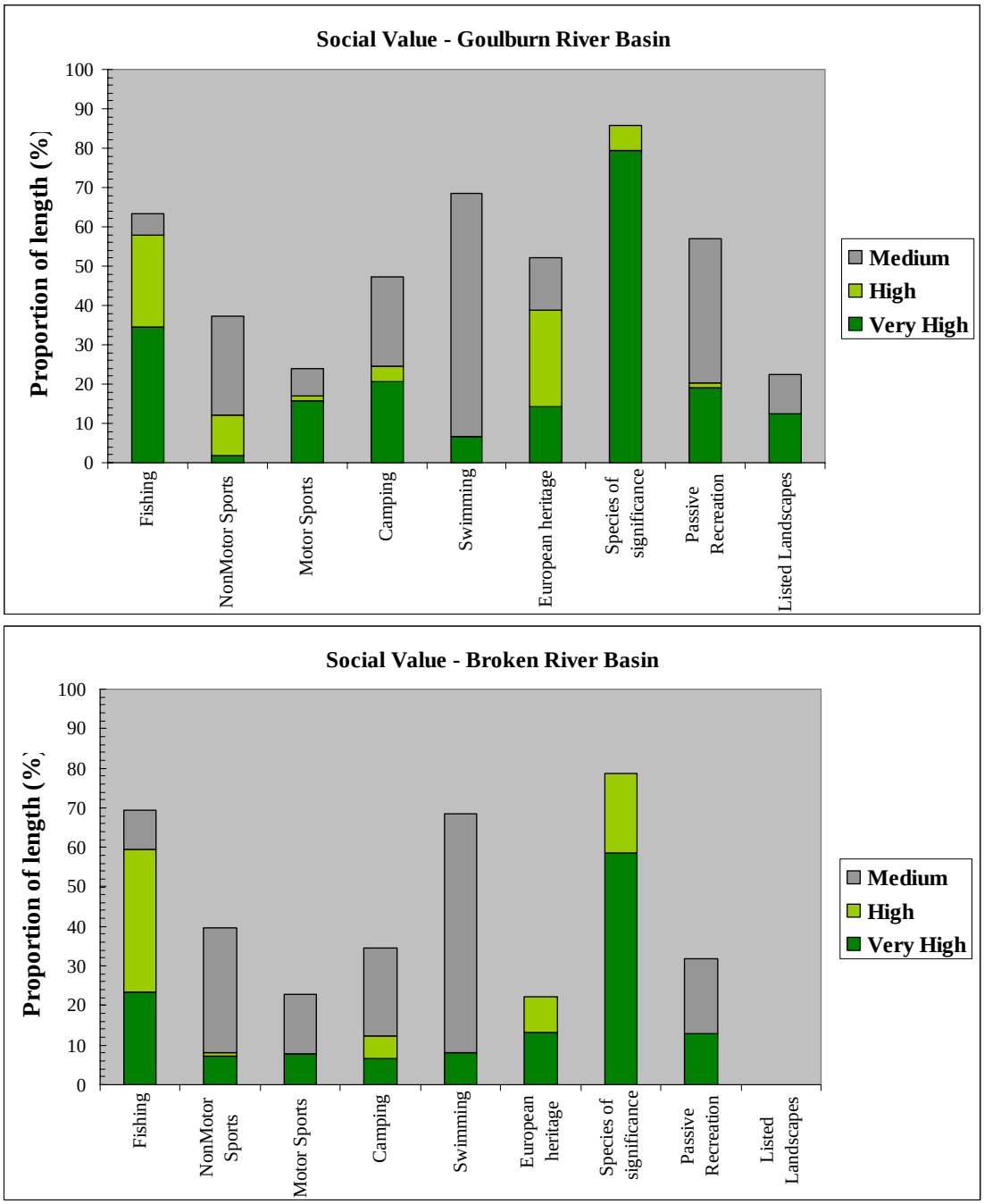


Figure 2.3. Proportion of stream length in the Goulburn and Broken Basins with Very High to Medium Social rating.

2.4 Economic Assets

Six measures of economic assets have been recorded for the Goulburn Broken Catchment, representing water supply (both irrigation and potable related to collection and delivery), infrastructure, land value, tourism and power generation. Ratings of Very High and High value (Figure 2.4) are based on specific criteria for each economic asset (Table 2.4).

Table 2.4. Criteria for Very High or High value rating for economic assets.

Measure	Criteria for Very High or High value
Water supply (delivery)	Registered extraction site and/or carries irrigation water, OR Providing water to potable water supply.
Water supply (collection)	Water supply protection area, OR Proclaimed water supply catchment.
Infrastructure	Sealed road/major instream structure/culvert bridge, OR Major highway/major bridge/fully lined channel.
Land value	Some irrigated land/broad acre cropping/mixed grazing, OR Irrigation – dairy, orchard, vineyard, intensive agriculture – or urban residential.
Tourism	Formal use by tourists, OR Areas with a tourism focus or formal tourist events.
Power generation	Major power facility.

High or Very High value infrastructure assets are found throughout much of the Goulburn Broken Catchment, located in reaches that form 85% and 94% of the length of the Goulburn and Broken Basins respectively (Figure 2.4).

Much of the catchment is also used for water supply delivery (irrigation or potable) – 69% of the Goulburn and 63% of the Broken Basin. A small proportion of each catchment (18% and 8% in the Goulburn and Broken Basin respectively) has a high value for water collection.

Water Supply: Harnessing of water for irrigation and stock and domestic supply

Major infrastructure: Traversing major waterways in the region.

High or Very High land value occurs over 47% and 43% of the length of the Goulburn and Broken Basins respectively.

Thirty percent of the Goulburn length is used for high value formal tourist use, or has a tourism focus (it should be noted that a further 39% is used informally, incidentally or seasonally). Sixteen percent of the Broken Basin has similar high tourism value, but with a further 60% of the length with informal use.

The only major power generation structure in the Goulburn Broken Catchment is located on the Rubicon River. Some minor power contributions occur in other parts of the catchment.

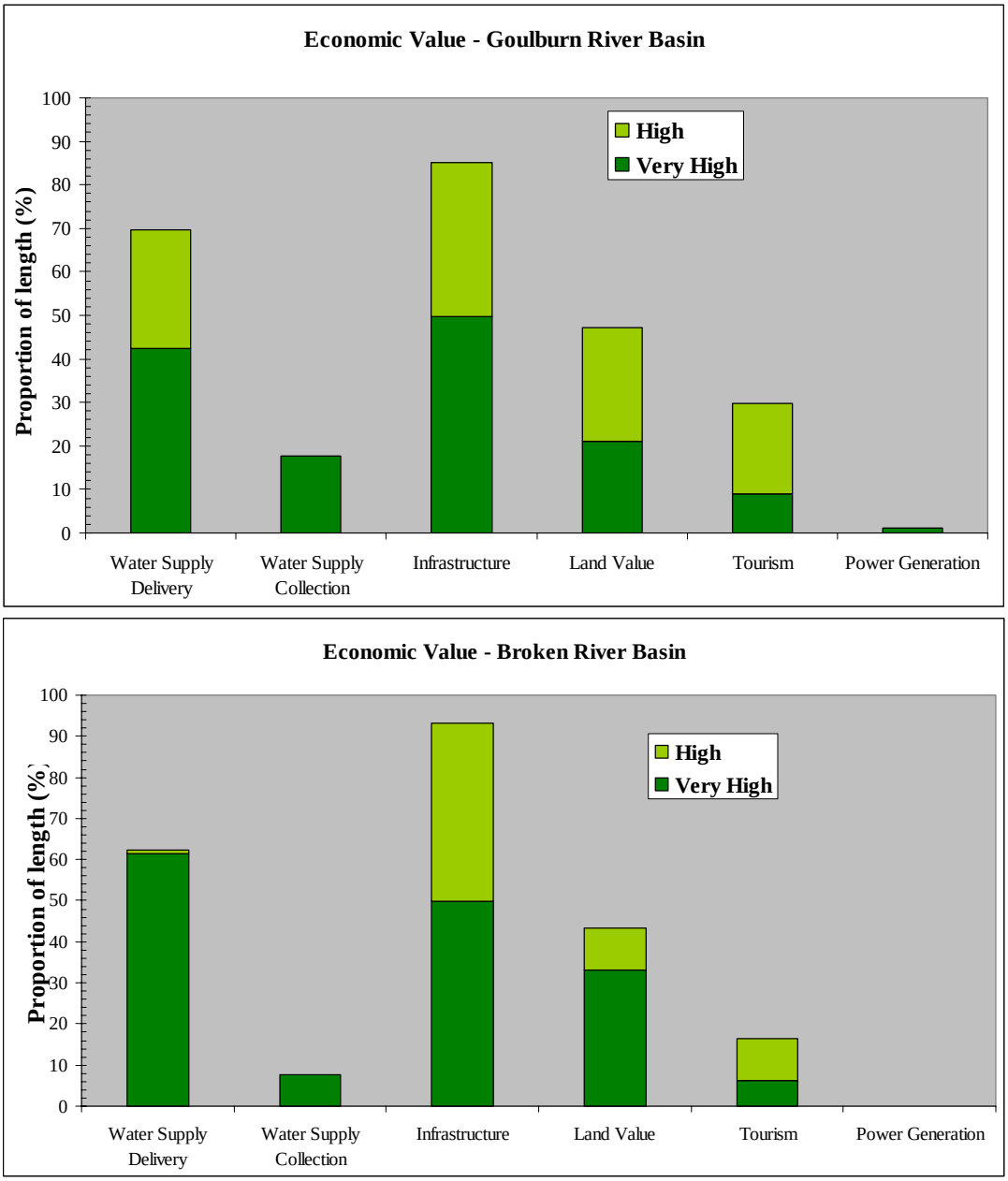


Figure 2.4. Proportion of stream length in the Goulburn and Broken Basins with "High" or "Very High" Economic rating.

2.5 Threats

Sixteen measures of threat have been recorded for the Goulburn Broken Catchment. These represent changes to the physical nature of the channel, changes to the flow regime, changes to water quality and biological changes. Of course, these categories are not mutually exclusive. For example, although wetland connectivity is used here as a measure of flow deviation (by examining the frequency of wetland inundation by high flows), there are also biological consequences associated with the threat.

Table 2.5. Threat measures used in RiVERS.

Category	Measures and comments
Physical	• Bank erosion – ranges from stable to extremely unstable. • Bed instability – ranges from stable to extremely unstable. • Channel form – related to levels of channel realignment and de-snagging. • Instream habitat – ranges from very poor to excellent. • Stock access – either present or absent.
Flow	• Hydrology – based on hydrology deviation index used in the ISC. • Wetland connectivity – a number of categories: no wetlands naturally existed, wetlands flooded naturally, wetlands flooded less frequently, wetlands permanently flooded or wetlands no longer connected.
Water quality	• Water quality trend – measure of trend in water quality parameters (e.g. significant increase or decrease in levels over time). • Water quality level – based on whether SEPP objectives are attained for measures of phosphorus, nitrogen, turbidity, conductivity, dissolved oxygen and pH. • Water quality SIGNAL – using macroinvertebrates to estimate the biological impact of water quality[7]. • Temperature – only based on cold water dam releases, based on dam size and off-take level. • Algal blooms – either absent or known to have occurred.
Biological	• Exotic fauna – based on presence and abundance of terrestrial pests. • Exotic flora – percent cover of weeds in riparian vegetation. • Barriers – presence and severity of barriers to fish migration. • Streamside Zone – based on the ISC measure

2.5.1 Physical threats

Extreme or extensive bank erosion or bed instability is rare in the Goulburn Broken Catchment (Figure 2.5). These levels are not recorded in the Broken Basin, and only 5% and 11% of the Goulburn Basin have extreme or extensive erosion or instability respectively. However, 25% of the Goulburn Basin and 18% of the Broken Basin have moderate levels of bank erosion. For bed instability, 17% of the Goulburn Basin and 15% of the Broken Basin has moderate instability.

Similarly, only 11% of the Goulburn and 17% of the Broken Basin has been subjected to extensive levels of channel modification (de-snagging and re-alignment). A further 14% in the Goulburn and 8% in the Broken Basin has undergone some de-snagging or realignment.

[7] The SIGNAL score is used in RiVERS as both a measure of an asset (part of the macroinvertebrate data) and as a measure of threat. As a threat, a low SIGNAL score represents a potential water quality threat. The SIGNAL score is used as an adjunct to the Water Quality level threat, as there are data on SIGNAL values in areas where no water quality data are available.

High levels of instream habitat loss occur over 18% and 33% of the Goulburn and Broken Basins respectively.

By far the most widespread physical threat is stock access to the river banks and bed which is common throughout the two basins, recorded at 76% and 89% of the length of the Goulburn and Broken Basins respectively.

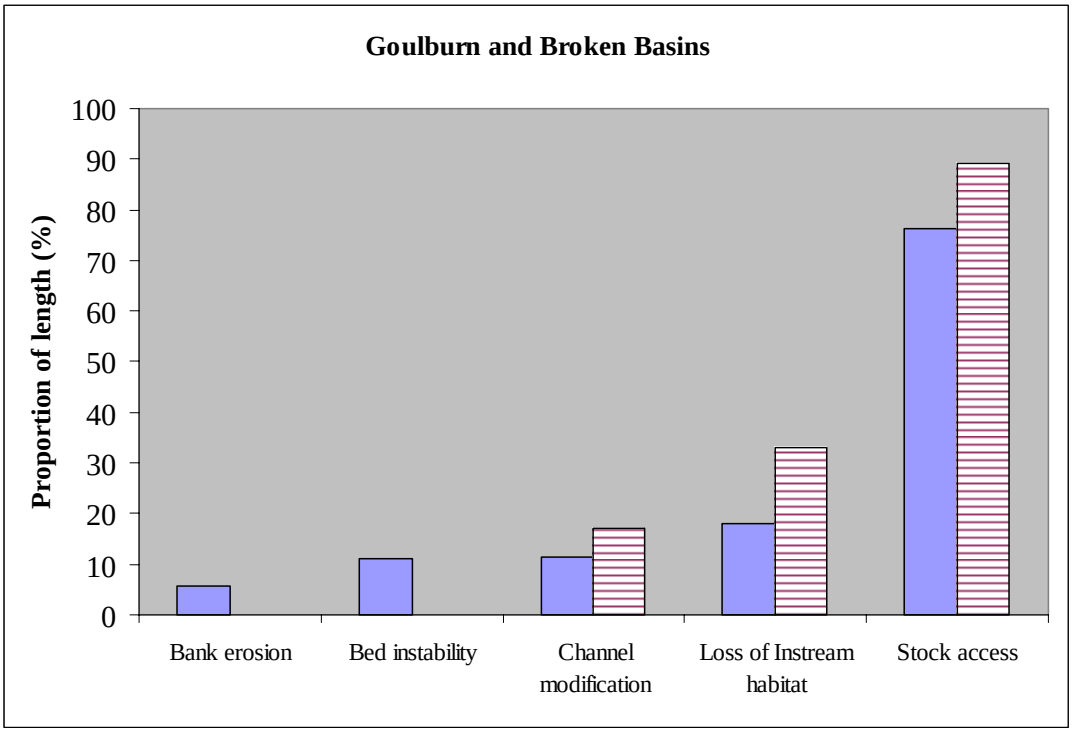


Figure 2.5. **Proportion of stream length in the Goulburn (solid) and Broken (hatched) Basins with Very High to High levels for physical threat measures.**

Bank erosion presenting a physical threat to the health of the adjacent waterway

Degraded streamside zone: Bank erosion, excess grazing – stock damage.

2.5.2 Flow threats

Flow deviation, compared to natural, in the Goulburn Basin is extreme or extensive over 23% of the total length. In the Broken Basin, 43% of the total length shows extreme or extensive flow deviation.

Wetland connectivity is essentially natural across the two basins (Figure 2.6), with some wetlands in the Goulburn Basin disconnected from the river and some Broken Basin wetlands less frequently inundated.

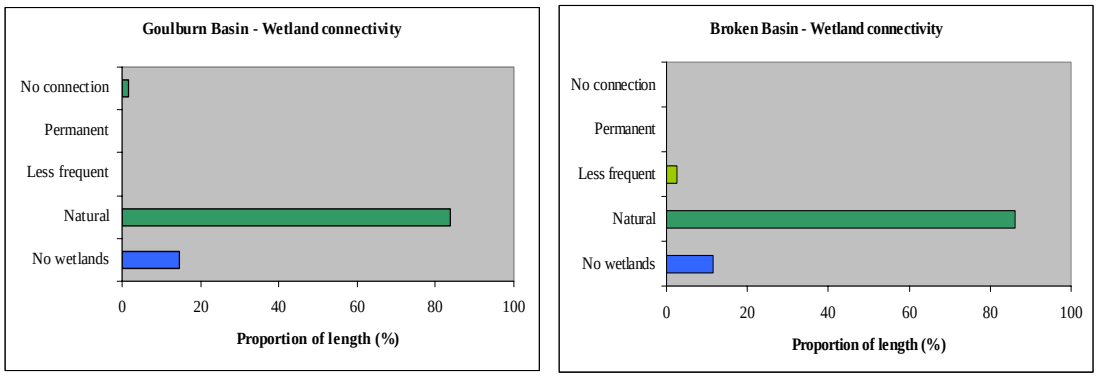


Figure 2.6. Proportion of stream length in the Goulburn and Broken Basins with each Wetland connectivity rating.

2.5.3 Water Quality threats

Five measures are used for the evaluation of water quality threats: level, trend, SIGNAL, water temperature and algal blooms.

Water quality level threats are evaluated by comparison with SEPP Waters of Victoria objectives for nutrients (nitrogen and phosphorous), turbidity, dissolved oxygen, pH and conductivity. A High level of threat indicates that 2 or more of these parameters do not meet SEPP objectives.

Nutrients

Elevated nutrient (nitrogen and phosphorus) levels may cause excessive plant growth and/or algal blooms. Major sources of elevated nutrient levels in water bodies include: sewage treatment plants, urban stormwater run-off, irrigation drainage, intensive animal industries, soil erosion, agricultural run-off and forestry activities. The downstream effects of these inputs should also be considered, including effects on terminal waterbodies such as wetlands, lakes, estuaries and coastal marine waters.

Suspended Solids/Turbidity

Sediment entering waterways is a natural process, but human activities may cause excessive quantities to enter streams. Sources of increased sediment inputs include vegetation clearing, urban development, agriculture, forestry activities, roads, industrial and sewage discharges, dredging and housing development.

Dissolved Oxygen

Dissolved oxygen (DO) levels in a water body are dependent on temperature, salinity, biological activity and rate of transfer from the atmosphere. Although DO levels naturally fluctuate, excessive sources of organic matter such as sewage effluent, excessive plant growth or decaying plant material, has the potential to greatly deplete DO levels in a waterbody.

pH

Natural freshwater systems generally have a pH range between 6.5 to 8.0. Changes in pH can occur due to a number of activities, primarily industrial or mining.

EC- Salinity

There are two major causes of increasing salinity (salinisation): the clearing of deep-rooted native vegetation and replacement with shallow-rooted crops and pastures; and large-scale irrigation. Both result in the water table moving closer to the surface, bringing accumulated salts that cause salinisation of water bodies and soils.

The **Water Quality trend** threat measure shows whether there is a significant increase or decrease in the level over time.

As a threat, the **Water Quality SIGNAL** score is used as an adjunct to the Water Quality level threat, as there is data on SIGNAL values (primarily an indicator of elevated nutrient levels) in areas where no water quality data is available.

The Water **temperature** threat only refers to reductions in water temperature in reaches downstream of major storages.

The **Algal Bloom** threat measure refers to reaches where algal blooms have been recorded in the past.

For the majority of water quality parameters examined, there are little or no data available for the majority of reaches in the Goulburn Broken Catchment (Figure 2.7). Where data is available, water quality is generally poor (a high level of threat) with at least 2 water quality parameters not meeting SEPP guidelines. High level water temperature threats are confined to a few reaches downstream of major dams and algal blooms are localised.

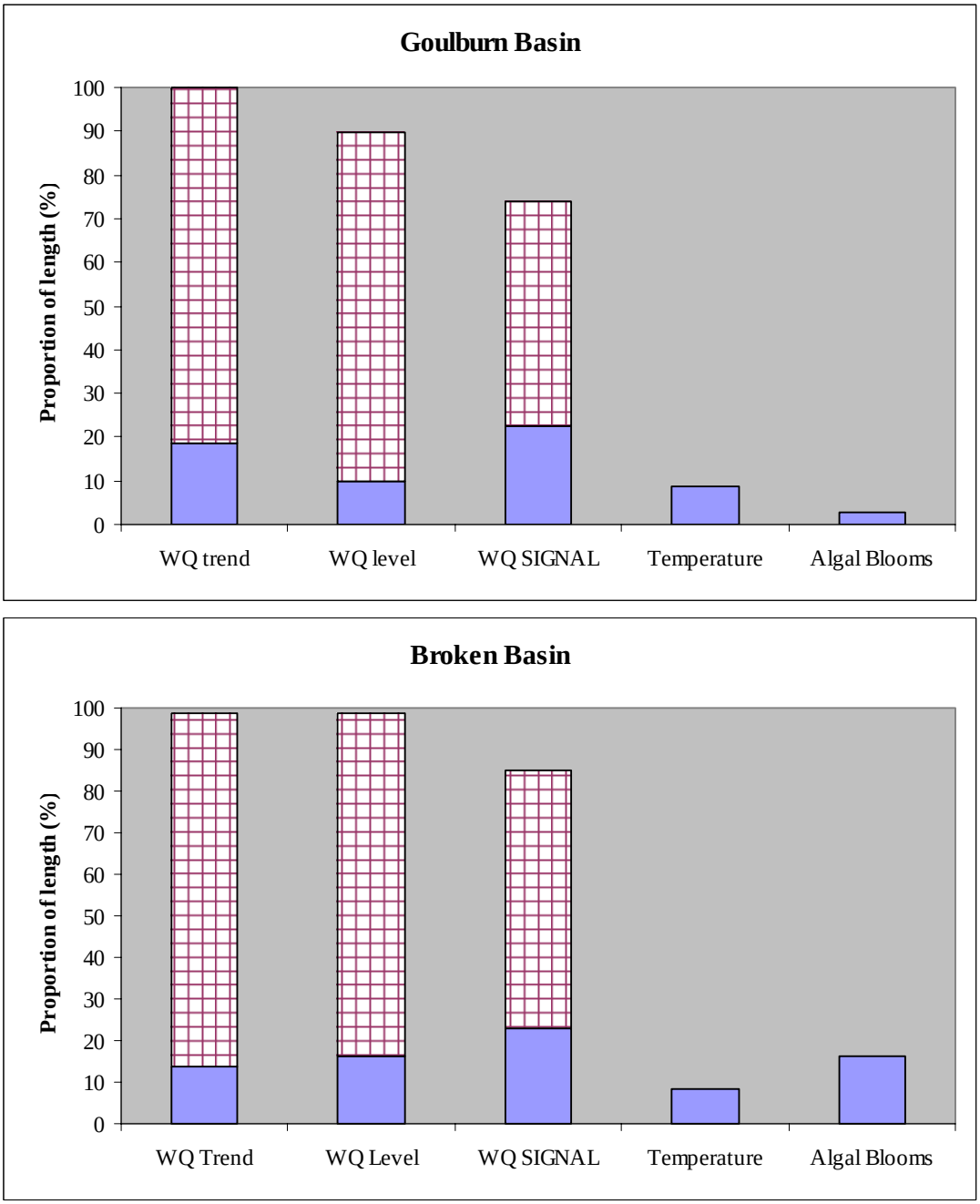


Figure 2.7. Proportion of stream length in the Goulburn and Broken Basins with Very High or High threat levels for water quality measures. (Hatch – No data).

Adequate water quality data is available from only 21 sites included in the Victorian Water Quality Monitoring Network (VWQMN) in the Goulburn Broken catchment. The attainment of SEPP Waters of Victoria objectives for nitrogen, phosphorous, DO, pH, turbidity and electrical conductivity at each of these sites is shown in Table 2.6.

Table 2.6. Attainment of SEPP objectives for 6 water quality parameters in the Goulburn Broken catchment at 21 VWQMN sites. ✗ - not attained, ✓ - attained, blank – insufficient data.

VWQMN Site code	Location	Nitrogen	Phosphorous	DO	pH	Turbidity	EC
404206	Broken River at Moorngag	✗	✗	✓	✓	✗	✓
404207	Holland Creek at Kilfeera	✓	✗	✗	✓	✗	✓
404210	Broken Creek at Rices Weir	✗	✗		✓	✗	✓
404214	Broken Creek at Katamatite	✗	✗	✗	✓	✗	✓
404216	Broken River at Goorambat	✗	✗	✗	✓	✗	✓
404224	Broken River at Gowangardie	✗	✗	✗	✓	✗	✓
405200	Goulburn River at Murchison	✓	✓	✗	✓	✓	✓
405203	Goulburn River at Eildon	✓	✓		✓	✓	✓
405204	Goulburn River at Shepparton	✓	✗	✗	✓	✓	✓
405205	Murrindindi River at Murrindindi	✓	✗	✓	✓	✓	✓
405209	Acheron River at Taggerty	✓	✗	✓	✓	✓	✓
405212	Sunday Creek at Tallarook	✗	✗	✗	✓	✗	✗
405214	Delatite River at Tonga Bridge	✓	✗	✓	✓	✓	✓
405219	Goulburn River at Dohertys	✓	✓	✗	✓	✓	✓
405231	King Parrot Creek at Flowerdale	✗	✓	✓	✓	✓	✓
405232	Goulburn River at McCoy Bridge	✗	✗	✓	✓	✗	✓
405234	Seven Creeks d/s Polly McQuinn Weir	✗	✗		✓	✗	✓
405237	Seven Creeks d/s of Euroa	✗	✗	✗	✓	✓	✓
405240	Sugarloaf Creek at Ash Bridge	✗	✗	✗	✓	✗	✗
405251	Brankeet Creek at Ancona	✗	✗	✓	✓	✓	✓
405264	Big River d/s of Frenchman Creek	✓	✗	✓	✓	✓	✓

2.5.4 Biological threats

Biological threats in the Goulburn Broken Catchment come from exotic flora (weeds species in the riparian zone), exotic fauna (terrestrial species in the riparian zone), barriers to fish migration and the condition of the Streamside zone (Figure 2.8).

The most common of the biological based threats in the Goulburn Broken Catchment is the presence of barriers to fish migration. A high or very high rating for this threat refers to barriers that permanently block the passage of fish (i.e. the barrier never drowns out to allow passage). This type of barrier affects 62% of the length of the Goulburn Basin (mainly the entire catchment above Goulburn Weir) and 69% of the length of the Broken Basin.

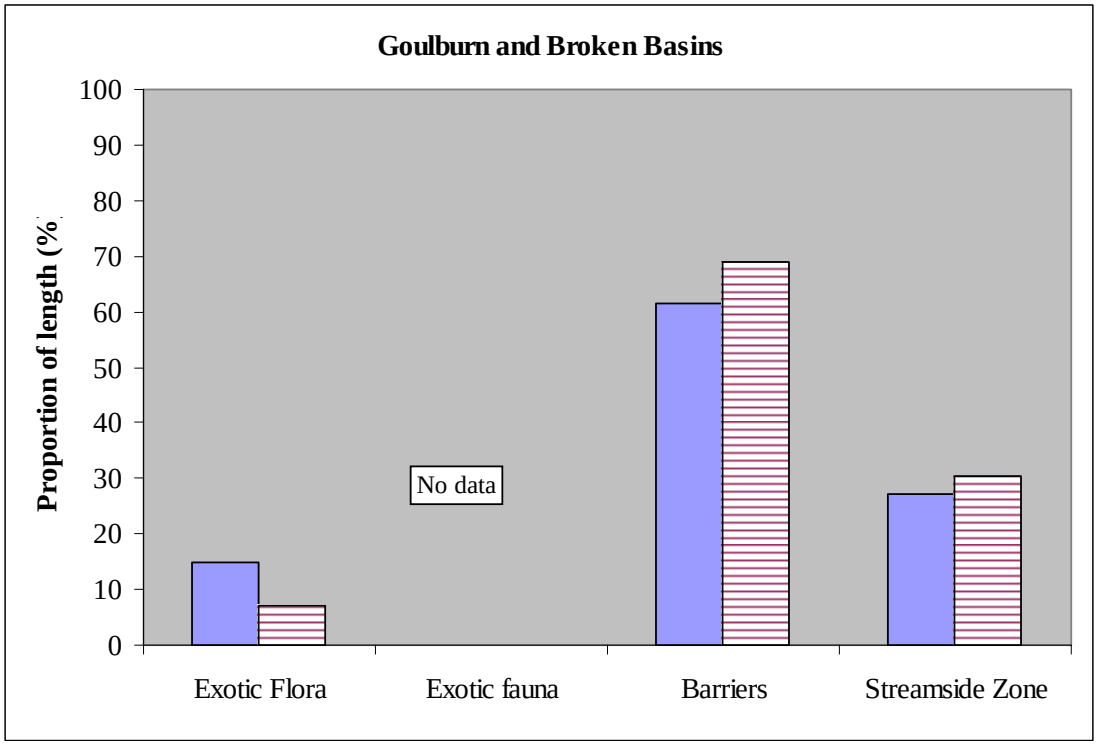


Figure 2.8. Proportion of stream length in the Goulburn and Broken Basins with Very High or High threat levels for biological measures.

Exotic flora dominates the landscape over relatively little of the Goulburn Broken Catchment – 15% of the Goulburn and 7% of the Broken Basins.

There are no data for exotic terrestrial fauna over much of the Catchment. Only 8 reaches have data, and these show moderate or low levels of infestation.

The Streamside Zone threat (based on the overall ISC measure, which is a combination of width, continuity and structural intactness) is Very High or High over 27% of the Goulburn Basin and 30% of the Broken Basin.

Exotic flora dominating lowland streams (aquatic vegetation)

3. References

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Appendices

Appendix 1. List of assets included in RiVERS.

Environmental value	Data source
Significance	
Significant Fauna	DSE Fauna database
Significant Flora	DSE Flora database
Statewide EVC	DSE Flora database
Fish Migration	DSE Fish database, expert knowledge
Wetland Significance	DSE Wetland database
Wetland Rarity	DSE Wetland database
Sites of Significance	Reports, local knowledge
Heritage River	Heritage River Legislation, LCC 1991
Naturalness	
Width of riparian vegetation	Index of Stream Condition (ISC)
Longitudinal Continuity	ISC
Structural Intactness	ISC
Invertebrate Observed/Expected	AUSRIVAS, ISC
Fish Observed/Expected	Expert knowledge, fish database
Fish proportion introduced	Expert knowledge, fish database
Ecologically Healthy River	VRHS criteria
Representativeness	
Representative River	River Health Strategy (NRE, 2002)
Social value	
Recreation Fishing	Local knowledge
Non Motor Boats	Local knowledge
Motor Boats	Local knowledge
Camping	Local knowledge
Swimming	Local knowledge
Passive Recreation	Local knowledge
European Heritage	Heritage Department
Listed landscape	Local knowledge
Species of Local Significance	Local knowledge
Economic value	
Water supply	DSE
Infrastructure	Local knowledge
Land value	Local knowledge
Tourism	Local knowledge
Power generation	Local knowledge

Appendix 2. Threats to environmental, social and economic values included in RiVERS.

Threat	Data source
Bank erosion	ISC
Bank stability	ISC
Channel form	ISC
Barriers to fish migration	ISC, Local knowledge
Flow Deviation	ISC
Water quality (trend)	EPA
Water quality (physicochemical)	EPA Water quality database
Water quality (SIGNAL score)	ISC
Temperature	Local knowledge
Algal Blooms	Local knowledge
Exotic Flora	ISC
Degraded Riparian Vegetation	ISC
Introduced Fauna	Local knowledge
Loss of instream habitat	ISC
Wetland Connectivity	Local knowledge, wetland database
Stock Access	ISC

Appendix 3 **Rare or threatened fauna in the Goulburn Broken catchment. (FFG: L – Listed; EPBC: End – Endangered, Vul – Vulnerable; AROT: V – Vulnerable; VROT: e – endangered, v – vulnerable, r – rare, k – Data deficient)**

Common name	Scientific name	FFG	EPBC	AROTS	VROTS
Amphibians					
Barking marsh frog	*Limnodynastes fletcheri*				**k**
Spotted tree frog	*Litoria spenceri*	**L**	**End**		**e**
Warty bell frog	*Litoria raniformis*		**Vul**	**V**	**v**
Birds					
Australasian bittern	*Botaurus poiciloptilus*				**e**
Australasian shoveler	*Anas rhynchotis*				**v**
Barking owl	*Ninox connivens*	**L**			**e**
Black falcon	*Falco subniger*				**e**
Blue-billed duck	*Oxyura australis*	**L**			**v**
Brolga	*Grus rubicunda*	**L**			**v**
Brown quail	*Coturnix ypsilophora*				**k**
Bush stone-curlew	*Burhinus grallarius*	**L**			**e**
Diamond firetail	*Stagonopleura guttata*	**L**			
Glossy ibis	*Plegadis falcinellus*				**v**
Great egret	*Ardea alba*	**L**			**e**
Grey goshawk	*Accipiter novaehollandiae*				**r**
Grey-crowned babbler	*Pomatostomus temporalis*	**L**			**e**
Hardhead	*Aythya australis*				**v**
Helmeted honeyeater	*Lichenostomus melanops cassidix*	**L**	**End**		**e**
Hooded robin	*Melanodryas cucullata*				
Lewin's rail	*Rallus pectoralis*	**L**			**e**
Little egret	*Egretta garzetta*	**L**			**e**
Musk duck	*Biziura lobata*				**v**
Nankeen night heron	*Nycticorax caledonicus*				**v**
Pacific gull	*Larus pacificus*				**r**
Painted honeyeater	*Grantiella picta*	**L**			**v**
Pied cormorant	*Phalacrocorax varius*				**r**
Powerful owl	*Ninox strenua*	**L**			**e**
Red-chested button-quail	*Turnix pyrrhothorax*				**v**
Regent honeyeater	*Xanthomyza phrygia*	**L**	**End**		**e**
Royal spoonbill	*Platalea regia*				**v**
Sooty owl	*Tyto tenebricosa*	**L**			**v**
Speckled warbler	*Chthonicola sagittata*				**v**
Square-tailed kite	*Lophoictinia isura*	**L**			**e**
Superb parrot	*Polytelis swainsonii*	**L**	**Vul**	**V**	**e**
Swift parrot	*Lathamus discolor*	**L**	**End**		**e**
Turquoise parrot	*Neophema pulchella*	**L**			**r**
White-bellied sea-Eagle	*Haliaeetus leucogaster*	**L**			**e**
Fish					
Barred galaxias	*Galaxias fuscus*	**L**	**End**		**e**
Bluenose(Trout) cod	*Maccullochella macquariensis*	**L**	**End**		**e**
Crimson-spotted rainbowfish	*Melanotaenia fluviatilis*	**L**			**k**

Common name	Scientific name	FFG	EPBC	AROTS	VROTS
Flat-headed galaxias	*Galaxias rostratus*				**k**
Freshwater catfish	*Tandanus tandanus*	**L**			**v**
Golden perch	*Macquaria ambigua*				**v**
Macquarie perch	*Macquaria australasica*	**L**	**End**		**e**
Mountain galaxias	*Galaxias olidus*	**L**			**k**
Murray cod	*Maccullochella peelii peelii*	**L**			**v**
River blackfish	*Gadopsis marmoratus*				**k**
Silver perch	*Bidyanus bidyanus*	**L**			**e**
Invertebrates					
Damselfly	*Hemiphlebia mirabilis*	**L**			**v**
Murray spiny cray	*Euastacus armatus*				**k**
Mammals					
Brush-tailed phascogale	*Phascogale tapoatafa*	**L**			**v**
Common bent-wing bat	*Miniopterus schreibersii*	**L**			**v**
Eastern horseshoe bat	*Rhinolophus megaphyllus*	**L**			
Leadbeater's possum	*Gymnobelideus leadbeateri*	**L**	**End**		**e**
Southern myotis	*Myotis macropus*				**r**
Spot-tailed quoll	*Dasyurus maculatus*	**L**	**Vul**	**V**	**e**
Squirrel glider	*Petaurus norfolcensis*	**L**			**e**
Reptiles					
Bandy bandy	*Vermicella annulata*	**L**			**r**
Tree goanna	*Varanus varius*				**k**
Woodland blind snake	*Ramphotyphlops proximus*				**v**

Appendix 4.. Rare or threatened flora in the Goulburn Broken catchment. (FFG: L – Listed; EPBC: none; AROT: V – Vulnerable, E – Endangered, R – rare, K – insufficiently known nationally; VROT: e – endangered, v – vulnerable, r – rare, k – insufficiently known in Victoria)

Common name	Scientific name	FFG	EPBC	AROTS	VROTS
Alpine bent	*Agrostis meionectes*			**R**	**r**
Ausfeld's wattle	*Acacia ausfeldii*			**R**	**v**
Austral trefoil	*Lotus australis*				**k**
Bluish raspwort	*Haloragis glauca f. glauca*				**k**
Buloke	*Allocasuarina luehmannii*	**L**			
Button rush	*Lipocarpha microcephala*				**v**
Cliff cudweed	*Euchiton umbricola*				**r**
Common joyweed	*Alternanthera nodiflora*				**k**
Coolibah grass	*Panicum queenslandicus*				**e**
Dookie daisy	*Brachyscome gracilis*	**L**			**v**
Forde poa	*Poa fordeana*				**k**
Forest sedge	*Carex alsophila*				**r**
Golden dodder	*Cuscuta tasmanica*				**k**
Green-top sedge	*Carex chlorantha*				**k**
Highland bush-pea	*Pultenaea williamsonii*			**K**	**r**
Hypsela	*Hypsela tridens*				**k**
Late-flower flax-lily	*Dianella tarda*				**v**
Leafy templetonia	*Templetonia stenophylla*				**r**
Leafy wallaby-grass	*Austrodanthonia bipartita s.s.*				**k**
Mallee golden wattle	*Acacia notabilis*				**v**
Matted water-starwort	*Callitriche sonderi*				**k**
Narrow goodenia	*Goodenia macbarronii*	**L**		**V**	**v**
Netted daisy-bush	*Olearia speciosa*				**k**
Pale spike-sedge	*Eleocharis pallens*				**v**
Round-leaf pomaderris	*Pomaderris vacciniifolia*				**v**
Royal grevillea	*Grevillea victoriae ssp.*				**r**
Sand rush	*Juncus psammophilus*				**r**
Short-awned wheat-grass	*Elymus multiflorus*				**k**
Silky browntop	*Eulalia aurea*				**r**
Slender tick-trefoil	*Desmodium varians*				**k**
Small scurf-pea	*Cullen parvum*	**L**		**E**	**e**
Smooth minuria	*Minuria integerrima*				**r**
Spiny-fruit saltbush	*Atriplex spinibractea*				**e**
Spurred spear-grass	*Austrostipa gibbosa*				**r**
Summer fringe-sedge	*Fimbristylis aestivalis*				**k**
Swamp billy-buttons	*Craspedia paludicola*				**v**
Swamp star	*Hypoxis exilis*				**v**
Toothed leionema	*Leionema bilobum ssp. 3*				**r**
Tough scurf-pea	*Cullen tenax*	**L**			**e**
Veiled fringe-sedge	*Fimbristylis velata*				**r**
Waterbush	*Myoporum montanum*				**r**
Woolly buttons	*Ixiolaena sp. 1*				**r**

Appendix 5. Significant Ecological Vegetation Classes in the Goulburn Broken catchment. Note: no status is given as the same EVC may have a different status in different Bioregions.

Ecological Vegetation Class
Alluvial Terraces Herb-rich Woodland
Alluvial Terraces Herb-rich Woodland/Creekline Grassy Woodland Mosaic
Black Box Chenopod Woodland
Box Ironbark Forest
Brackish Lake
Cool Temperate Rainforest
Creekline Grassy Woodland
Creekline Grassy Woodland/Red Gum Wetland Mosaic
Damp Forest
Drainage Line Complex
Floodplain Riparian Woodland
Floodplain Riparian Woodland/Floodplain Wetland Mosaic
Floodplain Riparian Woodland/Plains Grassy Woodland Mosaic
Gilgai Plain Woodland/Wetland Mosaic
Granitic Hills Woodland
Grassy Dry Forest
Grassy Woodland
Heathy Dry Forest
Herb-rich Foothill Forest
Lagoon Wetland
Low Rises Grassy Woodland/Alluvial Terraces Herb-rich Woodland Mosaic
Lowland Forest
Moira Plain Wetland
Montane Damp Forest
Montane Dry Woodland
Montane Riparian Thicket
Montane Wet Forest
Perched Boggy Shrubland Complex
Pine Box Woodland
Pine Box Woodland/Riverina Plains Grassy Woodland Mosaic
Plains Grassland/Gilgai Plain Woodland/Wetland Mosaic
Plains Grassy Woodland
Plains Grassy Woodland/Creekline Grassy Woodland Mosaic
Plains Grassy Woodland/Gilgai Plains Woodland/Wetland Mosaic
Plains Grassy Woodland/Plains Grassland/Plains Grassy Wetland Mosaic
Red Gum Wetland
Red Gum Wetland/Plains Grassy Wetland Mosaic
Riparian Forest
Riparian Forest/Creekline Grassy Woodland Mosaic
Riparian Forest/Swampy Riparian Woodland/Riparian Shrubland/Riverine Escarpment Scrub/Disturbed Mosaic
Riparian Scrub
Riparian Shrubland
Riverina Plains Grassy Woodland/Plains Grassland/Gilgai Plain Woodland/Wetland Mosaic
Riverine Escarpment Scrub
Riverine Grassy Woodland

Ecological Vegetation Class
Riverine Grassy Woodland/Black Box Chenopod Woodland/Wetland Mosaic
Riverine Grassy Woodland/Gilgai Plain Woodland/Wetland/Riverina Plains Grassy Woodland
Riverine Grassy Woodland/Riverina Plains Grassy Woodland Complex
Riverine Grassy Woodland/Riverina Plains Grassy Woodland/Black Box Chenopod Woodland Complex
Riverine Grassy Woodland/Riverine Sedgy Forest/Wetland Mosaic
Sand Ridge Woodland
Shrubby Dry Forest
Shrubby Foothill Forest
Slopes Box Grassy Woodland/Box Ironbark Forest Complex
Spring Soak Woodland
Sub-alpine Woodland
Swampy Riparian Complex
Swampy Riparian Woodland
Swampy Riparian Woodland/Percherd Boggy Shrubland Mosaic
Treeless Sub-alpine Mosaic
Unclassified Lunette Woodland
Valley Grassy Forest
Valley Grassy Forest/Plains Grassy Woodland Complex
Valley Heathy Forest
Wet Forest
Wetland Formation

Appendix 6 - Index of Stream Condition

The ISC is an integrated tool for catchment management that can assist Catchment Management Authorities together with their regional communities to set management objectives and measure the effectiveness of long term programs for the rivers in their catchment (refer to Victorian Water Resources Data Warehouse: http://www.vicwaterdata.net/)

The ISC is an indicator of environmental condition that integrates information of the major components of our river systems that are important from an ecological perspective. It brings together information on the current river flow regime, water quality, condition of the channel and riparian zone and the invertebrate communities living in the stream. It provides an overall indication of changes in river condition.

The ISC benchmarking is a snapshot of river condition during 1999. It should be noted that the ratings reflect river condition in this year only. 950 river reaches representing 18 000km of Victoria's major rivers and their tributaries were surveyed.

Objectives

The two main objectives of the ISC are to:

- benchmark the condition/health of streams across the Victoria
- assist Catchment Management Authorities (CMAs) to set management objectives for rivers

The 5 Sub-indices

The ISC contains 5 sub-indices. These five sub-indices are made up of a total of 19 key indicators. The ISC provides a summary of the extent of change from natural or ideal conditions to each of the 5 sub-indices:

1. hydrology (flow volume and seasonality of flow)
2. physical form (stream bank and bed condition, presence of and access to physical habitat)
3. streamside zone (quality and quantity of streamside vegetation and condition of billabongs)
4. water quality (nutrient concentration, turbidity, salinity and acidity), and
5. aquatic life (diversity of macroinvertebrates)

Hydrology	Streamside Zone	Physical Form	Water Quality	Aquatic Life
• AAPFD (Amended Annual Proportional Flow Deviation) – looks at the difference between natural and existing monthly flows • Catchment permeability • Presence of hydroelectric power stations	• Width • Longitudinal continuity • Structural intactness • Cover of exotic vegetation • Regeneration of native species • Billabong condition	• Bank stability • Bed stability • Artificial barriers • Instream physical habitat	• Total phosphorus • Turbidity • Electrical conductivity • pH	• Diversity of macroinvertebrates (SIGNAL and AUSRIVAS)

Calculating the ISC score

Each sub-index is scored out of a maximum of ten. An inverse ranking is then applied to the sub-index scores. The total score is then scaled back to a maximum value of 50. Thus the overall score for the ISC will vary between a minimum of 0 and a maximum of 50.

When either/ or the water quality/ aquatic life sub-index scores are missing (ie. no data available) these are estimated on a pro rata basis so as to allow the aggregated ISC score to be calculated. Where pro rata values have been used, an asterix is attached to the aggregated ISC score.

Condition ratings

The condition of reaches can be classified into one of five classifications:

Condition	ISC score
Very poor	0 – 19
Poor	20 –25
Moderate	26 – 34
Good	35 – 41
Very Good	42 - 50

The maximum amount of information can be extracted from the ISC by looking at the individual sub-index scores and the ratings behind these. The overall ISC score can only provide a broad indication of river condition.

Publications

A number of publications are available which have detailed information on how the ISC was developed and applied:

- Index of Stream Condition: Reference Manual (second edition) details how the ISC was developed and applied along with details of each sub-index.
- Index of Stream Condition: Field Manual details procedures for the collecting of field data to evaluate indicators in the Streamside zone and Physical form sub-indices.
- Index of Stream Condition: Catchment managers manual provides advice on how ISC results can be interpreted and used in strategic waterway management.
- Index of Stream Condition: Users Manual (second edition) how to undertake data collection and data entry for the ISC (early 2001).
- Victorian Rivers: An Environmental Report Card is a brochure introducing the web site and major findings

Further information

For more detailed information please contact: Department of Sustainability and Environment (Victorian Water Resources Data Warehouse**:** http://www.vicwaterdata.net/)