IMPROVING EAST GIPPSLAND RIVERS

Priorities for River Health 2007-2012

EAST GIPPSLAND
CATCHMENT
MANAGEMENT
AUTHORITY

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EAST GIPPSLAND CATCHMENT MANAGEMENT AUTHORITY

Victoria The Place To Be

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John Pearson

Communications Coordinator

East Gippsland Catchment Management Authority

September 2009

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John Pearson
Communications Coordinator

FOREWORD

This booklet is designed to show off our East Gippsland Rivers and provide some history around works completed on each one.

Further the booklet seeks to explain the most recent strategic objectives of the Victorian Government, expressed as the Authority's Catchment Goals up to 2012.

The Catchment Goals have been derived from the East Gippsland Regional River Health Strategy which was developed after extensive consultation with the East Gippsland community in 2002-2005. The catchment goals are used to gauge progress towards managing the key threats to the rivers in our region. Progress made toward the goals indicates achievement in keeping the rivers in the region in good health.

It takes a long time for rehabilitation works to show their real benefits in improved river health. We are planning our works over a five year timeframe, but fully expect the benefits will not become obvious for 10-20 years. If you look through the book for examples of work completed over previous long timeframes (see cover), you will get a feel for what we expect the rivers of East Gippsland to look like in another 10-20 years.

The Victorian Government understands that long term sustained effort on river rehabilitation by the whole community is required if we are going to keep our rivers in good shape for future generations. The Authority is very grateful of the continued investment provided by the Victorian Government which is underpinning proven river health value now and for the future.

This booklet outlines projects that are underway or have been completed at this time (mid-2009). Other works will be undertaken to achieve the goals by 2012.

The goals do not summarise all the Authority's work. For example, maintaining or increasing bank side vegetation and controlling major weed threats other than willows are also priorities for keeping our rivers healthy. However, the aim of this publication is to communicate the main goals and the work being undertaken towards them.

I trust that this publication gives you a greater understanding of the work undertaken by the Authority in maintaining and improving the rivers in our region.

Dr Peter Veenker
Chairperson, East Gippsland Catchment Management Authority

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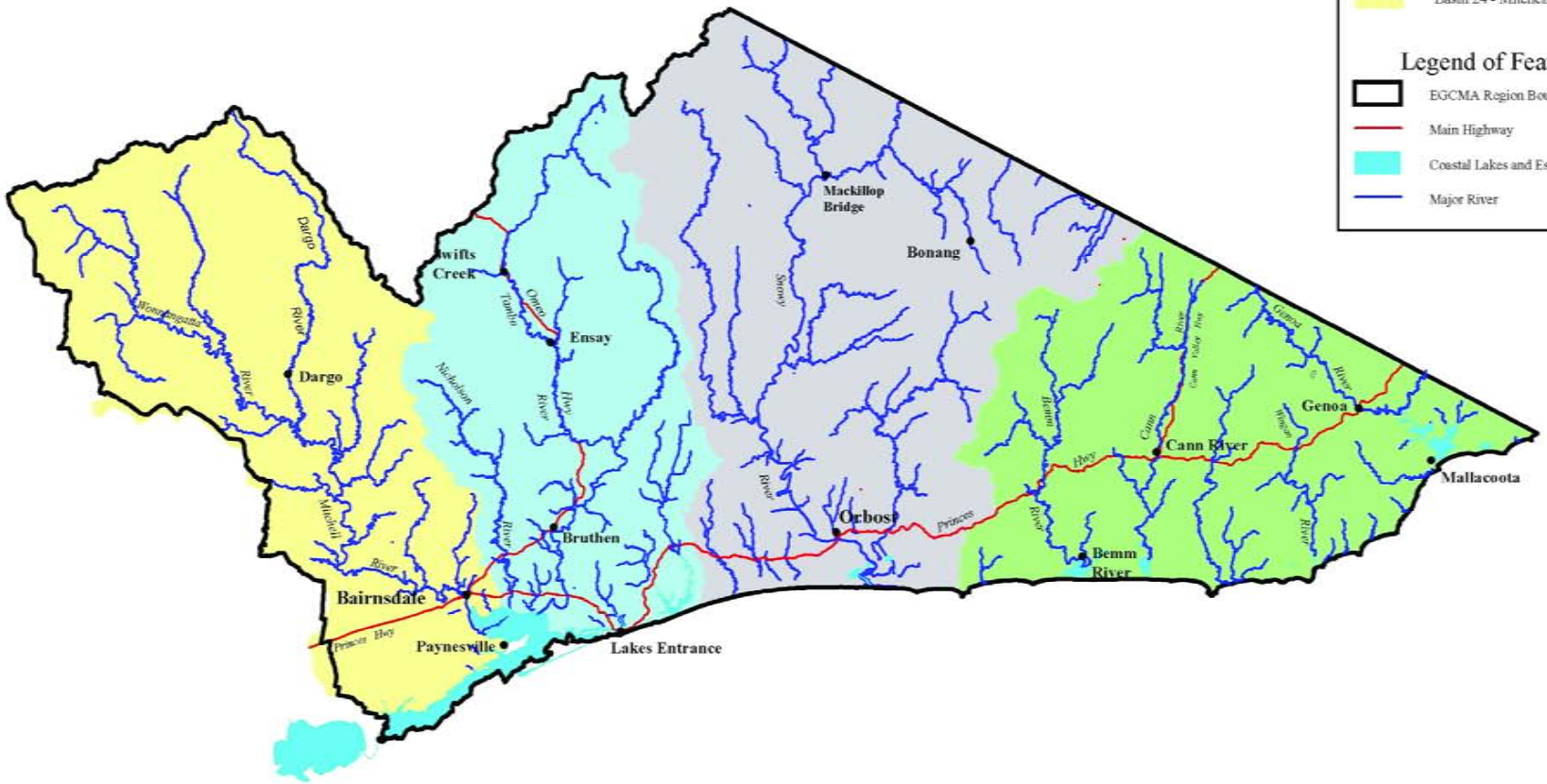

EAST GIPPSLAND CATCHMENT MANAGEMENT AUTHORITY

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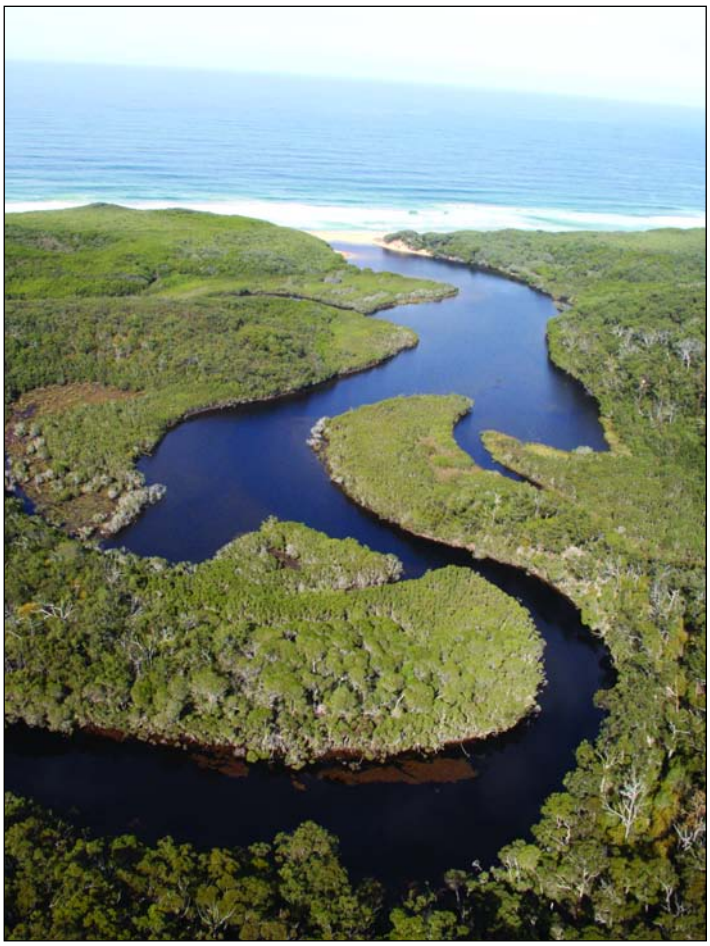
REGIONAL CATCHMENT STRATEGY

A major responsibility of the East Gippsland Catchment Management Authority is the development and co-ordination of the Regional Catchment Strategy (East Gippsland Catchment Management Authority 2005) and supporting plans. The Regional Catchment Strategy identifies the broad priorities for natural resource management in the region. Specific strategies and plans are then developed to manage particular elements of the natural assets in the region like native vegetation, biodiversity and river health.

RIVER HEALTH STRATEGY

The East Gippsland Regional River Health Strategy (East Gippsland Catchment Management Authority 2005a) outlines the economic, recreational and environmental values of rivers, streams and estuaries; the major threats such as bank erosion and pest plants and animals; and the river management priorities including water quality monitoring, restoration of fish habitat, structural works to prevent erosion and native vegetation restoration.



Benedore River Estuary, Far East Gippsland.

The priorities identified in the Regional River Health Strategy protect the healthiest (high value) rivers from any decline in condition, maintain the condition of ecologically healthy rivers, and improve the environmental condition of all other streams.

In all, 37 rivers in the East Gippsland region have been identified as High Value Streams with high community values for environmental, social and economic reasons. Protecting these rivers from willows and other weeds, erosion and other threats has a high priority in the Authority's works program. In addition, works on other rivers are designed to achieve an overall improvement in their condition.

CATCHMENT GOALS

The Authority's goals for river health have been derived from the Regional River Health Strategy (East Gippsland Catchment Management Authority 2005a). They address the highest priorities to be achieved for each river by 2012. The goals are:

- All rivers east of the Cann will be free of willows and fenced from grazing stock.
- The Cann River channel will be stabilised in the floodplain reach. All reaches above Weeragua and below the Princes Highway Bridge will be free of willows.
- The Bemm River will be free of willows and fenced from grazing stock.
- The Snowy catchment will be free of willows from the Victorian headwaters to the Jarrahmond Gauge. The floodplain reach will have a continuous riparian zone from the Jarrahmond gauge to the estuary fenced from grazing stock.
- The Tambo and feeder streams will be free of willows above Ramrod Creek.
- The Nicholson and feeder streams will be free of willows and have a continuous riparian zone between the Princes Highway Bridge and the Great Alpine Road fenced from grazing stock.
- The willow control works completed in the Mitchell River by June 2009, will be consolidated as free of willows. An additional 50 kilometres above the Glenaladale off-take will be fenced from grazing stock and revegetated.
- Environmental Water Reserves will be established for all waterways in East Gippsland.

This booklet provides further information about each of these goals, including the works undertaken by the Authority, other agencies and community groups to maintain and improve the condition of the rivers in East Gippsland.

EXAMPLE OF RIVER REHABILITATION WORKS

Bank stabilisation works on a critical bend on the Cann River in May 2000.

The same bend with vegetation on the banks and bed of the river in July 2008.

All rivers east of the Cann will be free of willows and fenced from grazing stock.

Introduction

Many of the rivers in East Gippsland are in 'near pristine' condition. This is due to the extensive forested areas in the catchments and the limited amount of clearing of vegetation along rivers in the past for agriculture and settlement. Ensuring they remain in excellent condition is an important priority for the Authority.

In some areas, a problem in the past has been erosion and sediment on the Genoa River and tributaries which has required extensive efforts to rectify over many years.

Considerable progress has now been made. Today, it is often difficult to imagine that a well-protected river bank, thickly vegetated with native trees and shrubs could be the same site that previously was denuded and badly eroded.

The following pages illustrate that careful planning, persistent effort and nature itself can repair damaged sections of our rivers and streams.

FAR EAST CATCHMENTS

Genoa and Wallagaraugh River catchments

The Genoa River starts in southern New South Wales near Bombala and flows southwards into Victoria before joining with the Wallagaraugh River (which also starts in New South Wales). Both rivers flow into Mallacoota Inlet.

Large tracts of the Genoa River catchment are public land. In New South Wales, the Genoa National Park (former Nungatta and Nalbaugh National Parks) and Mt Imlay National Park (near Eden) are located wholly or partly in the catchment. There are also State Forests in New South Wales located wholly or partly in the Genoa and Wallagaraugh catchments.

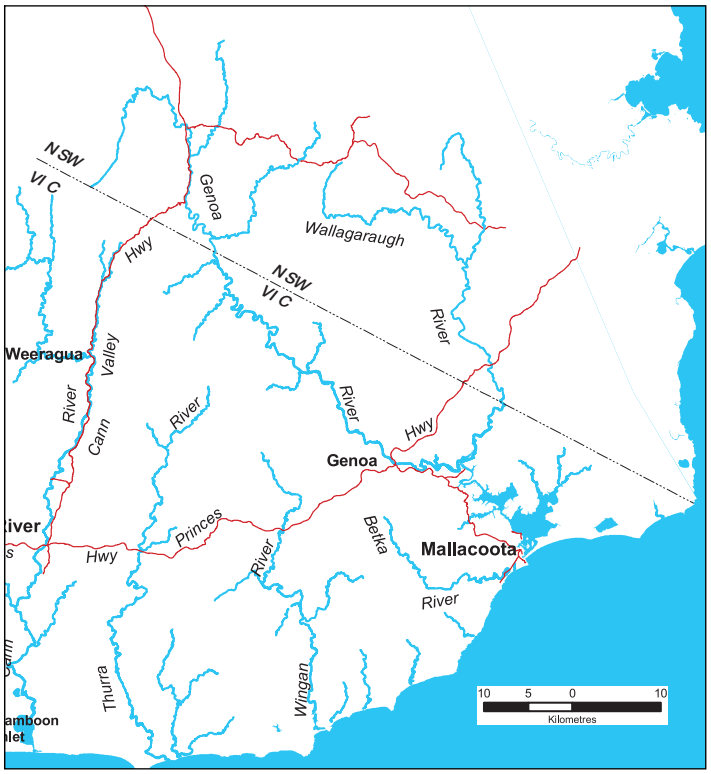
Wallagaraugh River, Far East Gippsland.

In Victoria, there are two national parks: Coopracambra, a wilderness area that adjoins the Genoa National Park, and the Croajingolong National Park that extends along the coastal strip from the New South Wales border to Sydenham Inlet. There are also large areas of State Forest in the Genoa and Wallagaraugh catchments in Victoria.

In Victoria, there are small pockets of freehold land mainly used for grazing at Wangarabell, Stony Creek, Genoa, Gipsy Point, Johnson Bridge and Maramingo.

About half the rivers in this catchment have been identified as High Value Streams because of their heritage values – the upper Genoa River because of the Genoa River gorge, scenic landscapes and botanical sites, and the lower reaches of the Genoa River because of the significant wetlands (including Mallacoota Inlet) and recreational fishing.

Other High Value Streams in this catchment are Wangarabell Creek, an ecologically healthy river, and the Wallagaraugh River because of its association with Mallacoota Inlet.



River catchments, Far East Gippsland.

There are now very few willows remaining in this catchment. Other weeds such as Blackberry, Wandering Jew and Blue Periwinkle are a high priority for control in the future.

Betka and Remote Coastal Streams catchment

The Bekta River (37 kilometres in length) and the Remote Coastal Streams pass through the Croajingolong National Park and flow into estuaries that are intermittently open to the sea.

The Bekta River, the source of domestic water for the township of Mallacoota, and the remote coastal streams are considered to be in 'Excellent' condition.

There are some areas of Blackberry in this catchment. Significantly, willows and other serious weeds are not present in this area, so monitoring to ensure they do not spread from other areas is an important priority.

Thurra and Wingan River catchments

The Thurra and Wingan Rivers and their minor tributaries flow through predominantly public land, including the Alfred National Park and parts of the Coopracambra and Croajingolong National Parks. These rivers terminate in coastal inlets that are intermittently open to the sea.

Large portions of the rivers and streams in the catchment are in 'Excellent' (59%) or 'Good' (7%) condition. The main problems are weeds, such as Willow, Blackberry and Kikuyu on the Wingan River; the loss of riparian vegetation particularly on the lower Thurra River; river bed instability (erosion and sediment deposition); and loss of in-stream habitat in some parts.

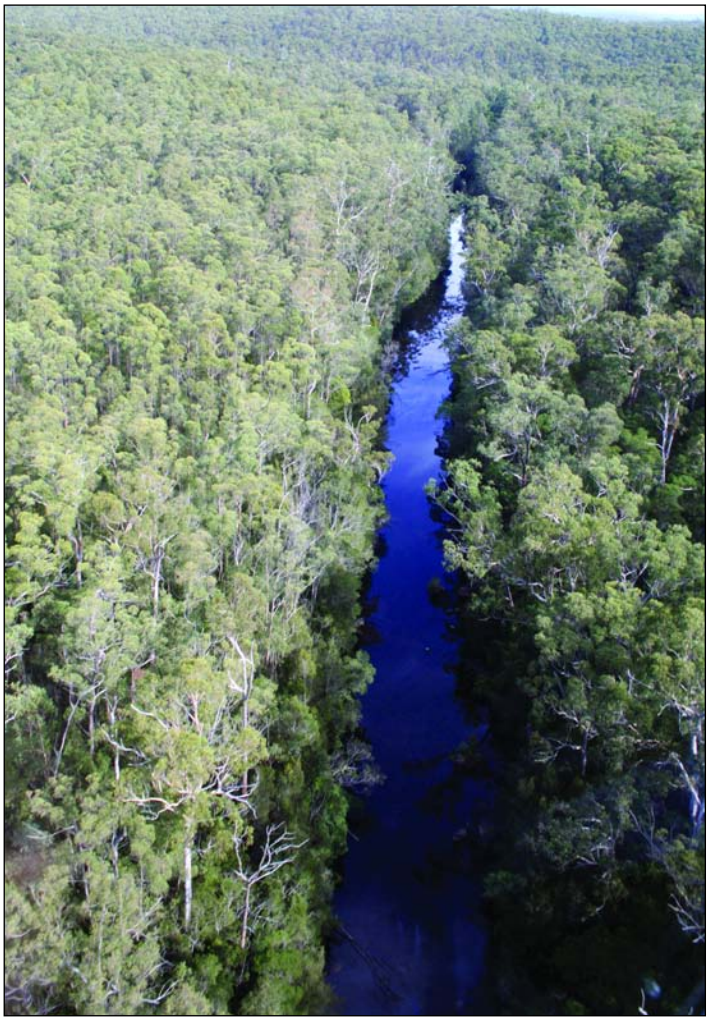
Most invasive weeds are absent from the Thurra River, so preventing the spread of these pest plants from other areas is an important priority.

WILLOW CONTROL

Although willow control is still required in some places (for example, on sections of Wangarabell Creek), this pest plant is no longer widely distributed in the Far East. An aerial survey in May 2009 revealed less than 50 trees along the Genoa River and its tributaries. These will be dealt with in 2010.

The main task now is to control regrowth in areas where willows have been removed in the past. It is also important to monitor rivers and streams that have been free of willows to ensure that infestations do not occur from seeding willows.

In 2006-2007, works to control regrowth were conducted along the entire length of the Genoa River, from the border with New South Wales to the tidal zone a few kilometres below the Princes Highway Bridge, and along the Wallagaraugh River from the New South Wales border to the confluence with the Genoa River at Gipsy Point.



Thurra River, Far East Gippsland.

Bekta River Estuary, Far East Gippsland.

Monitoring for the presence of willows was also carried out along the entire length of the more remote streams in the region - the Betka, Wingan, Benedore, Red and Thurra Rivers, and Shipwreck Creek. Small numbers of willows were found and these were re-treated in 2009.

PAST PROBLEMS ON THE GENOA RIVER AND TRIBUTARIES

While catchments in the Far East are extensively forested and are in 'Excellent' condition, there have been problems in the past with bank erosion along sections of the Genoa River and with sediment (sand) travelling downstream and threatening the ecology of significant wetlands, including Mallacoota Inlet.

A report (Erskine 1992) concluded that different types of erosion – channel, gully, wildfire-induced, forestry-induced, agricultural-induced and erosion resulting from road construction - were the principal sources of sediment in the Genoa River. These sources included the reconstruction of the Monaro Highway at Rockton; the establishment of pine plantations on Bondi Creek, White Rock River and Nungatta Creek; and gully erosion on cleared agricultural land on Nungatta Creek, the Genoa River at Rockton, Wangarabell Creek at Wangarabell, Big Flat Creek at Wangarabell and the Wallagaraugh River at Timbillica.

This report also identified frequent fire and flood events as important sources of sediment. Intense fires have occurred in the Genoa River catchment such as those in January 1979 and the early months of 1983 (Jones Creek) which, when combined with steep slopes and readily erosive soils, predispose the area to erosion.

Floods have also contributed to sediment loads in the Genoa River. East Gippsland has the greatest frequency of 24 hour rainfall in excess of 75 mm in Victoria resulting in periods of high rainfall intensity. Among many floods in the catchment, the one in February 1971 caused significant channel erosion along extensive sections of the Genoa River.

The 1992 Erskine Report concluded that future management activities to control erosion and sedimentation should focus on the rehabilitation of erosion sites in the main channel and immobilise the sand through revegetation of the stream verges. To do this along the entire Genoa River, interstate cooperation between river management authorities in Victoria and New South Wales was needed.

In the following years, the East Gippsland Catchment Management Authority and its predecessor the East Gippsland River Management Board completed restoration works that significantly reduced erosion on the priority sites identified in the report. The works included bank stabilisation, fencing and revegetation, and interstate programmes to control pest plants, with a focus on the eradication of willows.

These works were very successful and it is often difficult to recognise the rehabilitated sites today when comparing them with past photographs of the same sections of rivers. Some examples of these works using 'before' and 'after' photographs are briefly described here.

BIG FLAT CREEK

On Big Flat Creek, drop structures, rock chutes, bank protection works, stock-proof fencing and vegetation plantings were completed. By 2001, this tributary was no longer considered to be a major source of sand to the Genoa River.

Drop structure, rock beaching and revegetation, Barber property, Big Flat Creek, during construction in January 1994 and in July 2008.

JONES CREEK

On Jones Creek, a major sand source to the Genoa River in the past, silt traps were constructed from timber and rock. These have been successful in trapping vast quantities of sand as the photographs taken during construction and in July 2008 show.

Silt traps on Jones Creek during construction in February 1994 and in July 2008.

GENOA RIVER AT GENOA

Considerable attention was also directed towards controlling bank erosion on the Genoa River at Genoa, particularly below the Princes Highway Bridge. In the past, the river banks on the fertile floodplain had been cleared for agriculture. This resulted in extensive bank and bed erosion. The river became wider and shallower, with unprotected banks prone to further erosion, particularly during flood events such as the one that occurred in 1971.

Genoa River before the opening of the highway bridge in 1989.

An Expert Panel Report (Brooks, Erskine & Finlayson 2001) acknowledged the success of previous works in controlling erosion and reducing sand inputs, and concluded that identifying and stabilising the existing areas of sediment (sand 'stores') should be a priority task for the management of the Genoa River and its tributaries.

In recent years, this has been done by planting long stem native plants indigenous to the area in the sand. These sand deposits can be difficult to vegetate as they are exposed to extreme temperatures and shallow planted tube stock can be easily washed away during high river flows. Unlike small stem tube stock, those planted deep in the sand have a greater resilience to high river flows, better access to moisture and, as a result better long term survival rates.

Long stem native plants, Genoa River.

Photographs of a section of the Genoa River about four kilometres downstream of the highway bridge taken over a 20 year period illustrate the success of works designed to rehabilitate the river. Photograph 1 shows a badly eroded bend in 1968. Photograph 2 shows the same bend in 1989. Photograph 3 taken in April 2009 shows the extensive vegetation cover now established on this bend and along the river banks.

Picture 1 - Bank erosion, lower Genoa River, 1968.

Picture 2 - Bank erosion, lower Genoa River, 1989

Photograph 3 – Rehabilitated bend, April 2009.

Pile driving, lower Genoa River, January 1991.

Picture 4 shows major works in progress on the same eroded bank before pile fields (retards) were constructed. These works were severely damaged during floods soon after this photograph was taken and had to be repeated.

Picture 5 shows the same site now. Note the dense vegetation cover along the river bank and the extensive reed beds *(Phragmites australis)* now established behind the piles. Deep pools have also formed in the river bed, providing habitat for fish and other aquatic life.

Picture 5 - The same river bend in July 2008.

Another effective strategy to restrict the movement of sand has been the introduction of logs in the river channel. Placed at various angles and tethered with cables, these logs slow water flow, trap sediment and, where scouring under the logs takes place naturally, create pools of water that provide habitat for small aquatic plants and animals that are essential in a healthy river environment. In helping to stabilise the sand, these logs promote the conditions for native plants to grow in the exposed sandy river bed and for reeds to grow where deeper pools of water have formed. Vegetation of these types provides natural defences against erosion of the river bank and bed.

THURRA RIVER

Preventing stock access to rivers and river banks is an important part of preventing damage to native trees and shrubs and preventing erosion. The Thurra River is rated in 'Excellent' condition and will now remain this way with total frontage to private farming land fully fenced off from stock. Off-stream watering points for stock have been set up away from the river.

GENOA RIVER INTERSTATE LIAISON COMMITTEE (GRILCO)

GRILCO is a partnership between industry, the Victorian and New South Wales Governments and private landholders, focusing on weed management across the Genoa and Wallagaraugh Rivers and the Mallacoota Inlet catchments. The control of Blackberry and riparian Willow are priorities.

In 2007/08, the focus was sites in the upper Genoa, along Nungatta Creek, Yambulla Creek, Captains Creek and Bondi Creek. These sites are located upstream of the Genoa River and Coopracambra wilderness areas. The works have been undertaken by Nungatta and Rockton landholders, National Parks and Wildlife Service (NPWS), Forests New South Wales and Bega Valley Shire Council.

In the lower Genoa River catchment, Parks Victoria have completed spraying at Howe Flat, Mallacoota Lake and Barracoota Lake while the Authority has undertaken Blackberry control works on the Wallagaraugh and Genoa Rivers.

These works led to improved river conditions, water quality and environmental habitat, as well as reduced seed production and potential re-infestation and improved pasture production.

Weed monitoring by National Parks and Wildlife Service and Parks Victoria along the Genoa River through declared wilderness areas of the South East Forests National Park (New South Wales) and Coopracambra National Park (Victoria) in autumn 2008 revealed a low density of weeds. However, the monitoring also identified Blue Periwinkle infestations upstream of the wilderness area to be targeted by ongoing seasonal spraying.

Revegetation, fencing and grade control works by the Authority along 2 kilometres of the Wangarabell Creek and 0.5 kilometres on the Genoa River will provide enhanced water quality through stock exclusion, improved stability on river banks and reduced sediment and nutrient inputs.

FRIENDS OF MALLACOOTA

The Friends of Mallacoota are restoring rainforest at Devlins Gully. This gully adjoins the township of Mallacoota and flows into the estuary near Bastion Point. The project, funded by CoastAction/CoastCare and the Department of Sustainability and Environment, mainly involves the hand removal or spraying of weeds such as Asparagus Fern and Honeysuckle, and the propagation and planting of native plants.

WATERWATCH

Waterwatch is a community water quality monitoring network established by the Australian Government in 1993. In the East Gippsland region, 57 monitors sample water quality at 110 sites. In 2007-08, 439 water samples were collected and analysed.

Dot de Gues has been a Waterwatch monitor on the Genoa River below the highway bridge for over 10 years. Her beef cattle property has a long frontage to the lower Genoa River and this has given her a keen interest in river health issues. She maintains responsible farming practices, controlling stock access to the river and looking after plantations of native vegetation along the river banks.

Waterwatch volunteer Dot de Gues, Genoa River,

Watchwatch data are recorded on a central database and reports prepared to assist in natural resource management including the maintenance and rehabilitation of waterways and catchments.

The Cann River channel will be stabilised in the floodplain reach.
All reaches above Weeragua and below the Princes Highway Bridge will be free of willows.

Introduction

The catchment goal for the Cann River outlines the focus of the Authority's plans to improve river health along the Cann River and its tributaries.

There have been widespread concerns among local residents and river management authorities about the stability of the Cann River channel for more than a century. A devastating flood in February 1919 resulted in significant changes for the worse to the river around Noorinbee. Other major floods have also impacted on channel stability, such as incision (deepening) of the river bed and the erosion of the river banks.

Over the years, many works have been undertaken to manage the immediate problems posed by flooding and the long term threats to the stability of the river channel. The information about past works which is presented here has been drawn from published reports and in discussions with those with personal experience of the history of the river.

CANN RIVER CATCHMENT

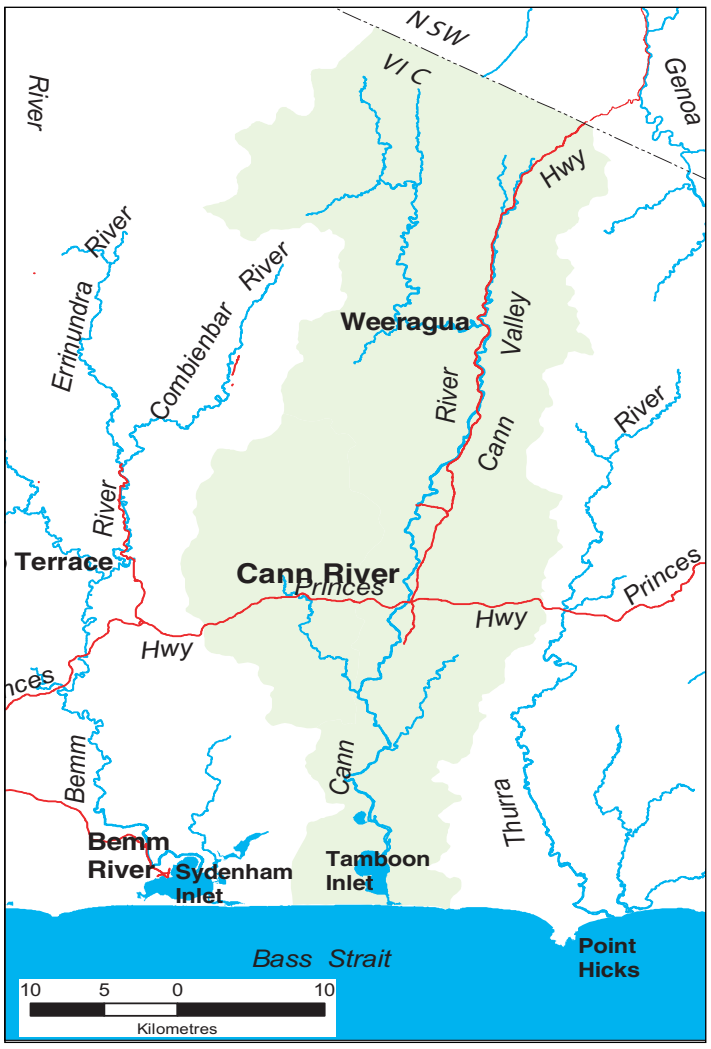
The Cann River catchment (1,167 square kilometres) comprises the forested upland areas on the Victorian and New South Wales border, the cleared agricultural land on the Cann floodplain around Noorinbee, and the Cann River township and Tamboon Inlet on the lower reaches of the river.

The river is formed at the confluence of two streams – the East and West branches of the Cann - at Weeragua. The main tributaries are the Buldah, Chandlers, Lock Up, Reedy, Kate, Tonghi, Granite and Gibbs Creeks. The Cann River flows into Tamboon Inlet, a coastal lagoon that is intermittently open to the ocean. Lake Furnell is also located on the lowland reach of the river.

Public land in the catchment includes sections of Coopracambra and Croajingolong National Parks. These remote areas support a number of ecosystems including eucalypt forests, heathlands, rainforests, granite peaks and coastal headlands. These ecosystems support a diversity of flora and fauna, including 328 fauna and 1000 flora species recorded in the Croajingolong National Park.

Cann River downstream of 'Double Bridges' north of Noorinbee.

The fertile Cann River floodplain mainly supports dairying and beef cattle grazing. The small township of Cann River, located at the junction of the Princes and Monaro Highways, is a rest stop for travellers and a starting point for visitors to the Coopracambra and Croajingolong National Parks.



Cann River catchment.

CATCHMENT GOAL

The catchment goal states that *the Cann River channel will be stabilised in the floodplain reach. All reaches above Weeragua and below the Princes Highway Bridge will be free of willows.*

A river 'channel' (or course) is defined by the bed and banks. A 'stabilised' channel means that the bed and banks of the river are resistant to erosion during high flows including flood events.

There have been major concerns about the stability of the Cann River channel since early last century and particularly since the disastrous floods of February 1919. Over time, the channel in the floodplain reach downstream of Weeragua became wider, deeper and straighter and contained much less woody debris. These changes were initiated by several large floods, aided by channel clearing and straightening and the removal of riparian vegetation associated with land clearing for agriculture.

Cann River at Noorinbee, looking downstream, 1939. (DSE River Health Collection)

In its original state, the floodplain reach of the river was similar to many other places in East Gippsland. It had a small channel capacity, a high density of woody debris, and tight meander bends with the river banks well covered with native vegetation. During times of high river flows, the river would 'break its banks' and spread out over the floodplain. In doing so, the velocity of the water was reduced and the sediment carried in the water was deposited on the floodplain.

After the 1919 floods, the river below Weeragua became wider and straighter. As it did so, a greater volume of water was confined within the river channel. This increased erosion of both the banks and the bed of the river, with large amounts of sediment carried in the swiftly flowing water and deposited downstream. During times of peak flows, significant areas of valuable farm land were lost through erosion.

Flood damage at Noorinbee 1934. (DSE River Health Collection)

Over the years, river management works designed to reduce flooding were undertaken. These included desnagging (removal of woody debris from the river bed), channel straightening and the clearing of riparian vegetation. However, these works actually led to *increases* in channel volume and capacity resulting in increasing erosion of the bed and banks of the river. This exacerbated the problems rather than reduced them.

Cann River downstream from the Princes Highway bridge, 1934. (DSE River Health Collection)

WILLOWS

The catchment goal also notes the Authority's aim to remove willows above Weeragua - that is, on the East and West branches of the Cann River – and below the Princes Highway Bridge.

Willows have been present on many rivers in East Gippsland for over 100 years. Extensive plantings occurred between 1950 and 1970 in an effort to control erosion as the impact of desnagging, the clearing of riparian vegetation and unrestricted stock access to waterways became evident.

However, while willows were often originally planted in an effort to provide bank stability and prevent erosion, they have been found to contribute to increased erosion and flooding and, in some situations to diversions of the river channel (avulsions).

Problems arise when willows planted on the river bank encroach into the river channel. Fallen branches and old trees trap debris and reduce the capacity of the channel to handle high water flows. On narrow rivers, this can lead to blockages across the river channel. Another problem is that willows can become established in the river channel, trapping sediment that forms in-stream islands. Water flowing downstream is diverted around these islands, and erosion occurs on the adjacent exposed banks behind the willows lining the original river bank. These impacts further increase erosion particularly during floods.

Willows also have many other detrimental effects on rivers. For instance, the shading of the river in Spring and Summer, and the extensive shedding of leaves during Autumn suppress native vegetation and aquatic life that are necessary to maintain river health and water quality.

Willow control has been necessary to maintain the Cann River in good condition. Mechanical removal of willows has already been undertaken on sections of Buldah Creek (a tributary of the west branch of the Cann River) and at various other sites.

In the lower floodplain reaches, native vegetation is gradually improving and assisting bank stability in some places. At these sites, willows will be gradually removed following bank stabilisation works, fencing off to prevent stock access to the river and the continued revegetation of the river banks with native plants.

THE CANN RIVER BEFORE EUROPEAN SETTLEMENT

Before European settlement in the 1870s, the Cann River around Noorinbee was a meandering stream with well vegetated banks. The bed of the river contained a great deal of woody debris from branches and trees falling into the river. These provided 'steps' that stabilised the river bed as the river descended in height and eventually reached sea level in the lower reaches.

Like many East Gippsland streams, the channel capacity was small and during periods of high flow, the river frequently 'burst its banks' and spread out over the floodplain. This occurred frequently and for relatively long periods. At times, the river shifted as it meandered across the floodplain.

Cann River at Noorinbee 1939. (DSE River Health Collection)

The floodplain was covered with tall Eucalypt trees and thickets of Leptospermum and Melaleuca. The trees near the river replenished the wood in the stream that provided stability to the river bed and the native vegetation stabilised the bank.

East Gippsland experiences periods of high rainfall intensity (over 75mm in a 24 hour period) leading to high river flows. Before European settlement, the natural condition of the river channel and adjacent floodplain provided protection during heavy downpours of rain.

Frequent bushfires would have occurred in the catchment before settlement as they do now. Bushfires destroy vegetation and expose slopes to erosion, particularly during periods of heavy rain soon after the fires. However, the good condition of the river indicates that fires had little detrimental effect on the river in the period before European settlement.

EUROPEAN SETTLEMENT

Clearing for agriculture in the Cann Valley commenced in the 1870s. On the fertile floodplains, trees were ringbarked or felled, and vegetation was removed and burnt. Paddocks were ploughed, pasture sown and stock introduced. River banks were cleared to provide stock access to water, for river crossings and by stock grazing.

These changes appear to have had little effect until the onset of a major flood in February 1919. This flood commenced a process of bank erosion, channel widening and the stripping of topsoil from the floodplain. Photographs in the 1930s, 1940s and 1950s show a massive widening of the river channel with high, eroding banks following major flood events.

The sediment from the eroding banks moved downstream (often termed a 'sand slug'), filled the channel and diverted the flow causing further bank erosion and a rising of the river bed over time (aggradation).

These destructive processes accelerated further following other major floods such as those in February 1971 and June 1978.

A major investigation (Erskine & ID&A 1997) concluded that:

The net change between 1935 and 1995 has been a 325% increase in [river] channel width, 39% increase in depth, 489% increase in area, 174% increase in mean stream power and a 31% decrease in sinuosity [a measure of meandering]. These changes are truly cataclysmic and illustrate the metamorphosis of channel form which has occurred this century.

There were other problems. A concern of local residents following the 1919 flood was that an avulsion (diversion) would occur from the main channel into Blue Nose Creek. Another concern was the erosion of the river bank behind the old butter factory and the potential threat this posed to the Cann River township.

MANAGING THE PROBLEMS

Since the 1919 flood, a range of river management works have been undertaken. Initially, the works were done by private landholders, some funded through State Rivers and Water Supply Commission grants. Most grants were for desnagging between 'Double Bridges' and 'The Narrows', and the clearing of bank-side vegetation for stock access to the river.

In September 1963, following requests from landholders, the Cann River Improvement Trust was formed. It consisted of seven elected Commissioners and one Government nominee.

The objectives of the Trust were to 'reduce the extent of flooding on the adjacent river flats by removal of snags and other restrictions along certain sections of the river and to stabilise eroding river banks'.

Funding for operational and maintenance costs was derived from rate revenue and grants for flood restoration works. By 1967, the removal of 'obstructions' along the river had been completed. River management activities then focused on the 'protection of severely eroded banks by river training fencing and the establishment of vegetative cover (mainly willows)'.

Alignment fencing was constructed on many badly eroded river banks. This consisted of wire mesh about one metre high supported on angle iron posts. Willows were planted behind the fences and, when these were uprooted during periods of high river flow they were lashed to the fences. An apron in front of the fence was designed to prevent sand washing away and undermining the fence.

Alignment fencing, Broome property, July 1968.

Much of this fencing was severely damaged in major floods in January and February 1971. It was repaired using heavier railway iron as posts. Remnants of these alignment fences can still be seen along the river today.

Damaged alignment fences, Walker property, 1990. Note the high, eroded river bank.

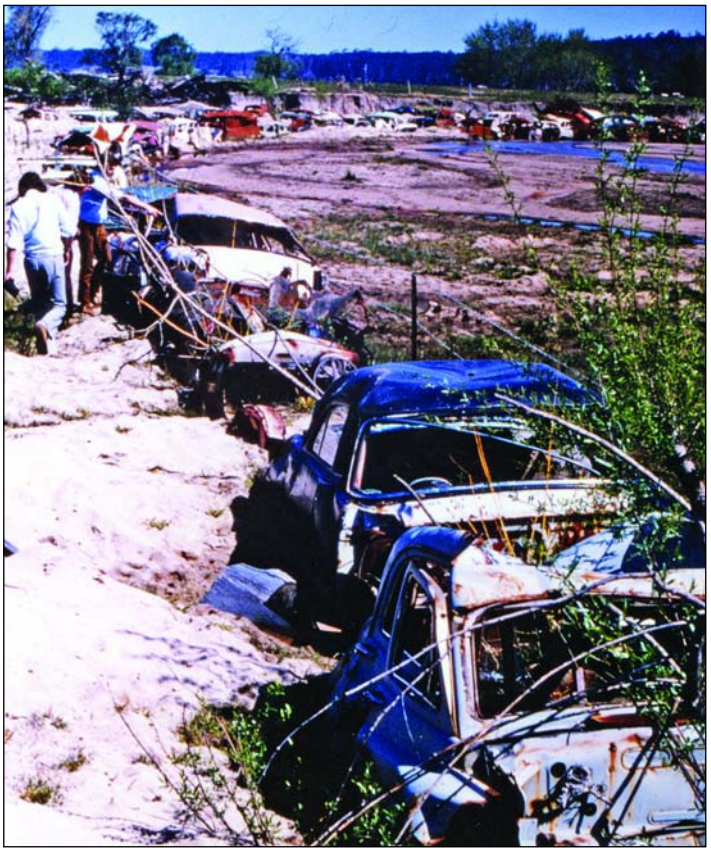
CANN RIVER IMPROVEMENT TRUST (1963-1990)

In the ten year period after its formation in September 1963, the Cann River Improvement Trust focused on de-snagging, bank protection, alignment training and some channel straightening in an attempt to manage flood damage. These works involved the removal of logs and vegetation in the bed of the river, the construction of metal fencing and wooden piles in the vicinity of badly eroded banks, and the planting of willows (Cann River Improvement Trust 1985).

However, these activities often caused more problems than they solved. As one report noted, these works increased flow velocity and stream power and significantly reduced the ability of the channel to withstand erosion (Erskine & ID&A 1997). Without trees and large branches that formed log 'steps', the bed of the river eroded and became deeper. Without bed stability, the toe (foot) of the high banks became more prone to erosion.

Alignment fencing at old butter factory ('McKinnons'), March 1970.

These effects were very evident in early 1971. Floods in January caused major erosion, removed riparian vegetation and waterlogged the banks. A month later, the highest recorded flood wrecked havoc along major sections of the river. Alignment fencing designed to protect the banks was carried away, or the strongly flowing water was diverted under or around these structures. Severe erosion then occurred on the unprotected banks.



North of old butter factory October 1972.

In an effort to protect the banks from further erosion following these floods, the Improvement Trust resorted to some desperate measures, as the above photograph of car bodies along the same section of river bank (McKinnons) show.

Another major flood in 1978 also caused extensive damage. Structural works and riparian vegetation were washed away. Photographs of the river behind the old butter factory (without the car bodies now!) show a high eroded bank unprotected from further damage.

Old butter factory ('McKinnons') March 1972.

Unprotected river bank near old butter factory ('McKinnons'), 1978.

EAST GIPPSLAND RIVER MANAGEMENT BOARD – 1990-1997

The East Gippsland River Management Board continued many of the works previously managed by the Improvement Trust. Emphasis was still placed on bank protection works using piles and alignment structures, but these were redesigned to prevent failure during floods. The absence of major floods between 1978 and 1998 enabled native vegetation to re-establish along sections of the river. Willows and wattles in the river channel were removed, stock exclusion fencing was erected along the river bank, and rock ramps, bars and groynes were constructed to stabilise sections of the river.

In 1995, the East Gippsland River Management Board commissioned a study of the Cann River. The review (Erskine & ID&A 1997) recommended several key management strategies for the river:

- construction of rock ramp bed control structures, which permit fish passage and stabilise the river bed;
- development of a floodplain management plan in consultation with the community of the Cann Valley;
- promotion of the natural healing process for the river with vegetation along the banks and bed of the river; and
- monitoring of the river channel, aquatic life and bank side habitat.

EAST GIPPSLAND CATCHMENT MANAGEMENT AUTHORITY – 1997+

The report (Erskine & ID&A 1997) was given detailed consideration by the Far East River Management Group and the East Gippsland Catchment Management Authority before and after the floods of 23 and 24 June 1998.

On 15 December 1998, a public meeting was held in Cann River to outline the recommendations of the report. At this meeting, a presentation provided an historical account of river channel changes and management responses, a model to account for the behaviour of the river under different conditions, a vision for the future and some management strategies to achieve that vision.

The crucial issue that the East Gippsland Catchment Management Authority and the community needed to resolve was the balance between natural healing processes, assisted by complementary management strategies, without allowing channel capacity to reduce so much that the frequency of floodplain inundation became unacceptable.

As outlined in the report, a natural healing process was expected to occur during years of normal river flows. Vegetation would encroach into the channel, protecting the bed of the river against incision (deepening) and encouraging the deposition of sand from upstream. Over time, the river channel would reduce in size and, in times of major floods, the power of water in the channel would decrease. However, the flow capacity of the channel would also decrease. Management strategies including groynes, rock bars and stream bank protection would be undertaken to encourage this process.

It was anticipated that occasional major floods could interrupt this recovery process and cause erosion in sections of the river bed and along the river banks. However, this damage would be isolated, unlike the significant damage along substantial sections during major floods in the past, because the river would no longer be contained within a smaller channel. Instead, it would 'break its banks', spreading out over the floodplain and dissipating the destructive energy previously contained within the channel.

But more frequent flooding on the floodplain would cause stock and pasture management problems for farmers and sometimes restrict access to paddocks. So farmers were concerned that channel capacity was not reduced too much and the frequency and duration of floodplain inundation did not become unacceptable. They were also concerned that river management actions might also place restrictions on the nature and extent of cultivation close to the river, and that land may need to be set aside for plantations of trees and shrubs in the vicinity of potential avulsions (diversions).

The public meeting on 15 December passed a resolution – 19 'For' and 2 'Against' – supporting five recommendations for the future management of the Cann River subject to a future review of channel capacity. The recommendations were to:

1. install rock structures to control the grade of the river bed;
2. plant vegetation (sedges, tussocks and reeds) to anchor sediment on the river bed and protect the lower bank, supplemented with low growing shrubs along the riverbanks; protect active erosion sites; and maintain existing structures, as required;
3. the eradication of willows (except Dwarf Willows);
4. control stock access, manage exotic vegetation (weeds) and a range of other actions; and
5. monitor and review the works and present these to the community.

The implementation of these works were to be staged over 25 years to allow for the availability of funds, adjustment by floodplain landholders to the increased frequency of flooding, and further monitoring and increased knowledge about river flows.

RESTORING THE RIVER

In recent years, a 'natural healing approach' has been taken to restore the health of the river. Following consultation with the local community, vegetation has been allowed to encroach into the river channel to capture and stabilise sediment (sand).

West Cann Bridge, looking downstream, April 1969.

West Cann Bridge, looking downstream towards rock chute No.5, July 2008.

Pile rock bar No.7, upstream of highway bridge at Cann River.

Various works have been undertaken to complement this natural healing process. Rock chutes and pile fields have been constructed in an effort to stabilise the river bed, retain sediment and provide a stable environment for reeds and other aquatic plants to become established.

At the same time, native trees and shrubs have been planted to stabilise the banks. Fences have been erected along the river to prevent stock eating and trampling new plants including those that have regenerated naturally.

This healing process is expected to take some years to occur. As the vegetation becomes established it will provide natural defences against erosion during flood events. Over time, the river channel is expected to reduce in size. During major floods, the river is expected to 'break its banks' and flow onto the floodplain, releasing the destructive force of the water that was previously retained within the river channel and caused so much damage.

Native vegetation cannot compete when willows are present. The dense shade during Spring and Summer, and the heavy loss of leaves during Autumn do not provide suitable conditions for indigenous shrubs to become established along the river banks or for aquatic plants such as reeds to thrive on the river bed. As shrubs and reeds become established, gradual removal of willows can be undertaken, restoring the river to its natural condition.

It is expected that occasional major floods could interrupt this recovery process and cause erosion in isolated sections of the river bed and along the river banks. This occurred during high river flows in July 2007. These sites have now been repaired with rock, fenced off from stock and planted with native shrubs to provide a natural defence against further damage. These flood recovery works are important in preventing small erosion sites extending over larger sections of the river.

Repairing active erosion site, Filmer property at Noorinbee.

MONITORING RIVER HEALTH

Another important part of maintaining and improving river health is monitoring for pest plants such as willows and other weeds. These have a detrimental effect on river health when they suppress native vegetation that is essential to a healthy river system.

Between 2005 and 2007, the Authority conducted an extensive monitoring program for willows and other high priority weeds along many rivers in the Far East. On the Cann River, inspections were made on a 15 kilometre section of the river, commencing three kilometres below the Princes Highway Bridge. Extensive sections of the river were found to be infested with Willow and Blackberry. Control of these weeds is an important part of improving the health of the river. While some sites have been treated, 10 kilometres of willows remain to be controlled on the lower Cann.

The monitoring also located isolated patches of Bridal Creeper and Wandering Jew. These weeds will receive attention in the future.

Alignment training (9 years old) on boundary of Broome and Harrison properties, July 2008.

CANN RIVER SHARED PATH

Works that will improve the quality of water flowing into the Cann River and beautify the area are currently underway between Tamboon Road and Tyson Street by East Gippsland Shire. These works include the removal of willows, stabilisation of sections of the creek with rock and indigenous shrubs, and the construction of a walking track. This is the first stage of a more extensive walkway which, when completed will make the river more accessible from the town.

Shared path, Cann River, July 2008.

The Bemm River will be free of willows and fenced from grazing stock.

Introduction

The goal for the Bemm River catchment identifies the direction of the Authority's plans to improve river health and water quality along the Bemm River and its tributaries, such as the Errinundra and Combienbar Rivers.

In the main, these rivers are in good condition due to the extensive forested areas that cover most of the catchment.

However, in some places land clearing for agriculture has resulted in the removal of native vegetation along the river banks. This vegetation removal has, over time increased the level of soil erosion and reduced the stability of the river bed and its banks. The works undertaken on the Bemm River and tributaries, including those to manage active and potential erosion sites are outlined in this description of the catchment goal.

THE BEMM RIVER CATCHMENT

The Bemm River is formed at the confluence of the Errinundra and Combienbar Rivers, 10 kilometres upstream from the small township of Club Terrace. Major tributaries are the McKenzie, Arte and Goolengook Rivers which join with the Bemm downstream of Club Terrace.

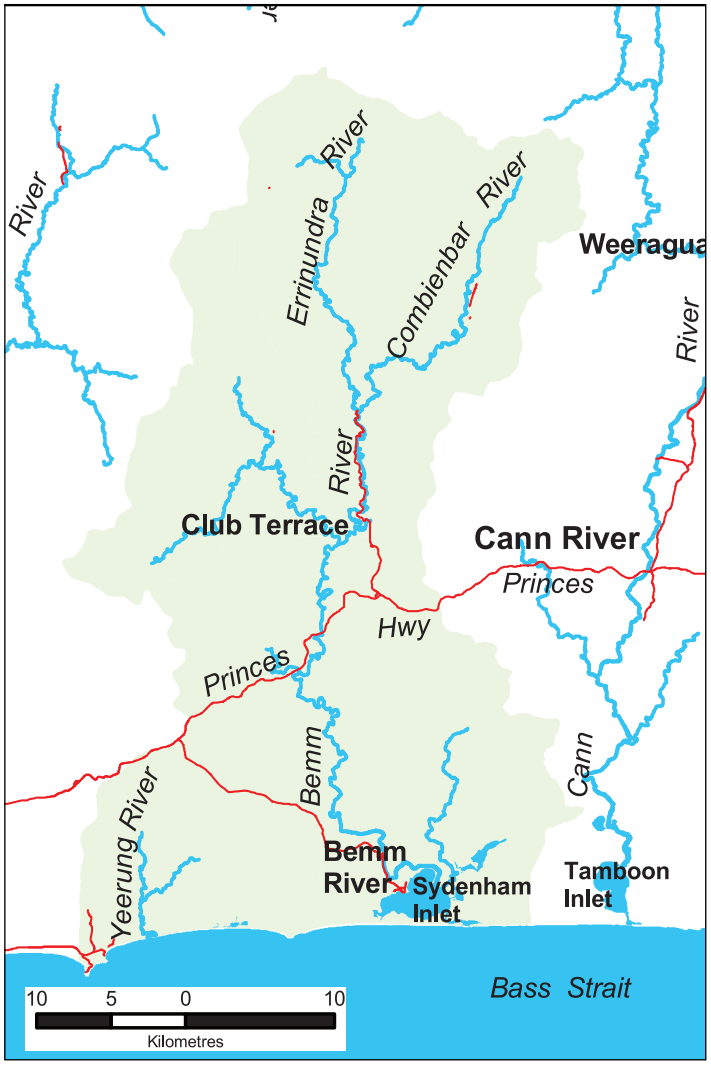
The catchment comprises mainly public land, including Cape Conran Coastal Park, Bemm River Scenic Reserve, Errinundra National Park and the Lind National Park. These areas have a broad range of ecosystems including Cool and Warm Temperate Rainforest, ancient Wet Eucalypt Forest, Coastal Heathland and Banksia Woodland.

The Errinundra National Park (25,100 hectares) in the north-east of the catchment contains Cool Temperate Rainforest unique to East Gippsland. Eucalypt forests containing trees over 400 years old are also an important feature in this park. The Errinundra Plateau is the source of seven rivers flowing north, south and east.

The Lind National Park south of the small township of Club Terrace contains a variety of eucalypt forest types such as Grey Gum, Messmate and Silvertop Ash with areas of Warm Temperate Rainforest in gullies.

Cape Conran Coastal Park (11,700 hectares), along with Marlo Coastal Reserve to the west and Croajingolong National Park to the east is part of the 'Wilderness Coast'. These areas include a diverse range of habitats including sandy dunes, mudflats, wetlands and estuaries that contain healthy and diverse native plant and animal communities.

The Bemm River flows into Sydenham Inlet (included in Cape Conran Coastal Park), a coastal lagoon that is intermittently open to the ocean. The Inlet is an important location for recreational fishers. Lowland wetlands adjoining the Inlet include Swan, Cygnet and Mud Lakes. These are important breeding locations for waterfowl, migratory birds and other aquatic animals.



Bemm River catchment.

BEMM RIVER

Beware Reef Marine Sanctuary (220 hectares) is located five kilometres offshore, west of the point where Sydenham Inlet flows into Bass Strait. This marine park supports a wealth of marine life including various types of seaweeds, Bull Kelp, Fur Seals, Maori Octopuses and more than 20 species of reef fish including the Long-Snouted Boarfish.

Water quality in the Bemm River and its tributaries was rated Excellent or Good in the 2004 Index of Stream Condition (ISC) report (Department of Sustainability and Environment 2005). The ISC combines information on five key aspects of river health – hydrology (flow), water quality (phosphorus, turbidity, salinity, pH), physical form (banks and river beds), streamside vegetation and aquatic life. These high ratings are largely due to the extensive forested areas in the catchment and the limited impacts of human settlement and agriculture.

The Bemm River and its tributaries have heritage river status due to the environmental values associated with these rivers such as Cool Temperate and Warm Temperate rainforest areas (from 1200 metres to sea level), long-footed Potoroo habitat, Australian Grayling habitat, native fish diversity in the lower reaches and Sydenham Inlet, and the land form characteristics of Sydenham Inlet.

Sydenham Inlet.

Fertile floodplain areas on the Combienbar River, and along the Bemm River between it's confluence with the Errinundra River and the Princes Highway, have been cleared and support mainly beef cattle grazing.

There are two small rivers in the region that are independent of the Bemm River – the Little River which flows into Sydenham Inlet and the Yeerung River (East and West branches) which flows directly into Bass Strait.

CATCHMENT GOAL

The catchment goal states that the Bemm River will be free of willows and fenced from grazing stock (by 2012).

Willows were first introduced to the Errinundra and Combienbar Rivers and along the Bemm River to control erosion on river banks where native vegetation had been cleared. Without the protection provided by native plants and shrubs, the banks readily eroded, particularly during major flood events.

Willows were selected because they were easily propagated, fast growing and had a root system that was considered to be effective in stabilising the soil.

Native plants are very effective in stabilising river banks and preventing erosion. For instance, the Kanooka or Water Gum *(Tristania laurina)*, which is common along streams and moist shaded slopes has root systems that are very effective in stabilising river banks. Whilst they strengthen the bank, they do not invade the river channel like willows. This is evident along most of the Bemm that was not cleared for agriculture.

In 1999, willows were considered to be among Australia's worst weeds, a weed of National Significance, due to their highly invasive nature and negative impact on the environment.

Willows, Combienbar River.

In recent years, the Authority has undertaken extensive willow control works in the Bemm River catchment. Willows are now under control along the Errinundra River. On the Combienbar River, willows are also under control above and below the floodplain reach. On the Combienbar floodplain reach, willow control works are ongoing. Mechanical removal of willows was undertaken in 2004 and 2005, followed by fencing and planting of native vegetation. Follow up willow control has been completed since then. Further willow removal will take place as problems with bank instability at some places are resolved.

Bemm River at Bemm Bridge, September 2008.

NATURAL CATCHMENT CONDITIONS

In its original state, before settlement and land clearing for grazing, the fertile floodplain areas along the Bemm River were similar to other river 'flats' in East Gippsland. The river had a small channel capacity, large amounts of woody debris in the bed of the river, and tight meander bends. The river banks and the floodplain itself were well covered with native vegetation. These conditions enabled the river to stay in good condition during many fire and flood events that occurred in the catchment.

During times of high river flows, the river would 'break its banks' and spread out over the floodplain. When this happened, the velocity of the water was reduced and the sediment carried in the water was deposited on the floodplain. The well-protected banks remained intact because of the vegetation cover and the low volume of water carried within the river channel.

Land clearing radically altered the natural conditions that had prevailed for thousands of years. At many places along the river, the vegetation on the floodplain was cleared to the water edge and tree branches and trunks were removed from the river channel to provide stock access to the river. Removing the 'snags' so that debris would not accumulate was also thought to prevent damage during high river flows.

Flood damage, Combienbar River, 1961.
(DSE River Health Collection)

The effects of earlier land clearing are very evident on the floodplain reach of the Combienbar River. Without the protection of native vegetation, the river channel became vulnerable to damage during major flood events. Floods caused deepening (incision) or widening of the river channel, or a combination of both effects along some sections of the river. Over time, deepening of the channel progressed upstream, increasing the grade of the stream bed and the power of the water flowing downstream. Higher stream power lead to greater erosive forces operating on the bed and banks of the river. The channel deepened and/or widened leading, in some places to increased meandering across the floodplain.

The deepening and widening of the river will continue unless actions are taken to manage these changes. Experience gained from the management of similar problems on other rivers indicates that this can best be done by increasing channel 'roughness' – that is, by laying and securing logs on the stream bed to trap sediment, and by creating densely vegetated channel bars, banks and buffer zones that, when fully established will restore natural protection against further damage.

RIVER REHABILITATION WORKS

Pile field, Combienbar River.

Fenced river frontage, Combienbar River.

The banks along some sections of the Combienbar River are readily erosive without the protection provided by natural vegetation cover. On cleared sections of the river bank, the management of these sites has typically involved fencing off to prevent stock access and the planting of native trees, shrubs and reeds indigenous to the area. In some places, piles have been driven into the river bed to prevent further erosion and to encourage the accumulation of silt and small debris. This helps to create pools of water that provide habitat for native fish and other aquatic organisms that are vital to maintain water quality. Rock is also used to protect vulnerable sections of the banks and bed of the river.

While the cleared flood plain reaches of rivers are particularly vulnerable to damage during floods, erosion can also occur at sites that still retain much of the natural vegetation cover.

Identifying and assessing flood damaged sites and completing appropriate remedial works is necessary after each major flood event. In this example on the Combienbar River after the June 2007 floods, the obstruction caused by the fallen tree has been removed but the log in the river bed has been left as this helps to maintain the stability of the river bed.

Another important strategy in improving river health is fencing off the river from stock. Stock grazes and tramples riparian vegetation that provides natural defences against erosion along the banks. Fencing protects new plantings of trees and shrubs and native plants that regenerate naturally.

Flood recovery works, Combienbar River (Johnstone property).

Repaired flood damage.

The Errinundra River is generally in good condition. However, erosion has been a problem at some sites where native vegetation has been cleared. This has been managed in the past by lashing logs together and securing them to the banks. These structures also provide good habitat for native fish which can shelter under the logs. Weed control, mainly Blackberry is an on-going management issue at some sites on the river.

Old log bank protection, Errinundra River.

WEED CONTROL

Monitoring rivers for pest plants such as Willow, Blackberry and other weeds is important in maintaining and improving river health. These weeds have a detrimental impact on riparian vegetation that is essential to a healthy river system.

Between 2005 and 2007, inspections were carried out along the entire length of the Bemm River, and on the Errinundra River upstream of the confluence with the Combienbar River. The total length inspected was 59 kilometres. Several types of weeds were found along these rivers.

Types of Weeds

Weeds are 'plants that are unwanted in a given situation and may be harmful, dangerous or economically detrimental' (dpi.vic.gov.au).

Wandering Jew *(Tradescantia fluminensis)* is an aggressive creeper that forms a mat-like cover on the ground that smothers other plants. It thrives in moist, shady places.

Wandering Jew.

Blackberry *(Rubus fruticosus)* is a semi-deciduous shrub with prickly canes that form dense thickets up to several metres high. It is one of the most widespread weeds in temperate areas of Australia.

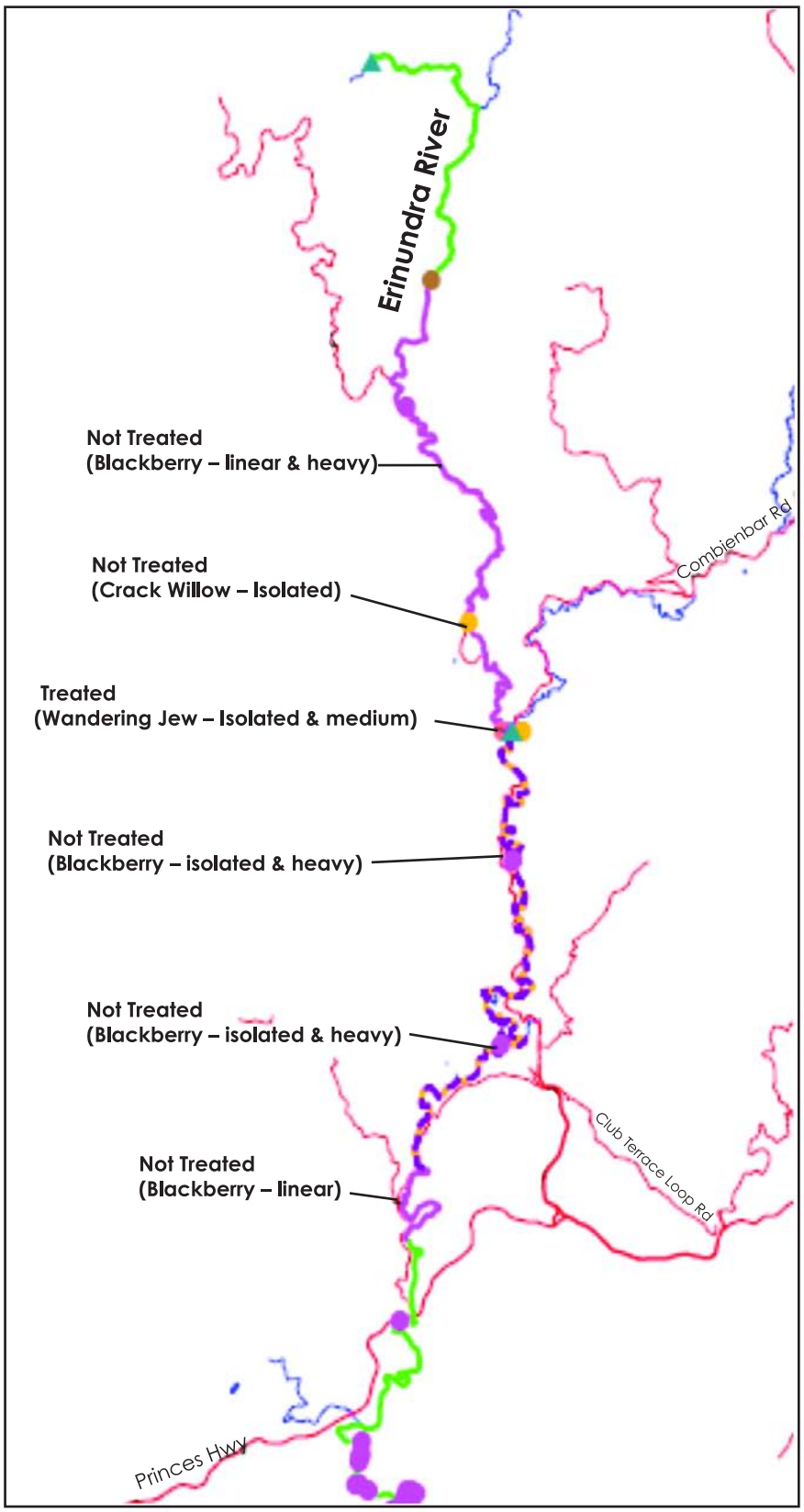
Blackberry on Errinundra River.

Willows *(Salix spp.)* are highly invasive, causing physical changes to rivers and suppressing native vegetation.

Blackberry and Willow are regarded as 'weeds of national significance' by Weeds Australia (weeds.org.au/natsig.htm).

Willow control site on Combienbar River.

WEED CONTROL PROJECTS



Weed Control Extent of Works

- Start & End Points

Weed – Linear Distribution

- No Targeted Weeds Found
- Blackberry
- Willows
- Blackberry and Willow

Weed – Isoluted Population

- Blackberry
- Bridal Creeper
- Crack Willow
- Poplar
- Tortured Willow
- Wandering Jew

Willow, Wandering Jew and Blackberry control areas, Errinundra and Bemm Rivers.

Bemm River Wandering Creeper Control Project

The aim of the project was to conduct chemical treatment of Wandering Jew on the Bemm River. This pest plant has been identified as a threat to maintaining East Gippsland's high value rivers. The area treated is located at the confluence of the Errinundra and Combienbar Rivers.

Goolengook, Arte and Mckenzie Rivers Willow Control

This project involved the identification and control of willows on several rivers. The works began at the top of the catchment and continued downstream to the confluence with the Bemm River. Approximately 70 kilometres of river were investigated and control undertaken as required.

Combienbar River Willow Control

This project was a follow-up to previous works along the Combienbar River to the confluence with the Bemm River, a distance of approximately 12.8 kilometres.

Errinundra River and Bemm River Willow and Blackberry Control

This was a follow-up Willow and primary Blackberry control project on the Errinundra (including East and West branches) and Bemm Rivers. These infestations had been identified as a threat to maintaining East Gippsland's high value rivers. The works involved approximately 50 kilometres of the Bemm and Errinundra Rivers at a cost of $98,000.

Stock watering point, lower Bemm River.

FENCING OFF AND REVEGETATION ON LOWER BEMM RIVER

Controlling stock access to a river is essential in preventing erosion to the river bank. It is also important to prevent damage to native trees and shrubs that provide natural vegetation defences against erosion. A well vegetated river bank also creates habitat for insects that provide food for fish and other aquatic animals that contribute to water quality.

While much of the lower Bemm River has been fenced from stock and revegetated, access to the river for fishing and other recreational activities has been maintained. Platforms have been constructed at three places on the lower Bemm River to cater for fishing and sightseeing along the river.

Fenced and revegetated river bank, lower Bemm River.

Fishing platform, lower Bemm River.

Extensive sections of river bank along the lower Bemm River and the foreshore along Sydenham Inlet have now been fenced off to prevent stock access to the river. Over 1200 metres of frontage were fenced and revegetated in 2007. On Sydenham Inlet, a similar length of fencing was also completed and planted in 2006. Stock access to most of the river is now restricted to fenced off watering points.

WATERWATCH

Russell and Christine Pardew own a farm on the Lower Bemm River which has been in the family since the late 1930s. The family was initially involved in dairying and growing beans (dry and green). The relatively isolated position provided a disease free location for producing dry beans for seed.

BEMM RIVER

Farming activities have changed over time. As a result of dryer conditions, irrigation was introduced to water beans and pasture. However, after a few years of pumping from the river, the salt content of the water became a problem. This required setting up the pumps to draw water from the less salty top layers of water, and timing pumping to suit river conditions.

Russell has also noticed that the river is now shallower due to sand deposits, the water flow is lower due to dryer conditions in recent years and that some of the old trees along the river have died. Over time, the salt condition of the water has got worse. He has also found that local conditions affect the salt content in the river. When the estuary is shut, southwest winds stop the river flowing downstream and the water is held back in the river, increasing salt levels at the pump site.

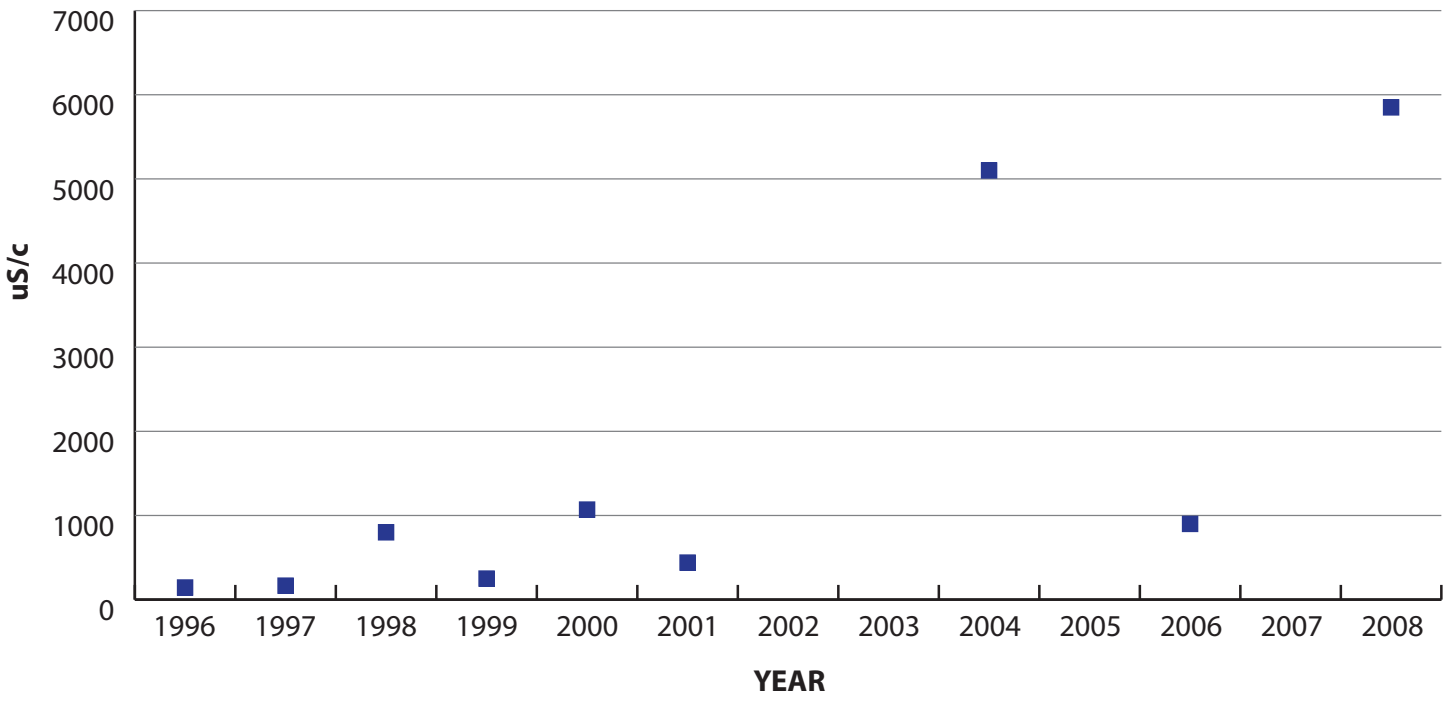
The problems caused by the salt content of irrigation water lead to the family's interest in water quality on the Lower Bemm River. Christine took over from her daughter Kelly as Waterwatch monitor and she has been regularly taking water samples each month from a site at the top of the estuarine reach of the lower Bemm River. Christine tests for salinity (electrical conductivity) and turbidity (suspended sediment) and sends her data to the regional Waterwatch Coordinator in Bairnsdale.

Data on salinity for April from 1996 to 2008 indicates higher salinity levels and greater variability (high and low levels) in recent years when compared with earlier years. This could be due to a variety of conditions such as closure of the estuary to the ocean, low river flows and wind directions in the estuary. Similar trends are evident when data for other months between these years are charted.

Readings in 2004 and 2008 are at the Medium/High tolerance level when water becomes unsuitable for poultry and pigs (6,250 uS/cm). For contrast, the maximum tolerance for humans is 2,300 uS/cm. Drinking water has a salinity level of under 100 uS/cm.

Electrical Conductivity Levels in the Lower Bemm

1996 – 2008 (April)



Note: No data are available for April 2002, 2003, 2005 and 2007. The unit of measurement for salinity (electrical conductivity) is uS/cm (Microsiemens per centimetre).

The Snowy catchment will be free of willows from the Victorian headwaters to the Jarrahmond Gauge. The floodplain reach will have a continuous riparian zone from the Jarrahmond gauge to the estuary fenced from grazing stock.

Introduction

The Snowy is one of Australia's iconic rivers. The river has a prominent place in the history of the country and in the psyche of all Australians. The well-known poem of Banjo Paterson titled *The Man from Snowy River*, the 1982 film of the same name, the post-war Snowy Mountains Scheme and the first Government agreement in Australia regarding environmental flows have made the Snowy one of the country's best known rivers.

Much of the Snowy River flows through extensive forested areas. However, some areas of the catchment such as the Monaro Tablelands in New South Wales and the floodplain at Orbost in Victoria have been extensively modified since European settlement. The diversion of water as part of the Snowy Mountains Scheme has also impacted on the health of the river.

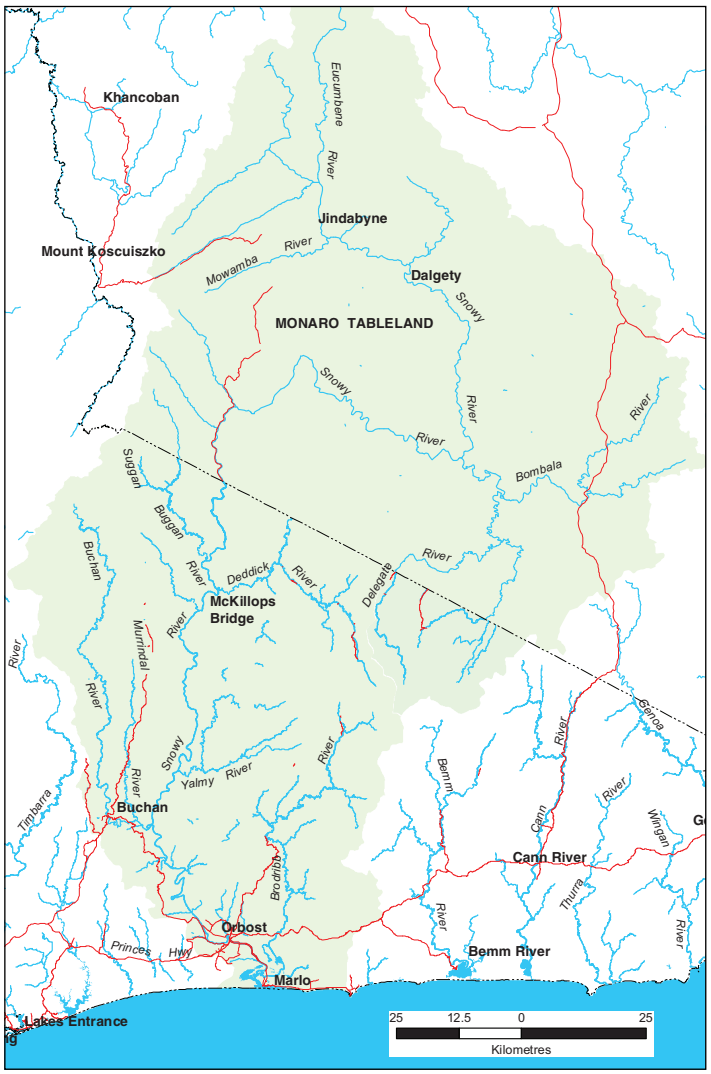
The following pages present information about the Snowy River catchment and the past and present works that have been undertaken by the Authority, its predecessors, other agencies and community groups to rehabilitate the lower Snowy River and maintain it in good condition for the future. It is not intended as a full account of the Snowy story but as a summary from existing documentation and records kept by agencies and individuals.

THE SNOWY RIVER CATCHMENT

The Snowy River starts in New South Wales on the slopes of Mount Kosciuszko, Australia's highest mountain. In the alpine region, water from the Snowy River and its tributaries is captured and regulated in a complex system of dams, tunnels, pumping stations and aqueducts as part of the Snowy Mountains Scheme.

In the Snowy-Tumut development, the Eucumbene River, a major tributary of the Snowy River, along with the Upper Murrumbidgee, Tooma and Tumut Rivers have been regulated and used to generate electricity at four power stations. The water is eventually released to the Tumut River, which flows into the Murrumbidgee River, and used downstream for irrigation purposes.

Since 1967, the Snowy-Murray development involved the regulation of the Snowy River at Jindabyne Dam, just below the junction of the Eucumbene and Crackenback Rivers. The water from Jindabyne Dam flows through a 28 mile tunnel under the Great Dividing Range to the Geehi River, where it is diverted and used to generate electricity at Murray 1 and Murray 2 power stations at Khancoban. It is then discharged into the Swampy Plains River and eventually, the Murray River. The headwaters of the Snowy River on the eastern side of the Divide are also used to generate electricity at Guthega Power Station before diversion to the main tunnel system at Island Bend.



Snowy River catchment.

SNOWY RIVER

A large part of the Snowy River catchment in New South Wales falls within the Kosciuszko National Park (proclaimed in 1967). Controls on alpine developments such as ski resorts and roads, and the withdrawal of grazing rights in the late 1950s, have helped to maintain this part of the catchment in good condition.

Below the Jindabyne Dam, the river descends through the Beloka Gorge and the Monaro Tableland. This area, first settled in the 1830s is mainly used for sheep and cattle grazing.

Some areas of the catchment here are in poor condition. The region was declared an area of erosion hazard in 1938, because of highly erodible soil types, inappropriate land clearing, damage by rabbits and poor land management practices such as over-grazing of stock. Extensive efforts have been made over many years to control erosion in the region.

Gully erosion on Currowong Creek, a tributary of the Snowy River in New South Wales. (DSE River Health Collection)

From the junction with the Quidong River, the Snowy enters a mountainous region that includes the Snowy River Gorge and extends for over 200 kilometres. Much of this area falls within the Alpine National Park (that joins with the Kosciuszko National Park) and further south, the Snowy River National Park.

Significant tributaries of the Snowy River include the Buchan, Yalmy, Murrindal, Suggan Buggan, Deddick and Delegate Rivers.

The river emerges on to the floodplain at Jarrahmond north of Orbost. Between Jarrahmond and the estuary at Marlo (32 kilometres) the river passes through rich floodplain land used mainly for cattle grazing, dairying and vegetable growing. Extensive works are continuing to rehabilitate this section of the river.

In all, the Snowy River catchment covers an area of 15,869 square kilometres of which 6,500 square kilometres are situated within Victoria.

Snowy River at McKillops Bridge, September 2004.

CATCHMENT GOAL

The catchment goal states that *the Snowy River catchment will be free of willows from the Victorian headwaters to the Jarrahmond Gauge (by 2012).*

Willows were first introduced to reduce erosion and stabilise the banks of rivers that had been cleared of native vegetation. However, willows have created many problems along our rivers. Willows are invasive, growing where they are not wanted such as in the river channel itself. Old willows on the bank fall into the river where they restrict water flow and trap sediment and debris that can divert the river to another course (avulsion). Collapsing willows can lead to bank erosion. Willows also provide poor habitat for aquatic and terrestrial life that contribute to a healthy river system.

Extensive works over many years have been conducted by the Authority and its predecessor, the Snowy River Improvement Trust to control willows on the Snowy River and on other rivers in the catchment. Willows are now under control from the New South Wales border to the start of the floodplain at Jarrahmond. This section of the river has received at least the first of three stages of treatments. On the floodplain, there are no plans for large scale willow removal at this time until the revegetation program is more firmly established. However, old willows are being removed on revegetation sites where they pose a potential danger to contractors or the public.

The catchment goal also states that *the floodplain reach will have a continuous riparian zone from the Jarrahmond gauge to the estuary fenced from grazing stock.*

Stock trampling on the river bank or foraging on riparian vegetation contribute to bank erosion. Preventing stock access to the river is essential to maintaining a healthy river system. A survey in 1990 by Department of Conservation, Forests and Lands, (Orbost Region) of river frontages of the Lower Snowy and Brodribb Rivers found that 59% (65 kilometres) of the total length was not fenced on private land.

Considerable progress has been made since then to fence off the river. With the co-operation of local landowners, stock are now excluded from almost the entire length of the targeted area. Above the highway bridge, the river is fenced and stock excluded on all but two properties. Below the bridge, the river is totally fenced on private land on the Marlo and Lochend Roads except at the lower end of the Estuary. On the Brodribb River, fencing on some properties is still required to exclude stock from the river.

EUROPEAN SETTLEMENT ON THE LOWER SNOWY

The Snowy River was first crossed by Europeans in 1838. Settlement began in 1842 when Dr Peter Imlay took up the Orbost Run. In the years that followed, native vegetation – described by early settlers as 'a mosaic of swamp and rainforest' and as a 'jungle' - was cleared on the floodplain and along the river banks for cattle grazing and other farming production.

The Snowy River was used for commercial navigation after 1880 and extensive de-snagging – the removal of large trees and branches that had fallen into the river – was carried out to make the river upstream of Marlo easier to navigate. Little thought was given to the potential effects of these actions, although one writer in the Snowy River Mail in 1890 had the foresight to comment that: 'There is apparently every reason to fear that in a few years time the natural beauties of Australia, that owe their attractiveness to its woods and forests, will have disappeared . . . so surely will the day come when large sums of money will have to be spent in replanting the trees which are now so eagerly destroyed.'

Like many other East Gippsland rivers, the effects of land clearing and de-snagging first became evident during major flood events. On the Snowy River these occurred in June 1890 and December 1893 (and possibly earlier, in an extreme flood event in May 1870). Evidence indicates that the river doubled in width in the Bete Bolong and Gilberts Gulch reaches between 1870 and 1920. Comparisons of old and recent maps show the river has also widened in many other places on the floodplain.

De-snagging the Snowy, 1880s (State Library of Victoria)

Flood damage, 1971. (Lachlan McAlister)

Periods of heavy rain leading to major flood events can occur in East Gippsland at any time of the year. On the Snowy River, major floods have occurred on many occasions including June 1890, December 1893, January 1934, May 1942, February 1971 and June 1978. On each occasion, major erosion and sedimentation as well as damage to infrastructure and disruption of farming activities has occurred.

Land management practices in the past have also impacted on the floodplain reach of the river. A major concern has been stock access to the river. Stock grazing on the riparian vegetation and trampling the banks have contributed to erosion.

SNOWY RIVER REHABILITATION WORKS

In the years between 1920 and 1950, the major focus of works on the floodplain was flood mitigation and drainage. The works undertaken by the State Rivers and Water Supply Commission and the Shire of Orbost involved constructing levees at low points (gulches) to prevent flooding on the fertile floodplain areas, and building channels to drain farmland and wetlands.

The Snowy River Improvement Trust was constituted in March 1951, covering an area of 13,730 hectares. It consisted of eight commissioners, seven elected by ratepayers and one government nominee.

The purpose of the river improvement works undertaken by the Trust were stated as 'preservation and increasing of the productivity of the lands within the district and also the protection of property and communications by reducing flooding, siltation and erosion of these lands and by improving the drainage of them'. Responsibility for the three existing Drainage Areas constituted under the Local Government Act was also transferred to the Trust.

Over the next 40 years, the Trust completed a range of drainage, flood mitigation and river health works. According to members of the Trust, it was a 'battle against enormous odds, both financial and environmental/physical to keep this river and its surrounds in a reasonable state of environmental health' (Snowy River Interstate Catchment Coordinating Committee 1993). The problems were summarised as river bank erosion; removal of riparian vegetation; low flows of water causing progression of salinity further upstream; flattening of the river bed; water quality and temperature affecting fish; loss of habitat by infilling of deep holes; sewage effluent from Marlo, Orbost, Bombala, Jindabyne and Delegate; and nutrient from recreation and agriculture activities entering the river. Low flows in the river following the completion of the Snowy Mountains Scheme were also considered to be contributing factors to 'the flattening of the river bed and the filling in of large holes . . . [together with] the large amounts of sediment still being deposited in the bed of the river'.

By the early 1990s, the problems on the Snowy including reduced water flows following the completion of the Snowy Mountains Scheme were becoming more widely recognised. The Snowy River Interstate Catchment Coordinating Committee was formed in 1990. In 1993, this committee published *Resource Management Issues in the Snowy River Catchment*. This report recognised the impact of reduced flows on the Snowy River and recommended that the New South Wales, Victorian and Commonwealth Governments investigate the environmental benefits of increased flows for the Snowy.

In 1994, the Snowy Genoa Catchment Management Committee was formed. In 1996, it published *Expert Panel Environmental Flow Assessment of the Snowy River Below Jindabyne Dam*, an authoritative report on the hydrology of the river and the need for environmental flows to maintain a healthy river ecosystem downstream of Jindabyne. Importantly, the report also recognised that 'many other factors in addition to adequate river flow, including land management practices, water quality, and the health of riparian vegetation' were also necessary to maintain a healthy river catchment and river ecosystem.

By the late 1990s, environmental flows for the Snowy River and the general health of the river and its catchment were promoted by the local community and environmental groups, including the Snowy River Alliance. In 1999, Craig Ingram (MLA) was elected to represent the seat of Gippsland East after campaigning strongly for environmental flows from the Snowy Mountains Scheme to the river.

In 2000, the Victorian, New South Wales and Commonwealth Governments agreed to increase the flow to 21% within 10 years of corporatisation of the Snowy Mountains Authority, with an interim target of 15% of original flows within 7 years of corporatisation and a long term target of 28% by 2012. As the first major environmental flow agreement in Australia, this was a significant decision in thinking about river management. On August 28, 2002 the first environmental flows were released to the Snowy from the Mowamba River below Jindabyne Dam. However, three years later (February 2006), these environmental flows were discontinued.

Crossing the Snowy River, 1880s. (State Library of Victoria)

The campaign for environmental flows for the Snowy River was part of a broader vision of works by government agencies, community groups and landholders to improve the ecological health of the Snowy River. The latest and most comprehensive outline of works is the *Snowy River Rehabilitation: Plan of Works* (Department of Sustainability and Environment, 2004a). A copy is available on the Authority's website.

PROBLEMS ON THE SNOWY

European settlement and land clearing in the upper Snowy River and on the floodplain around Orbost, combined with the effects of periodic major flood events on riparian areas cleared of natural vegetation, radically changed the conditions that had existed along the Snowy River for thousands of years. The effects of these changes on erosion, sedimentation, salinity and in-stream habitat and ecology on the lower reaches of the Snowy River are briefly described here.

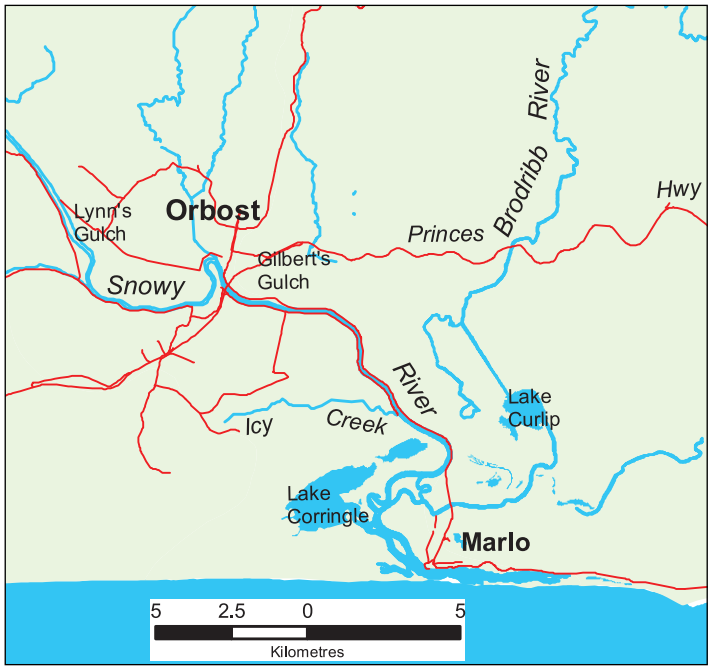
McKellers Crossing, Snowy River, 1915. (Centre for Gippsland Studies)

Erosion

River bank and gully erosion resulting from the clearing of native vegetation, and poor farm management practices such as overgrazing by stock, have been major problems in the Snowy River catchment. In the early years of last century, uncontrolled gully erosion contributed huge volumes of sediment to the river. In 1938, the entire New South Wales section of the Snowy River catchment was declared an area of erosion hazard under the State Soil Conservation Act.

Around Orbost, the floodplain was once covered with dense areas of rainforest, swampland and woodlands. In periods of high flow, the river 'broke its banks' in low areas known locally as 'gulches', covering the floodplain and dissipating the destructive power of the water in areas well protected by natural vegetation.

The clearing of riparian vegetation and stock grazing along the river banks have also been contributing factors to erosion. The poorly protected banks were then vulnerable to erosion during the flood events that have occurred before and after the construction of the Jindabyne Dam.



Snowy River floodplain at Orbost.

The Authority has been undertaking revegetation works on the lower Snowy since 2000. Riparian vegetation has been progressively reintroduced along the Marlo Road consistent with what was in place before European settlement. Revegetation has also taken place between Orbost and Jarrahmond and along Lochend Road following the removal of Willow, Blackberry and other pest plants. Works will soon begin on all remaining revegetation sites on the floodplain between Jarrahmond and Marlo.

Sedimentation

Large volumes of sand have been present in the river along the floodplain reach since the clearing of native vegetation left extensive areas in the upper catchment exposed to erosion. The Snowy River Improvement Trust (1992) believed

Sand deposits near Bete Bolong, 1959. (DSE River Health Collection)

sand disposition had occurred in the lower Snowy since 1911. The sources of this sediment were identified as 'poorly planned land clearing and burning practices, over-stocking, trampling, soil compaction and soil erosion'.

Reduced river flows since the construction of Jindabyne Dam were also believed to have contributed to sand deposits. The sand from flood waters 'dropped and stayed in the river to a larger degree' and the 'sudden return to a low flow regime post flooding' meant that sediment was not washed away.

This sand resulted in 'the flattening of the river bed and the filling in of large holes. The drop in the height of water levels has also meant the sand build up has become more obvious'.

The extent of sand build-up has been frequently debated. Other contributors to the same report stated that there was 'no scientific evidence for systematic aggradation' (rising of the river bed). Surveys of the river between 1920 and 1988 have indicated that the bed has been both scoured and filled over time. A more recent report prepared for the Authority (Gippel 2002) also concluded there was 'no evidence to support claims of channel aggradation. Since surveys began in 1920, the bed level has fluctuated ± 2 m in elevation'.

Revegetation, Snowy River at Orbost 2007.

In-stream Habitat and Ecology

The deposits of sand, and the absence of large logs that contribute to scouring of the river bed, have lead to a reduction of deep holes that are important for breeding by native fish species and in maintaining a diverse aquatic habitat for other organisms. The increased duration of periods of low fresh water flow since regulation may also have impacted on the width and depth of scouring of the river bed. The lack of deep holes may also be a factor in fish migration to the upstream reaches of the river.

Many large logs were removed from the river in the period before 1900 (a process known as desnagging). In later years, wood was removed from the river in the belief that this would allow flood water to pass quickly downstream, prevent the accumulation of debris in the river channel that could contribute to erosion, and reduce the amount of debris left on the floodplain after floods had subsided.

It is now known that logs create scour holes in the bed of the river. These logs also help to trap sand, enabling reeds and other aquatic plants to grow in and further stabilise the river bed. The re-introduction of logs (re-snagging) also helps to encourage the formation of a deeper and narrower low flow channel, providing more suitable conditions for fish passage along the river. Stability and diversity on the river bed is recognised as an important characteristic of a healthy river channel.

Logs were first placed in the river along the river frontage at Lochend Jungle (March 2000) and at a site opposite Forest park a couple of years later. As a result of these successful trials, the Authority introduced more logs into the river between Jarrahmond and Orbost, and on First and Second Islands at Marlo in 2009.

Salinity

Low fresh water flows especially during late Winter and early Spring are believed to contribute to increasing salinity on farmland resulting in lost farm production. Increasing salinity has also been thought to contribute to the depletion of bank and wetland vegetation.

The available scientific evidence suggests that the regulation of the Snowy River since the construction of the Jindabyne Dam and the resulting lower flows in winter and spring has allowed saline conditions to extend further upstream for longer periods. However, the effects are not always regarded as significant. A recent report (Gippel 2002) concluded, the changes 'should be seen as relatively minor alterations to the margin of the estuary, rather than representing a fundamental alternation to the character of the estuary'. The same report also concluded that there was 'no evidence linking changes in the position of the salt wedge since regulation to die back of riparian vegetation and/or erosion of river banks'.

Snowy River below Jarrahmond.

LANDCARE

Landcare groups are active in both the upper and lower regions of the Snowy River catchment. In the upper catchment, nine Landcare groups – seven in New South Wales and two in Victoria – are supported by the Snowy River Interstate Landcare Committee. The projects undertaken by these groups include erosion control, riparian fencing, revegetation and pest weed control.

In the lower Snowy around Orbost, local groups are members of the Far East Gippsland Landcare Network. The activities of some of the Victorian Landcare groups in the upper and lower catchment regions are briefly described here.

The **Bonang Landcare** group has been actively working on erosion control works to stabilise banks at two sites on the Bonang River, together with stock exclusion fencing along two kilometres of the Bonang River, four kilometres on the Jingalalla Creek (at the headwaters of the Deddick River) and 800 metres on an eroding gully leading into the Bonang River.

Broom control work has also been a priority in an effort to establish a buffer zone from the problems experienced over the border in New South Wales with the pest plant. On the Delegate River, a combined approach with local landowners has been implemented. Chemical control was used initially as the area covered with Broom was extensive. Goats were then allowed to graze the Broom. The results of this novel approach have been very promising.

In future, members of the group will be focusing on increasing their knowledge of native pastures, establishing shelter belts and windbreaks and adopting a coordinated chemical and biological control approach to Blackberry control.

Broom control site, Delegate River, before and after removal.

Landcare groups are also active further down the Snowy River and on the floodplain around Orbost.

The **Goongerah Landcare** group has recognised that one of the most significant catchment issues is weeds and regular action days are held to control infestations of pest plants such as Honeysuckle and Ivy along the Brodribb River.

In 2007, Landcare began a Willow eradication program along the rivers near Goongerah with the assistance of the Authority.

Another major problem plant is Blackberry. In recent years, community members and Government agencies have removed significant blackberry infestations from river systems. In late 2007, Goongerah Landcare was successful in securing funding to map Blackberries and other environmental weeds which has lead to the development of a management plan to control Blackberry.

In 2009, Goongerah Landcare purchased 2000 native trees and grasses which landholders planted on sites where weeds had been poisoned or removed.

Feral animals are also a target, with ongoing programs for fox baiting and cat trapping. Hair tubes are regularly set in the bush to monitor native animal numbers. Platypus monitoring commenced in July 2008.

The Linkages Project commenced in 2002 by the **Jarrahmond Landcare** group aims to 'biolink' the Snowy River and the Yalmy State Forest. New corridors of local vegetation have been planted to link up areas of remnant vegetation and improve biodiversity on both private and public land. These corridors provide wildlife habitat, shelter for grazing stock, improvements to degraded land and an attractive environment for the community.

The Gunns Creek Restoration Project was a coordinated erosion control effort which involved several property owners, with assistance provided by the Authority and the Department of Natural Resources and Environment.

Other projects undertaken by the group have included revegetation and remnant protection projects; maintenance of the Avenue of Honour; dung beetle releases; mistletoe control; silage wrap recycling; sustainable agricultural practices; and the compilation of a local bird list and brochure, along with the construction and installation of several owl nesting boxes.

As part of the Cabbage Tree Creek Revegetation Project, members of the **Marlo Plains Landcare** group have collected seed and propagated Cabbage Tree Palms. These have been distributed to property owners along Cabbage Tree Creek over a five year period to extend the rainforest along the banks of the creek.

WATERWATCH

Waterwatch volunteer monitor Frank Van Ekeren monitors seven sites on the lower Snowy River – at Marlo, Lake Corringle, Cabbage Tree Creek - and four sites on the Brodribb River.

He is a member of the Orbost Angling Club at Marlo. The club believes that assisting with water testing enables members to return something to the river and the environment. Frank also gains personal satisfaction from finding out more about the lower reach of the river and the estuary.

Frank uses his own boat to collect water samples with fuel costs paid by the Angling Club. Information collected is sent to Waterwatch for inclusion on the regional database and Frank presents reports about the data collected at monthly meetings of the Club.

The Tambo River and feeder streams will be free of willows above Ramrod Creek.

Introduction

The Authority's goal for the Tambo River is that *the Tambo and feeder streams will be free of willows above Ramrod Creek* (by 2012). The goal recognises the importance of controlling willows to maintain the river in an ecologically healthy condition.

Over half (58%) the Tambo River catchment is rated in 'Excellent' or 'Good' condition. However, human disturbance since European settlement such as land clearing, stock overgrazing and damage caused by rabbits, mining and logging activities has resulted in areas of gully and stream erosion. Natural events such as fires and floods have also contributed to this erosion.

When carried downstream, the sediment has presented problems on the river floodplain. The planting of willows was a past action used to stabilise this erosion, but over time was found to be a factor that is now contributing to poor river health.

The activities carried out to manage these erosion sites have included stabilising and revegetating river banks, the removal of pest plants and fencing to stop the damage caused by grazing stock. In the following pages, some of the activities undertaken by the Authority, other Government agencies and volunteer groups are outlined.

TAMBO RIVER CATCHMENT

The Tambo River starts on the southern slopes of the Great Dividing Range. Initially, there are two branches of the river – one beginning in the Bowen Mountains and the other (called the South Branch) on the slopes of Mount Bindi. From the confluence of these two branches, the river flows in a generally southerly direction through mountainous terrain, taking in the waters of Swifts Creek and Little River. The river then passes the settlements of Ensay South and Tambo Crossing, taking in the Haunted Stream, Timbarra River and Dead Horse Creek.

Tambo Cliffs at Tambo Upper.

Much of the upper catchment is forested and in good condition. However, extensive erosion has resulted in sediment transportation downstream. Significant amounts of sand are believed to have been mobilised by alluvial gold mining operations in the 1890s in the Cassilis Historic Area west of Swifts Creek, land clearing for agriculture, destruction of pasture and vegetation by rabbit plagues and by poorly managed logging operations in the period from 1900-1915.

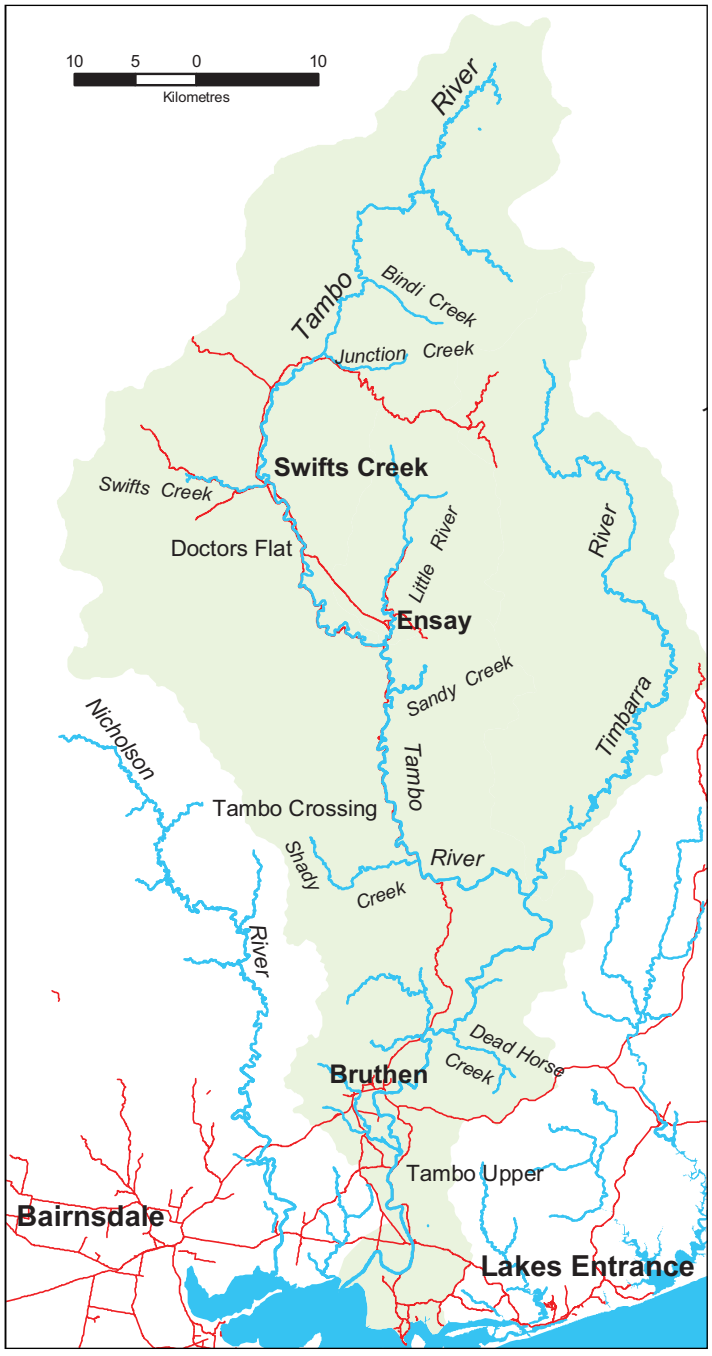
Below the confluence with Dead Horse Creek, the river meanders through undulating terrain until it reaches the township of Bruthen. Below Bruthen, the river enters the floodplain, an area known locally as the Tambo Flats or the Bruthen and Mossiface Flats.

South of Bruthen, the river originally flowed towards Wiseleigh before turning south past Mossiface ('old course'). The present ('new') course, the result of an avulsion in 1893, takes a more easterly route before joining the original course near Tambo Upper (McMorrow 1995).

Between Tambo Upper and Swan Reach, the river is confined by sandstone escarpments. Below Swan Reach, the river enters the coastal plain eventually flowing into Lake King in the Gippsland Lakes system.

The Flats between Bruthen and Tambo Upper are extremely fertile and were one of the first areas in the region to be cleared for agriculture. Drainage of this naturally low-lying land has been a major concern for farmers, a problem compounded by the deposition of sand (originating from the upper catchment in the late 19th and early 20th centuries) and the aggradation (rising) of the river bed.

TAMBO RIVER



Tambo River catchment.

The environmental condition of the Tambo River varies greatly depending on the location selected. According to the Index of Stream Condition 2004 (Department of Sustainability and Environment, 2005), the undisturbed river and stream reaches in the forested areas in the upper catchment are rated in 'Good' or 'Excellent' condition. In contrast, the river south of Bindi downstream to Ensay South received 'Poor' ratings on all variables except pH (acidity/alkalinity). This was attributed to 'the surrounding land having been heavily cleared for agriculture, the impact of stock access to the riverbanks or the impact of the 2003 fires'.

CATCHMENT GOAL

The catchment goal states that *the Tambo and feeder streams will be free of willows above Ramrod Creek* (by 2012).

Willow control focuses on: (a) monitoring rivers and streams to ensure this pest plant does not become established in areas currently free of willows; (b) achieving improvements in the environmental condition at specific sites, particularly where willows have created stream and bank instability and affected in-stream flows. Willow control is followed by revegetation (natural regeneration or new plantings). This also creates habitat for terrestrial and aquatic fauna that are a feature of a healthy river.

Willow control in the upper catchment is designed to prevent this pest plant moving downstream (a 'top-down' approach). However, willow control and revegetation is completed wherever improvements can be achieved in river health.

Willow follow-up site following mechanical removal.

Willow reduction works have been undertaken along the Tambo River for many years. In the last three years, programs involving chemical stem injection, foliar spraying and mechanical removal have been completed from the headwaters of the Tambo to below Swifts Creek including Bindi Creek, Junction Creek, Swifts Creek and Little River, in line with the aim of the catchment goal.

Willow reduction has also been completed on the lower Tambo downstream of Bruthen and between Sandy Creek and Shady Creek (19 kilometres) following the 2002-03 fires.

Most of the Timbarra River is free of willows except for one site near Timbarra. Therefore, it is important to control willows at this site as well as monitor the remainder of the river to ensure infestations do not occur where the river is in good condition.

The program for 2008-09 included further willow control works between Doctors Flat and Ensay (19 kilometres), Bindi Creek, Little River and on the Timbarra River.

EARLY SETTLEMENT ALONG THE TAMBO RIVER

The exploration of the Tambo River valley occurred during the 1830s (George McKillop) and 1840s (Angus McMillan).

Gold was discovered in the upper catchment in the 1850s. Mining commenced at Swifts Creek in 1857 and during the 1860s at Doctors Flat, Haunted Stream, Sandy Creek, Cassilis and Tongio West. Initially, alluvial gold was mined using hydraulic sluicing methods. Mining for reef gold expanded rapidly from 1890 to 1916.

Fording the Tambo River, 1913. (Centre for Gippsland Studies)

Vessels started navigating the lower Tambo River in the 1850s, initially to supply mining operations in the upper catchment and later, farmers and other settlers above Ensay and on the floodplain below Bruthen. Wharves were constructed at Mossiface, Battens Landing and Tambo Upper. Logs in the river that presented a hazard to navigation were removed (de-snagging). More regular shipping services started with the formation of Sale Steam Ship Navigation Company (1885). River cruises on the Tambo were a popular recreational activity.

Land clearing for agriculture proceeded rapidly on the fertile areas along the river and its tributaries above Ensay and on the floodplain reach of the river below Bruthen. On the Tambo Flats, channels were dug to drain wetlands and low-lying areas for agriculture. By the 1880s, the Tambo Flats had been extensively cleared and sown to pasture and crops. Problems with flooding during high river flows lead to the construction of levees on low areas along the banks in an effort to keep water flows to the main river channel and off the floodplain.

Another local industry was timber harvesting in the accessible forested areas. The red gum and grey box were used as pavers for Melbourne streets and as sleepers for the expanding railway network in Victoria. Wood was used in mining operations to fuel generators and steam engines.

Eroding gully on Ramrod Flat near Ensay, 1938. (DSE River Health Collection)

IMPACTS ON THE CATCHMENT

Mining, shipping, agriculture and logging activities resulted in a great deal of disturbance in the catchment and along the river. The effects became evident soon after a major flood in December 1893 with the movement downstream of large quantities of sediment from the upper catchment. This resulted in the aggradation (rising) of the river bed between Bruthen and Tambo Upper. The records held by the former gauging station at Bruthen indicated that the river bed in this area rose by approximately four metres in the period from 1890 to 1900. This increased the likelihood of water leaving the channel and spreading over agricultural land even at times of relatively low flow levels, further increasing drainage problems for farmers on the floodplain.

Following the December 1893 floods, the river changed course (avulsion) below Bruthen. Avulsions are a naturally occurring event on floodplains, and this avulsion was anticipated since much of the 'new' course already existed as a series of lagoons on the floodplain. However, the disturbance in the catchment provided the 'triggers' for this event to occur. These were the poorly designed drainage channels that confined the flows and prevented the water spreading over the floodplain and losing its destructive power, the clearing of riparian vegetation resulting in slippage of the banks and the erosion of fine sediment, and the sediment from alluvial mining and gully erosion in the upper catchment that had been carried downstream (McMorrow 1995).

Pleasure boat on Tambo River at the cliffs north of Swan Reach, early 1900s. (Centre for Gippsland Studies)

The sediment build-up in the lower Tambo made navigating the shallow river difficult and, along with competition from rail and road transport contributed to the end of commercial shipping on the lower Tambo in the 1930s.

Eroding gully, upper catchment, November 2008.

TAMBO RIVER IMPROVEMENT TRUST

The Trust was constituted in August 1953 to manage problems on the floodplain between Bruthen and the mouth of the Tambo at Lake King. It comprised seven Commissioners (five elected by ratepayers, one appointed by Tambo Shire Council and one Government nominee). The objectives of the Trust were to 'mitigate flooding of low lying areas by the removal of snags and other obstructing vegetative growth from the river channel', 'the construction of embankments across low break out areas' to prevent water spreading over farming land', the construction of drains in low-lying areas and the stabilisation of eroding sections of the banks by the 'construction of suitable works'.

Initially, the work of the Trust focused on drainage channels and floodgates, and the construction and maintenance of levee banks. Over time, the Trust became more concerned with broader issues related to river health. In the Master Plan published in 1985, the main issues were listed as bank erosion 'caused primarily by boat washes, grazing cattle, pedestrian traffic and boat launching and landing' between Swan Reach and Lake King; the 'sand slug' (sediment) in the river between Bruthen and Swan Reach; and the reduced channel capacity due to 'overgrowth of willows, poplars and eucalypts' and the 'collapse of bank side vegetation' along the 'new' course of the river (Tambo River Improvement Trust 1985).

The 'sand slug' from Bruthen to Swan Reach was a particular concern. The 'slug' was estimated at 15 kilometres long and five metres deep at Tambo Upper. This resulted in higher water levels, causing flooding and drainage problems for farmers and a deterioration of the aquatic habitat of the river. Physical removal of the sand and the scouring of sand during flood flows were considered as ways to deal with this problem.

The Tambo River Improvement Trust was replaced by the Tambo Nicholson River Management Board on 30 September 1993. Since 1997, the Tambo River (and other East Gippsland rivers) has been the responsibility of the East Gippsland Catchment Management Authority.

A report on the Tambo River around Bruthen published after the major flood in June 1998 (the largest flood last century), indicated that the problems of the past are likely to remain for many years. For instance, it is anticipated that significant amounts of sediment will continue to be deposited around Bruthen during major floods, the river channel will vary over time depending on flood events and sediment supply, and the meandering behaviour of the river will continue with similar rates of erosion as occurred in the June 1998 flood (Craigie, Brizga, Lawson and Treloar (1999).

BANK STABILISATION

The fine soils along the lower reaches of the Tambo River make these fertile areas for farming activities. However, the river banks along the floodplain reaches are very vulnerable to erosion. In poorly protected areas, undercutting of the bank leads to the 'slumping' of the bank into the river. The collapsed areas are carried downstream, leaving the bank behind the slumped section exposed to further erosion.

Natural vegetation along much of the river was cleared during settlement on the 19th century. In many places, the banks are now covered with Kikuyu grass which offers little protection against erosion.

Bank slumping, Tambo River, November 2008.

In recent years, a great deal of work has been undertaken to stabilise the banks on the lower Tambo River. Rock sourced from local quarries has been placed from the toe (bottom) of the bank to a height of half a metre above the water line. The rock is usually placed by a barge in the river as this method provides better access to the river bank and results in less rock being used. An excavator on the bank is often used to place the rock in the best position.

Excavator preparing trench for Phragmites planting.

After the rock has been placed in position, a trench is dug behind the rock. Clumps of common reeds *(Phragmites australias)* are then placed in the trench. When fully established, the reed beds minimise wave action caused by wind and boat wash and provide natural vegetation defences against undercutting and slumping of the bank.

IMPROVING AQUATIC HABITAT

The river originally contained many fallen tree trunks and branches. This wood contributed to the stability of the river bed and provided habitat for fish and other aquatic animals.

Over time, the wood deteriorated or was deliberately removed to improve river navigation. Land clearing removed large trees along the river banks and the wood in the river was not replenished. This resulted in the deterioration of the habitat of native plants and animals that is essential for a healthy river system.

Wood structure, lower Tambo River.

In recent years, the Authority has been putting wood structures into the river to provide new habitat and to link existing habitat for recreational fish species. These structures also attract aquatic plants and animals that are necessary for a healthy river.

In all, 38 structures have been placed between the mouth of the river and the highway bridge at Swan Reach. The structures last about 10 years before they need to be replaced.

WILLOW REMOVAL

The Authority's catchment goal has been focused on willow control above Ramrod Creek since the summer fires in 2006-2007, when gaining access to sections of the river became easier in heavily burnt areas.

Willow removal site, March 2007.

The same site following removal of willows.

Large quantities of burnt timber were removed from the river as part of the fire recovery program of works. At the same time, the equipment on site was used for willow control works along a 25 kilometre stretch of the Tambo River from Doctors Flat to Ensay, and at selected locations between Running Creek and Tambo Crossing. All willows were poisoned by stem injection and some willows mechanically removed. The cleared areas were then sown with native grasses to assist with the natural re-establishment of native vegetation.

In just a short time, the native vegetation has recovered. However, periodic follow-up spraying will be required to control regrowth so that the river does not become infested again with this pest plant.

Other organisations and agencies also contribute to maintaining and improving the Tambo River. The activities of Landcare and Waterwatch are briefly described here.

LANDCARE

Since 2007, the **Bruthen and District Landcare** group has been planning and implementing a habitat restoration project on the north bank of the Tambo River at the Bruthen township, between the main highway bridge and the rail trail bridge. The project is known as the Bridge-to-Bridge Habitat Restoration Project.

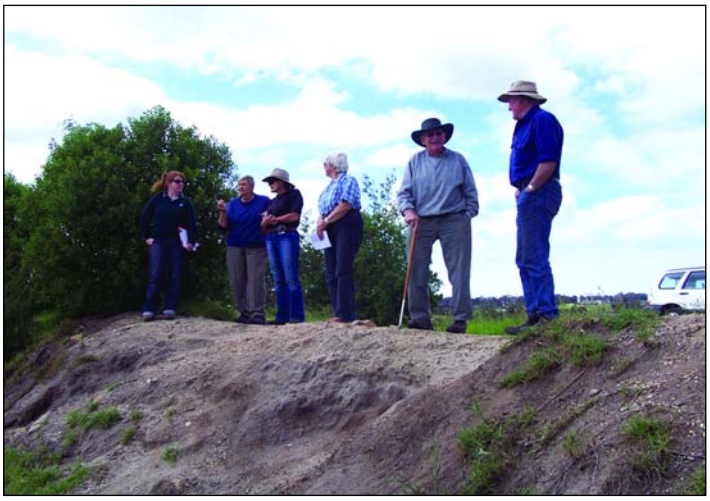
The aims of the project focus on controlling erosion on the river banks, improving local biodiversity by managing weeds and replanting with local rainforest and riparian species, and providing an attractive site along the river for the enjoyment of local residents and visitors to the area.

Tree planting, Lower Tambo River.

The first task was to remove rampant woody weeds from the site such as Blackberry, Box Thorn and Honey Locust. This was followed by planting around 2000 seedlings (20 species) during winter 2008, including flowering shrubs and trees as well as some fast growing plants such as Kangaroo Apple which provide cover for slower growing species. Also included in the mix was a locally uncommon plant known as Shrubby Spurge, propagated by a Landcare member from seedlings found growing on the site after the 2007 floods.

Most plants survived despite the very dry winter in 2008. Another 2000 seedlings were planted on the site during Autumn 2009. The main task in the intervening months has been to control a burgeoning new generation of broad-leaf weeds, mainly by hand-slashing. However, it is expected that there will be little or no need for weed control over the long run as the native plants grow and eventually shade the ground.

In addition to the dedicated efforts of members of Bruthen and District Landcare group, this project has benefited from expert advice provided by the Authority and East Gippsland Shire. The project has been funded by the East Gippsland Landcare Network and the Department of Sustainability and Environment (fire and flood recovery program). A Green Corp team from Central Victoria Group Training assisted with new plantings of trees and shrubs.



Lower Tambo Landcare members with Regional Landcare Coordinator Becky Hemming.

Rough Road plantation (2008).

The **Lower Tambo Landcare** group first became active on the lower reaches of the river in the mid-1990s. An early project was planting trees along Rough Road which runs alongside the river, and the propagation of seedlings by local residents Lynton and Dawn Barr from seed collected in the area. Members of the Johnsonville Angling Club, students at Swan Reach Primary School and local residents assisted with planting the seedlings. Additional plantings of trees and shrubs were made in later years.

More recently, members of the Lower Tambo Landcare group including Dawn Barr, Pat Stewart, and Rosemary and David Jennings have assisted with the planting of a native garden beside the Swan Reach Primary School. The site is connected to the Tambo River via a drain running alongside the Princes Highway that carries high storm water flows. The shrubs were germinated from local seed and grew robustly in the heavy clay on this site. This is now an attractive garden in a difficult to maintain area previously overgrown with Kikuyu.

Native garden beside Swan Reach Primary School.

Landcare members Penny and David Luckock have also made significant improvements on their own property on the Tambo River. The river frontage has been fenced from stock and planted with trees and shrubs indigenous to the area. Wetlands on the property have also been fenced off and now provide improved habitat for aquatic birds, as well as enhancing the overall attractiveness of the property.

Fenced river frontage, Luckock property.

Fenced wetland, Luckock property.

Fenced wetland, Kramme property.

Salt Creek

This is another wetland project that has been supported by Landcare, as part of the Gippsland Plains Lakes to Hinterland Landscape Rehabilitation and Recovery Project. It is located on Peter Kramme's property at Johnsonville, between the Princess Highway and Lake King. Since 2000, the extensive wetland including a five hectare island in the middle of the wetland has been fully fenced from stock. Trees and shrubs have been planted around the edges of the wetland.

Since stock was excluded from the wetland, a lot of degraded remnant vegetation such as Swamp Scrub and fringing reeds has regrown naturally. It just a few years, this regrowth and new plantings have transformed the wetland into an aesthetically more attractive area that has improved the condition of an important wetland connected to the Gippsland Lakes. Additional fencing upstream and downstream of the wetland has recently been completed to further restrict stock access to Salt Creek below the Princes Highway.

WATERWATCH

Coordinator Kim Snyder supports Waterwatch monitors throughout the region. She also keeps her own skills up to date by taking monthly samples at the highway bridge at Swan Reach and further upstream at The Cliffs.

Waterwatch Coordinator Kim Snyder taking a water sample at Swan Reach.

Water quality at these sites is consistently high when tested for turbidity, phosphorous, pH (acidity/alkalinity), salinity and dissolved oxygen. However, temporary events like high rainfall can increase turbidity and higher phosphorous levels can lead to the presence of blue-green algae. At these times, samples are tested more frequently until test results return to normal.

The Nicholson River and feeder streams will be free of willows and have a continuous riparian zone between the Princes Highway Bridge and the Great Alpine Road fenced from grazing stock.

Introduction

The Authority's goal is that the Nicholson River and its tributaries will be free of willows and the river banks downstream from the Great Alpine Road will be fenced to deny stock access to the river. The goal reflects the importance of a well-protected riparian zone for maintaining river health.

The present condition of the Nicholson River reflects land use along the river. The largely undisturbed upper catchment is rated in excellent condition and managed as State Forest, with control of weeds such as Blackberry and Blue Periwinkle the main concern. In contrast, the floodplain has been extensively cleared for grazing and is generally in poor condition.

Improving the condition of the floodplain reaches of the river is the focus of the catchment goal for this river. The Nicholson River is relatively short, so the potential to link the forested areas in the upper catchment with the Gippsland Lakes is greater than for other rivers. In doing this, a large improvement will be made to river health and the condition of the estuary into which the river flows.

In recent years, many works have been directed towards this goal. In the following pages, some of the works undertaken by the Authority, other agencies and volunteer groups will be described.

NICHOLSON RIVER CATCHMENT

The Nicholson River catchment is small (614 square kilometres) and the river relatively short in length (72.5 kilometres). It rises to the west of Mount Baldhead in forested areas and flows to the estuarine reach where it enters Lake King. Significant tributaries are the Yahoo, Bartmouth and Stutterin Fred (North and South Branches) Creeks.

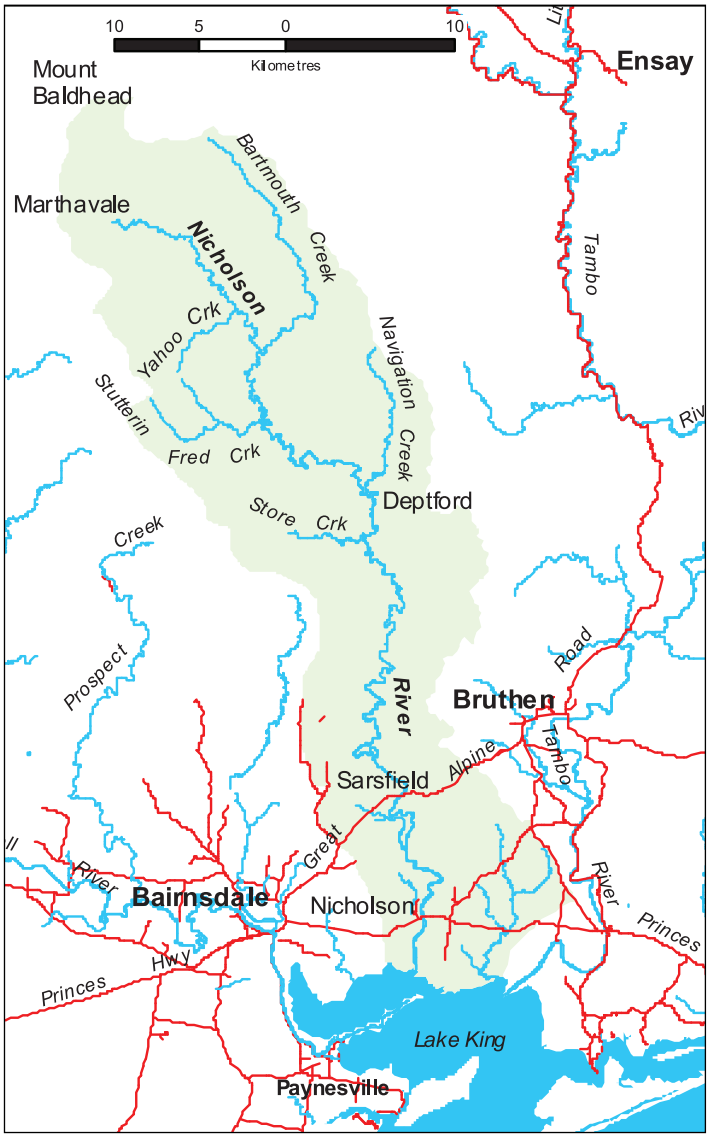
In keeping with its largely undisturbed condition, the upper catchment of the river was rated in 'Excellent' (22% of total length) or 'Good' condition (36%) in the Index of Stream Condition (ISC) in 2004 (Department of Sustainability and Environment, 2005). Below the Great Alpine (Bairnsdale to Bruthen) Road, the river was rated in 'Moderate' condition, reflecting land clearing for agriculture along the floodplain reach of the river.

Water flows on the river can fluctuate greatly. The river is prone to flooding following heavy rainfall. In recent years, substantial flooding occurred in 1978, 1998 and 2007.

In the forested upper catchment, the banks are generally stable and the river contains high quantities of logs, so good habitat is available for fish and other aquatic animals.

A small (640 megalitre) drought reserve storage dam operated by East Gippsland Water presents a restriction to fish migration along the river.

From the Great Alpine Road Bridge downstream to the mouth of the river at Lake King, some sections have been rocked and native trees and shrubs planted to stabilise the banks. In other places, the banks are in poor condition and subject to wind and wave action. Erosion is occurring on exposed high banks and on low-lying land particularly where stock have access to the river.



Nicholson River catchment.

Nicholson River and Backwater.

CATCHMENT GOAL

The catchment goal states that *the Nicholson River and feeder streams will be free of willows.*

Works to achieve this aim involve two actions - monitoring the river to ensure that willows do not become established in new areas; and willow control works such as poisoning and sometimes removal of old, large trees (primary treatment) or spraying of young, regrowth plants (secondary treatment).

The 2005-06 works program included primary and secondary treatment programs from Deptford downstream to the Great Alpine Road.

In the 2008/09 works program, major willow control works involved the primary treatment of willows from the headwaters above Marthavale downstream to the confluence with Navigation Creek. The secondary treatment of willows will take place from Navigation Creek downstream to the Great Alpine Road. The total distance in this program is 65 kilometres.

In addition, willow control has been undertaken at selected sites where bank stabilisation and revegetation works have been completed.

The catchment goal also states that *the Nicholson River and feeder streams will have a continuous riparian zone between the Princes Highway Bridge and the Great Alpine Road fenced from grazing stock.*

Nicholson River dam.

The rehabilitation of river banks degraded through willow infestations and unrestricted stock access requires revegetation, weed management and stock exclusion to protect new plants and those that regenerate naturally.

On freehold land with Crown land frontage to the river, these requirements are specified in an agreement between the landholder and Department of Sustainability and Environment. The costs of fencing and initial weed control are paid by the Authority. Landowners are expected to maintain the fence to exclude stock and undertake pest plant and animal control measures on the revegetation site.

Well-vegetated river bank, Stephenson property, lower Nicholson.

EARLY SETTLEMENT

Since European settlement, the upper Nicholson River catchment has remained forested and land disturbance has been minimal.

Gold mining in the 1880s occurred at various locations around Deptford such as Store Creek and Yahoo Creek. Alluvial methods were used to mine the gold but these were small in scale and only contributed limited amounts of sediment to the river. Only small areas of flat, fertile land along the river were cleared, in some cases to supply vegetables to mining settlements. Erosion has occurred at some of these sites but only to a limited extent.

Land disturbance has been greater in the lower catchment. Between the Great Alpine Road to below the Princes Highway Bridge, land clearing for agriculture has occurred on fertile land adjoining the river. By the 1880s, this land had been cleared of native vegetation and used for grazing or cropping.

The clearing of native vegetation to the river edge created similar problems to those on other rivers in the region. Without the natural defences provided by this vegetation, bank erosion soon occurred during times of high river flows. In an attempt to control erosion, willows were introduced creating problems for river management in later years.

In the estuarine reach of the river between the Princes Highway Bridge and the mouth of the river, land disturbance has been limited due to the extensive wetlands each side of the river. Most low-lying land close to the river was unsuitable for agriculture or grazing. However, in areas used for agriculture some sections of the river bank are in poor condition and require remedial works.

During the 1950s, river improvement trusts were constituted for the Snowy, Tambo and Mitchell Rivers to manage floodplain drainage and river improvement works. However, no trust was set up for the Nicholson River.

Specific attention was only given to issues on the Nicholson River when the Tambo Nicholson River Management Board was set up on 30 September 1993. Since 1997, maintaining and improving the Nicholson River (and other rivers in East Gippsland) has been the responsibility of the East Gippsland Catchment Management Authority.

The Nicholson River faces similar threats to other rivers in our region. Major problems are bank erosion and the presence of willows and other weeds.

EROSION

Bank erosion is evident in many places along the lower Nicholson River. In some places, the lack of vegetative cover leaves the bank subject to damage following heavy rain.

Exposed bank Nicholson River.

On low-lying land, the bank has retreated in areas previously protected by reeds and tea tree. Remnants of vegetation previously on the water edge are now islands several metres from the bank.

Retreating bank, lower Nicholson River.

In other places, undercutting has led to sections of the bank slumping into the river. These clumps are washed away, leaving the exposed bank subject to further erosion during high river flows.

Cattle foraging in wetlands lower Nicholson River, January 2009.

The contributing causes for these forms of erosion include cattle trampling the banks, bow wash from fast moving boats, intolerance of fringing vegetation to increasing salinity and carp disturbing the banks and bed of the river.

WEED CONTROL

Woody weeds such as Box Thorn, Hawthorn and Blackberry are prevalent on sections of the Nicholson River. On the limestone cliffs along the river, these invasive weeds are difficult to control.

These weeds were sprayed during 2009 on four sections of the river downstream of the junction of the main river channel with the Backwater. The work was carried out by the Department of Sustainability and Environment.

OTHER WORKS

The Authority's intention to establish a continuous riparian zone between the Great Alpine Road and the Princes Highway Bridge that is fenced from grazing stock is included in the catchment goal for the Nicholson River.

Stock trampling the bank and foraging on vegetation contribute to erosion and fouling of the water. Fencing the river from stock access is a simple and cost effective way to improve river health.

Fenced riverbank, Harvey property.

Replanting is not always necessary. In situations where remnants of original vegetation are close by, natural regeneration will occur over time without the need for new plantings.

Incense plant (Calomeria amaranthoides), revegetation site lower Nicholson.

WILLOW CONTROL

In recent years, willow reduction works have been undertaken in several places along the Nicholson River. The reasons for doing this depend on the problems presented by willows at specific sites.

Willows were planted until quite recently to stabilise the banks and prevent erosion after land clearing or when the gradual degradation of original vegetation by stock made the banks vulnerable to damage. However, willows typically do not contribute greatly to bank stability and usually have detrimental effects on river health.

In many cases, problems arise when willows encroach into the river channel. This can occur when willows grow over the water, shed branches or topple into the river. It can also occur when fragments of stems break off and start growing in the river. As they grow, these willows accumulate sediment that forms islands in the middle of the stream. These islands and the debris they accumulate have the potential to restrict or divert flows, especially during periods of high river flows. When this occurs, severe erosion of the banks opposite the in-stream island can occur.

Willow removal site, Coster property, Sarsfield.

For these and other reasons, willows are being removed when bank stability issues are resolved and plantations of native vegetation have been established.

In the 2005-06 works program, chemical stem injection and foliar spraying of willows was undertaken from Deptford downstream to the Omeo Highway Bridge. In 2007-08, poisoning and mechanical removal of willows was completed along two kilometres of the river at Sarsfield.

A major project in the 2008-09 works program was the treatment of willows on the Nicholson River and its major tributaries starting from the headwaters above Marthavale downstream to the confluence with Navigation Creek. At the same time, foliar spraying of young willows in previously treated areas was completed on the Nicholson River and its major tributaries from the Navigation Creek confluence downstream to the Great Alpine Road Bridge, a total distance of 65 kilometres.

This work will assist natural regeneration within the riparian zone and inhibit the spread of willows downstream.

NICHOLSON RIVER REVEGETATION PROJECTS

The Authority's current target for the Nicholson catchment is an improvement in the condition of 8.7 kilometres of river bank. This is being achieved through fencing to exclude stock from the river and either the natural regeneration of vegetation or new plantings. When established, this vegetation will improve bank stability and reduce the risk of erosion.

Bank erosion, lower Nicholson River.

In East Gippsland, projects of this type are recognised in a Crown land agreement for each site between the landholder and Department of Sustainability and Environment. Under these agreements, the costs of fencing off the river are met by the Authority. The landholder maintains the fence in good repair to insure that stock cannot access the revegetation site.

Revegetation site, Nicholson River.

Several targeted revegetation projects have been undertaken along the lower Nicholson River. In just a few years, native vegetation at these sites has recovered quickly, providing a natural defence against erosion caused by wind and wave action on the bank.

IMPROVING IN-STREAM AQUATIC HABITAT

The river originally contained many fallen tree trunks and branches. This wood contributed to the stability of the river bed and provided habitat for fish and other aquatic animals.

Over time, the wood deteriorated or was deliberately removed to improve river navigation or stock access to the river. Land clearing removed large trees along the river banks so that the wood in the river was not replenished. This resulted in the deterioration of the habitat of native plants and animals that is essential for a healthy river system.

Wood structure, lower Nicholson River, 2008.

In recent years, the Authority has been putting wood structures into the Nicholson and other local rivers to provide new habitat and to link existing habitat for recreational fish species. These structures also attract aquatic plants and animals that are necessary for a healthy river.

Six structures have been placed along the river mid-way between the Princes and Omeo Highways. The structures are expected to last about 10 years before they need to be replaced.

LANDCARE

The **Nicholson River Landcare** group looks after an area of approximately 3,100 hectares, bounded by the Omeo Highway-Sarsfield Bridge in the north, Stephenson's Road in the east, the Gippsland Lakes in the south and the Nicholson-Sarsfield Road in the west. The main land uses in the area are beef and cattle grazing, grape growing for wine production and life style living.

The area attracts listed vulnerable fauna species including the Royal Spoonbill, White Bellied Sea Eagle, Great Egret and the Little Turn. A wetland adjoining the river is the only recorded breeding site in the Bairnsdale region for the Great, Little Black and Little Pied Cormorants.

The group was formed in 2004 and consists of landowners living on or near the river and members of the Nicholson Angling Club. The group is currently focusing on stock exclusion fencing and revegetation projects on private and public land, pest plant and animal eradication, monitoring the condition of the water and increasing membership. Two members of the group – Doug Pemberton and Leo Rijs – have made significant areas of their land available for revegetation projects by the Authority and Parks Victoria.

Revegetation site, Nicholson River.

NICHOLSON CATCHMENT TUNNEL EROSION

In East Gippsland tunnel erosion inhibits the use of the land and has considerable off-site impacts through suspended sediments and nutrients entering waterways and the Gippsland Lakes. This erosion occurs mainly in the Foothills including the Nicholson River catchment.

The Department of Primary Industries, in partnership with the East Gippsland Landcare Network has been undertaking a project to determine the extent of tunnel erosion in the region and complete on-ground works to rehabilitate affected areas.

Over the past four years, the project has involved eight landholders who together have treated 71 hectares of land. A further 59 hectares was rehabilitated in 2009. This has prevented an estimated 393 tonnes of soil per year entering the Nicholson River and the Gippsland Lakes.

Tunnel erosion before treatment, Nicholson catchment.

WATERWATCH

Waterwatch volunteer monitors Ken and Margaret Bradley and Kevin Buchanan conduct water testing near the mouth of the river where it enters Lake King, and at three sites between the Princes Highway Bridge and the Great Alpine Road including one site on the branch of the river known as The Backwater.

They started monitoring in 1998 because they were concerned about the condition of the river. As local residents, the river has been a site for recreational boating and fishing for many years and they were concerned that the condition of the river seemed to be deteriorating.

Ken and Margaret use their own boat to travel to each site monthly. Members of the angling club also assist with monitoring and are informed of test results at regular intervals.

The tests indicate that water conditions at three sites are generally good, although readings vary at different times. In the upper estuary, water quality is often quite poor, with test results indicating low levels of oxygen and a pungent 'rotten egg gas' smell. Since the floods in July 2007, water quality has improved. A long term trend is increasing salinity.

Nicholson Angling Club members monitoring water quality.

Nicholson River at Waterholes Guest House.

NICHOLSON RIVER WATERHOLES GUEST HOUSE

This Trust for Nature covenanted property is located 32 kilometres north of Bairnsdale. Kaye and Bob Munro have owned the property for 33 years. It is set in a natural clearing and surrounded by State Forest. The property has a long frontage to the Nicholson River.

Most of the river frontage is forested but on a critical bend the vegetation had been cleared. In 1978, there were several floods that resulted in a section of the bank surrounding a large wombat hole collapsing into the river. Kaye and Bob realised that action needed to be taken to minimise further erosion before the next flood removed even more of the bank.

In the years that followed, Kaye and Bob adopted a conservative approach to managing the situation. They carefully observed the river during times of high and low water flow to work out what was needed to direct water away from the eroding bank. They removed small in-stream plants that when fully grown, would divert water on to the bank. They planted local species such as Woolly Tea Tree and Sedge already growing along the river in critical places to provide natural defences against erosion. The banks were not touched except to remove Black Wattles that had died and when uprooted, disturbed clumps of soil that could encourage erosion.

Their basic approach was to do nothing along the river that couldn't be done with a hand tool!

Over time, this approach has resulted in a remarkable transformation of the river bank. Huge quantities of sediment have been deposited in front of what was once a high, eroding bank. The natural vegetation cover now stabilises the bank, reducing the likelihood of damage during future floods. Over 30 years, the work undertaken has made a significant contribution to improving the condition of a potential erosion site in the upper catchment.

The willow control works completed in the Mitchell River by June 2009 will be consolidated as free of willows. An additional 50 kilometres above the Glenaladale off-take will be fenced from grazing stock and revegetated.

Introduction

The Mitchell River was recognised as a heritage river by the Land Conservation Council in 1991 for its social and environmental values. The river has also been nominated as an 'iconic' river in the Victorian River Health Strategy (Department of Natural Resources and Environment 2002) due to its high conservation value, naturalness of flows and size.

The Mitchell River also contributes substantial flows to the Gippsland Lakes so the health of its catchment is important in maintaining the condition of the Lakes and the adjoining wetlands.

MITCHELL RIVER CATCHMENT

The Mitchell begins at the confluence of the Wonnangatta and Dargo Rivers below the Dargo township. The Dargo River rises on the southern slopes of Mount Hotham. The main tributary is the Little Dargo River. The Wonnangatta River begins on the northern slopes of Mount Howitt. The main tributaries are the Crooked, Dry, Humffray, Moroka and Wongungarra Rivers.

Apart from small areas of cleared land along the Dargo and Wonnangatta Rivers, the upper catchment is predominantly forested public land including sections of the Alpine National Park and Mitchell River National Park. Another significant region is the Grant Historic Area where gold was first discovered in the 1850s.

Whilst the upper catchment is extensively forested, the steep slopes are subject to erosion during heavy rain events. Periodic fires in the region have impacted on the vegetation cover and contributed to land slippage and erosion of topsoil into rivers and streams.

The Mitchell is joined by the Wentworth River at Tabberabbera. Below this point, the river enters the Mitchell River National Park where it flows through spectacular gorges. A tributary, Woolshed Creek also has an impressive gorge mentioned in Aboriginal legends and known as the Den of Nargun.

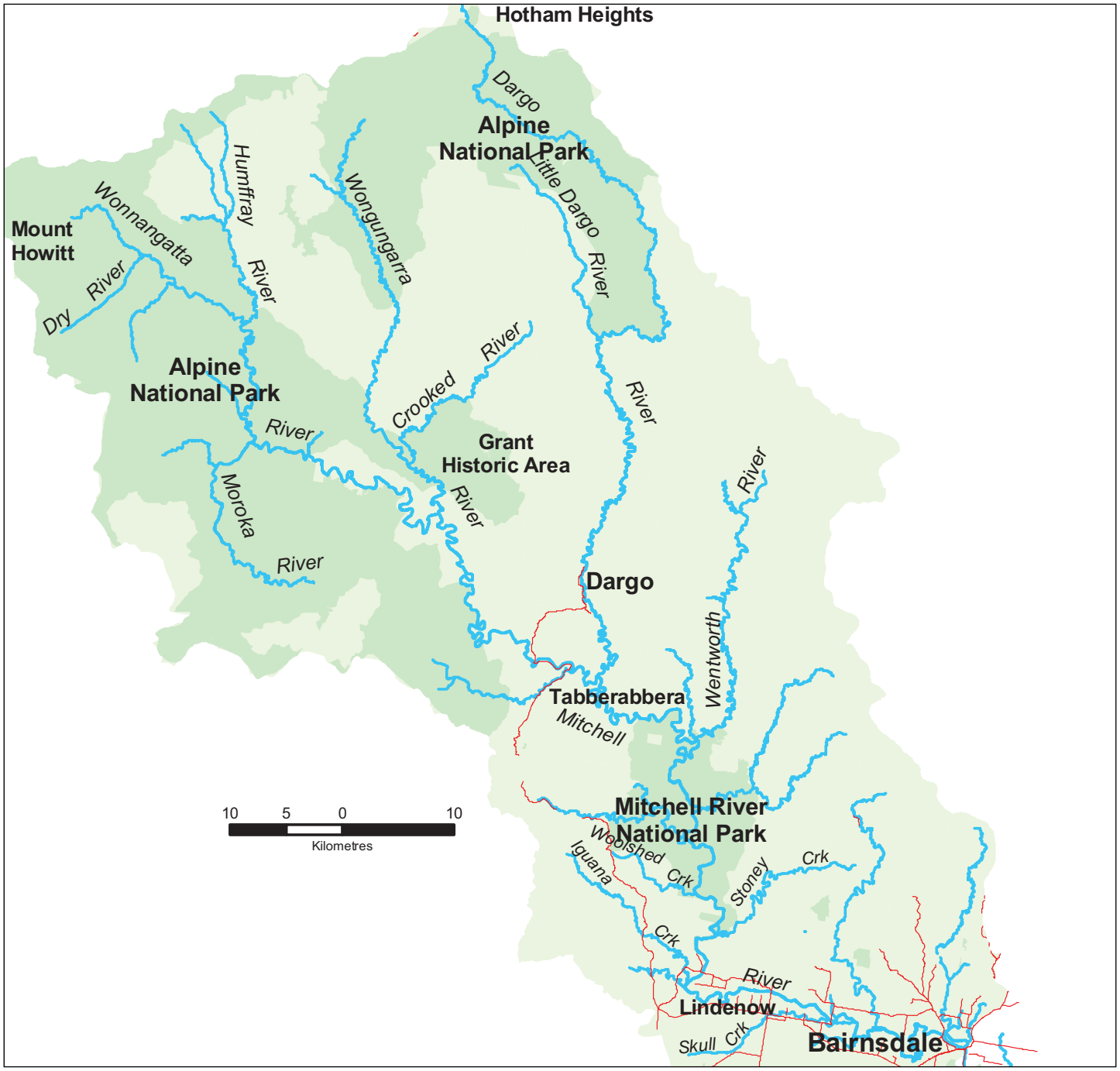
Below the national park, the river joins Iguana Creek and enters the floodplain. Stony and Skull Creeks also join the river. In this section, the river has cut a steep sided valley over three kilometres wide in places. Sediment deposits here have made this a fertile area for intensive agriculture. The steep sides of the floodplain, 30 metres below the surrounding Red Gum Plains, have resulted in steep grades on the creeks that descend on to the floodplain. As a result, extensive erosion has occurred in the past on many of these creeks. Tunnel erosion has also occurred on cleared land along the escarpment.

Easter Regatta, Bairnsdale, 1910. (Centre for Gippsland Studies)

Below Bairnsdale, the river flows through the coastal plain before entering Lake King through the silt jetties. Also known as digitate or finger jetties, these types of deltas are formed when large quantities of sediment are delivered to the river mouth during floods and protective vegetation prevents wave action dispersing the sediment.

A breach of the northern silt jetty known as the Cut now allows the river to pass directly into Jones Bay. This occurred during a flood in 1919 and it has been widening since that event. Another feature on this section of the river is a high eroding cliff at Eagle Point known as The Bluff.

According to the 1994 Index of Stream Condition (Department of Sustainability and Environment, 2005), 70% of stream length was in 'Excellent' or 'Good' condition. Most of these sites were in the upper catchment. Of the remainder, 25% was rated in



Mitchell River catchment.

'Moderate' condition and 5% in 'Poor' condition. The areas rated as 'Moderate' were in cleared areas in the upper catchment, along Iguana Creek and along the Lindenow Flats. The sites rated as 'Poor' were above and below Bairnsdale.

The Mitchell River catchment is large (4,778 square kilometres) and concentrated rain events result in huge volumes of water moving rapidly downstream. The steep gradient of rivers in the upper catchment also contributes to rapid flow rates. Together with the relatively short distance between the upper catchment and the floodplain - the distance from the junction of the Wonnangatta and Dargo Rivers to Lake King is 120 kilometres - rapid rises in river levels can occur immediately following periods of heavy rain. For instance, in the July 2007 floods, the Wongungarra River at the junction with the Crooked River rose over 3 metres in 24 hours.

In the *Victorian River Health Strategy* (Department of Natural Resources and Environment 2002), the Mitchell River is recognised as one of only two large rivers in Victoria that stand out because of their high conservation value, high level of naturalness of flows, relative intactness of the entire river system, and significance for larger systems (the Gippsland Lakes).

CATCHMENT GOAL

The catchment goal states that by 2012 *the willow control works already completed in the Mitchell River will be consolidated as free of willows.* This means that willow control works for the next three years will be focussed mainly on ensuring that previously treated areas remain free of willows. The catchment goal also states that *an additional 50 kilometres above the Glenaladale off-take will be fenced from grazing stock and revegetated.*

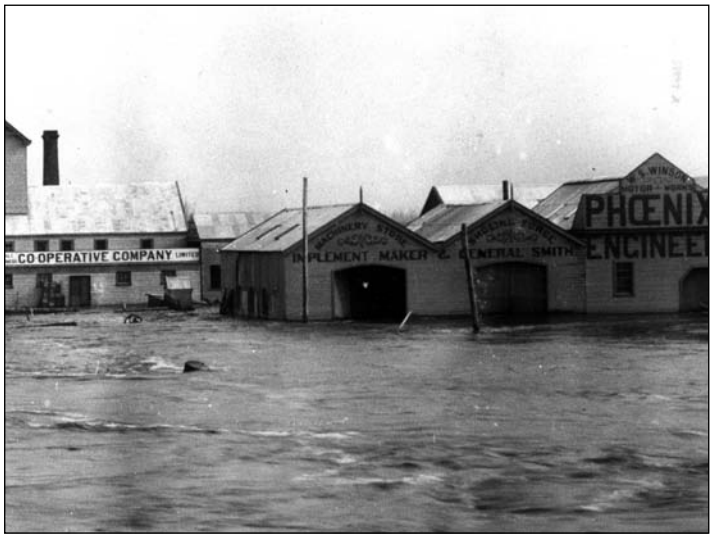
Following the clearing of native vegetation in the years following European settlement, willows were planted to prevent erosion on unprotected banks. However, willows have caused many problems along the river.

EARLY SETTLEMENT

The Mitchell River is closely associated with the early exploration and settlement of Gippsland. Angus McMillan named the river in 1840 after Major Mitchell, the Surveyor General of New South Wales. He commented that the river (at the location now known as Calulu) 'is surrounded by the most delightful country I ever beheld, well adapted for cattle, sheep or cultivation'.

Settlement followed on the fertile floodplain especially after the land acts of the 1860s. Later, the lure of gold brought miners to the Dargo-Crooked River area in the upper catchment. Dredges dug up and washed sediment on the bed of the river, and rock mined from local reefs was washed in the river. By the end of the 19th Century extensive areas of land had been cleared along the Dargo and Wonnangatta Rivers and on the floodplain around Lindenow.

Willows in main channel.



Mitchell River in flood, early 1900s. (Centre for Gippsland Studies)

Willows can easily germinate from broken branches, twigs and seed. A study by CSIRO (Brubaker & Young 2005) found that some seedlings in the Dargo River catchment had a genetic background similar to willows north of the Great Dividing Range. This indicated that pollen or seed were moving across the landscape, increasing the possibility of even more extensive infestations. As a result, willow control became particularly important for the health of the Mitchell and other rivers.

Fencing the riverbanks to restrict access to the river is important in preventing stock from trampling and grazing riparian vegetation and contaminating the water. Over 15 kilometres of river banks have been fenced over the past few years but more needs to be done to ensure a healthier Mitchell river.

Major flooding occurred on the Mitchell in 1870, 1891 and in the New Year period in 1893-94. These floods caused considerable damage to crops, roads and bridges. Because of the disturbance from mining and land clearing in the catchment, extensive erosion also occurred on rivers in the upper catchment resulting in sedimentation on the lower Mitchell. After the 1893-94 floods, silt deposits close to the mouth hindered shipping on the river.

In the following years, rabbit infestations prior to the introduction of myxomatosis and overgrazing of some areas by stock also contributed to gully and sheet erosion on freehold land. Bushfires also impacted on native vegetation on hillsides prone to sheet erosion.

RIVER REHABILITATION WORKS

Prior to the formation of the Mitchell River Improvement Trust in 1957, the major focus of works was flood mitigation on the floodplain around Lindenow and erosion control along rivers and streams in the upper catchment including Stony and Skull Creeks that drop sharply from the Red Gum Plains to the floodplain.

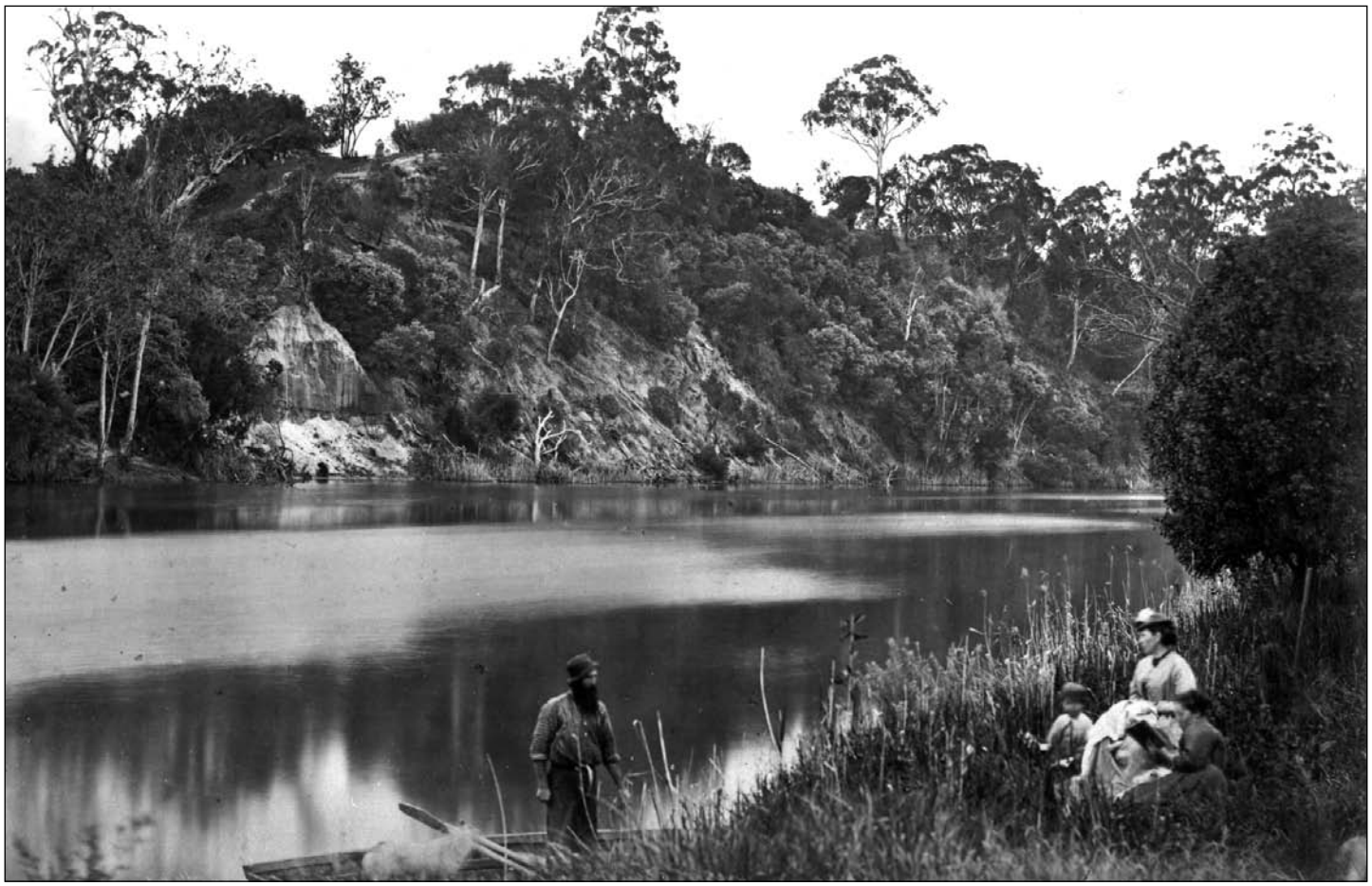
The works undertaken by local authorities were also directed at constructing levees at low points to reduce flood damage on the floodplain and to infrastructure such as roads and bridges. Timber and rock structures were also constructed to control erosion.

MITCHELL RIVER IMPROVEMENT TRUST

The Mitchell River Improvement Trust was constituted in 1957 following requests from landholders and the Bairnsdale Shire Council. The original Trust district was a narrow strip along the Mitchell River from just north of the confluence with Iguana and Stoney Creeks (and taking in part of Skull Creek) to the mouth of the river at Lake King. The district was extended in 1961 to take in a narrow strip along the lower section of Clifton Creek. The Trust consisted of nine commissioners, seven elected by ratepayers, one government nominee and one appointed by the Bairnsdale Shire Council.

The objectives of the Trust were to undertake works to control erosion along the banks of the river, and to reduce the frequency and severity of flooding of adjacent land by clearing obstructions from the river. Protection of river banks was adopted as the main objective.

The Bluff at Eagle Point now.



The Bluff at Eagle Point, c1866-1885. (Centre for Gippsland Studies)

MITCHELL RIVER MANAGEMENT BOARD (1987-1997)

The Mitchell River Management Board was established in October 1987. It was one of the first in Victoria based on a 'whole catchment' management framework rather than just a particular area like the floodplain.

A 1996 report prepared for the Board identified the priority stream management issues as bank stability, particularly downstream of Bairnsdale; management of exotic species, particularly those that spread rapidly (Blackberry, suckering Poplar, Willow); properly prepared areas for recreational access to prevent damage; poor alignment and associated bank erosion in the upper catchment; and sediment management in the catchments of Toms Creek and Clifton Creek.

The Mitchell River Management Board was replaced by the East Gippsland Catchment Management Authority in 1997.

Glenaladale Weir in 1914. (State Library of Victoria)

REGULATING THE MITCHELL

There have been many campaigns proposing regulation of the Mitchell River for the purpose of irrigating pasture and crops on the Lindenow flats, and two unsuccessful attempts to do so.

The first, the Glenaladale Weir, was located near the junction of the Mitchell River and Stony Creek. Construction commenced in 1891 and the foundation stone was laid on 3 March 1893 by Frederick Drevermann. The weir was damaged by floods later that year and never repaired. Sections of the weir wall are still visible today.

The second attempt did not proceed beyond the stage of preliminary works. In 1971, the Victorian Parliamentary Public Works Committee recommended that a dam be built on the Mitchell at Billy Goat Bend to provide irrigation water on the Lindenow Flats. The following year, a second dam was proposed at Tabberabbera (Angusvale) to irrigate a vast area of land between the Mitchell and Perry Rivers. This decision was confirmed in 1974 and again in 1978. Land around the site was acquired and the access road constructed. However, in May 1982, following the election of the Cain Labor Government, the Minister for Water Resources announced deferral of the project indefinitely.

RECENT WORKS ON THE MITCHELL

The works undertaken by the Authority have been improvements at specific sites which are designed to improve the overall condition of the river, from the forested areas in the upper catchment to the mouth of the river at Lake King. The projects illustrated include willow control, a grade control structure (rock chute), and wood structures to improve aquatic habitat and flood restoration works.

Glenaladale Weir now.

Erosion on Paynesville Road, Eagle Point Reserve, 1936. (DSE River Health Collection)

WILLOW CONTROL

Willow control works along the Mitchell River have been extensive and are on-going.

In 2008-09, primary (stem injection) and secondary (foliar spraying) treatments of willows were conducted in the Mitchell River National Park from Billy Goat Bend to the Glenaladale Pumping Station, a distance of about 50 kilometres. This complemented previous willow control works that reached the Angusvale camping ground in 2005-06 and Billy Goat Bend in 2006-07.

On the Dargo River, secondary treatment of willows from the headwaters to three kilometres above the Dargo township were completed. In the 2008-09 works program, primary control works were also completed at four properties in the Dargo township, and from a point approximately 6.5 kilometres downstream of the township to the confluence of the Dargo and Wonnangatta Rivers. Mechanical removal of willows occurred where appropriate (roadsides, camping grounds and bridges).

On the Wonnangatta, Moroka and Crooked Rivers and Thirty Mile and Twenty Five Mile Creeks, willow control works were completed in 2008-09. About 400 kilometres of these rivers and creeks have now been treated.

On Prospect Creek, previously poisoned trees were removed and the remaining trees poisoned along a 17 kilometre stretch of the creek from Melwood to the confluence with the Mitchell at Calulu. The majority of these works took place downstream of Hodges Estate Road. Mechanical removal also occurred where appropriate.

Primary and secondary treatment of willows was also completed along the Wentworth River and Swamp Creek in 2008-09.

GRADE CONTROL STRUCTURE

Grade control structures (weirs, rock chutes and pipes) are used when water drops from one level to another to prevent gully erosion. They can also help to trap sediment in the runoff water from entering the river.

During the 2008-09 works year, a rock chute was constructed where an old drainage channel entered the Mitchell River, a short distance upstream from Dockertys Road.

Eroding channel, Mitchell River floodplain.

Erosion was progressing up the channel, releasing sediment into the river. The new rock chute will stabilise the bed of the channel, allowing water to fall in a controlled way down to the river. The area has been fenced off and revegetated.

Rock chute under construction.

IMPROVING IN-STREAM AQUATIC HABITAT

The river originally contained many fallen tree trunks and branches. This wood contributed to the stability of the river bed and provided habitat for fish and other aquatic animals.

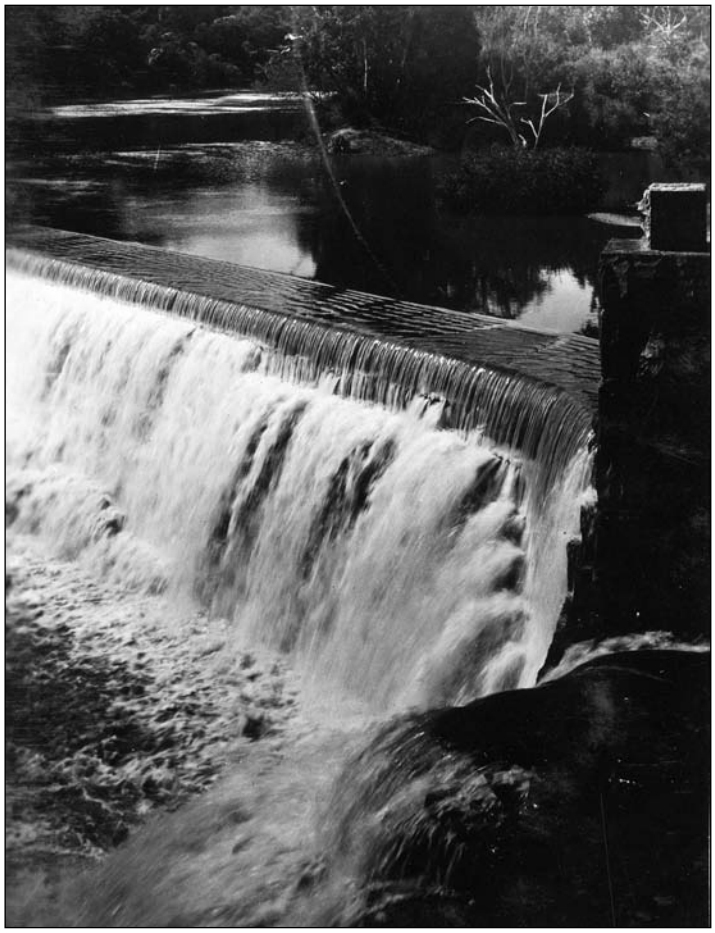
Over time, the wood deteriorated or was deliberately removed to improve river navigation or stock access to the river. Land clearing removed large trees along the river banks so that the wood in the river was not replenished. This resulted in the deterioration of riparian vegetation that is essential for a healthy river system.

Stabilisation of the banks is important to reduce the possibility of floods breaching the banks and affecting riverside infrastructure such as roads, homes and bridges. Along this section of the river, it is also important to reduce the risk of future floods creating another 'cut' directly into Jones Bay downstream of Bairnsdale, like the one that occurred during a flood in 1919.

Wood structure, lower Mitchell River.

In recent years, the Authority has been putting wood structures into the Mitchell and other local rivers to provide new habitat and to link existing habitat for recreational fish species. These structures also attract aquatic plants and animals that are necessary for a healthy river.

In all, 30 structures have been placed in Clifton Creek (The Backwater) and along the river between the Princes Highway Bridge and The Cut at Eagle Point. The structures are expected to last about 10 years.



Glenaladale Weir in flood time, August 1917.
(State Library of Victoria)

FLOOD RESTORATION

During the major flood on the Mitchell in July 2007, large sections of the eastern bank of the river downstream of the Princes Highway bridge collapsed into the river and were carried downstream, leaving the exposed bank susceptible to further damage. However, the Paynesville roadside bank which was stabilised with rock after the 1998 floods remained relatively intact, indicating the benefits of this method of bank stabilisation in the lower reaches of the river.

Following the July 2007 flood, rock sourced from local quarries was placed along the banks using a barge fitted with a tip tray. Various sizes of rock were used for better interlocking and stability, and to assist with the establishment of reeds and other water plants which provide natural vegetation defences against flood damage. This should prevent further undercutting of the bank and bank failure (slumping) during floods in the future.

Bank stabilisation works, lower Mitchell River.

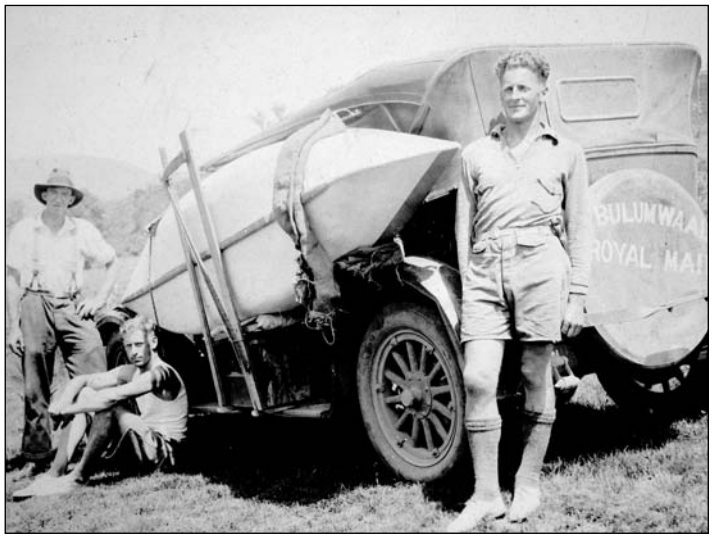
LANDCARE

The **Bairnsdale Urban Landcare** group, with assistance from the East Gippsland Shire, the Authority, the Botanical Society and schools, community groups and Green Corp volunteers has undertaken several bank stabilisation and landscape improvements along the Mitchell River since the development of a concept plan for the area in 1998. Poplar, Willow, Ivy and other exotic plants have been removed and the sites revegetated with native trees and shrubs.

Bank stabilisation and revegetation site, Mitchell River.

WORKS BY OTHER AGENCIES

Many agencies and community groups are active in maintaining and improving the condition of the river and the surrounding catchment. The activities of the Bairnsdale Urban Landcare Group to improve the Mitchell River in Bairnsdale, the Department of Primary Industries works to rehabilitate farm land affected by tunnel erosion and the activities of Waterwatch to monitor water quality in the catchment are briefly described here.



L/R: Alf Minter, Tom Eastern and Roy Henderson after canoeing the Mitchell from Tabberabbera to Bairnsdale in 1934. (Erma Hutton)

Walking tracks have been built and interpretative signs erected to highlight significant sites. New decking has been constructed to provide better access to the water for fishing, sightseeing and kayaking.

The **Dargo Landcare** group was formed in 1994. At present, 28 properties are represented, 16 belonging to families resident in the district and the remainder to absentee landholders who commute to their Dargo property.

Recent activities of the group have been a field day on soil composition and testing, and trials for the chemical control of Blue Periwinkle, a pest plant which forms a dense mat on the ground that smothers other vegetation.

Revegetation project, Dargo Landcare group.

Other activities of the group include the release of dung beetles on properties in the Dargo-Crooked river area, the design and maintenance of farm tracks, and the identification and control of Chilean Needle Grass and tunnel erosion.

In the last four years, the Department of Primary Industries in partnership with the East Gippsland Landcare Network, has been mapping the extent of tunnel erosion in the region and undertaking on-ground works to rehabilitate affected areas.

In the Mitchell River catchment, 351 hectares of land affected by tunnel erosion have been rehabilitated since the project started. The works have involved 18 farmers at 33 sites.

Tunnel erosion and rehabilitation site at Walpa.

DEPARTMENT OF PRIMARY INDUSTRIES

Tunnel erosion is a problem in many parts of East Gippsland including the Mitchell River catchment. In severely affected areas, farm production is lost and suspended sediments and nutrients enter rivers and estuaries. Some areas in the Bairnsdale Foothills around Glenaladale are particularly prone to tunnel erosion.

WATERWATCH

Nick Barton owns an 80 hectare farm close to Bairnsdale on the Mitchell River. He has been a Waterwatch monitor for 5 years, regularly taking water samples at a location on his frontage to the river. He does it partly because of his scientific background in 'measuring things' and also because of his interest in the quality of the water that passes his property and eventually flows into the Gippsland Lakes.

Developing tunnel erosion problem.

Nick Barton taking water sample, Mitchell River.

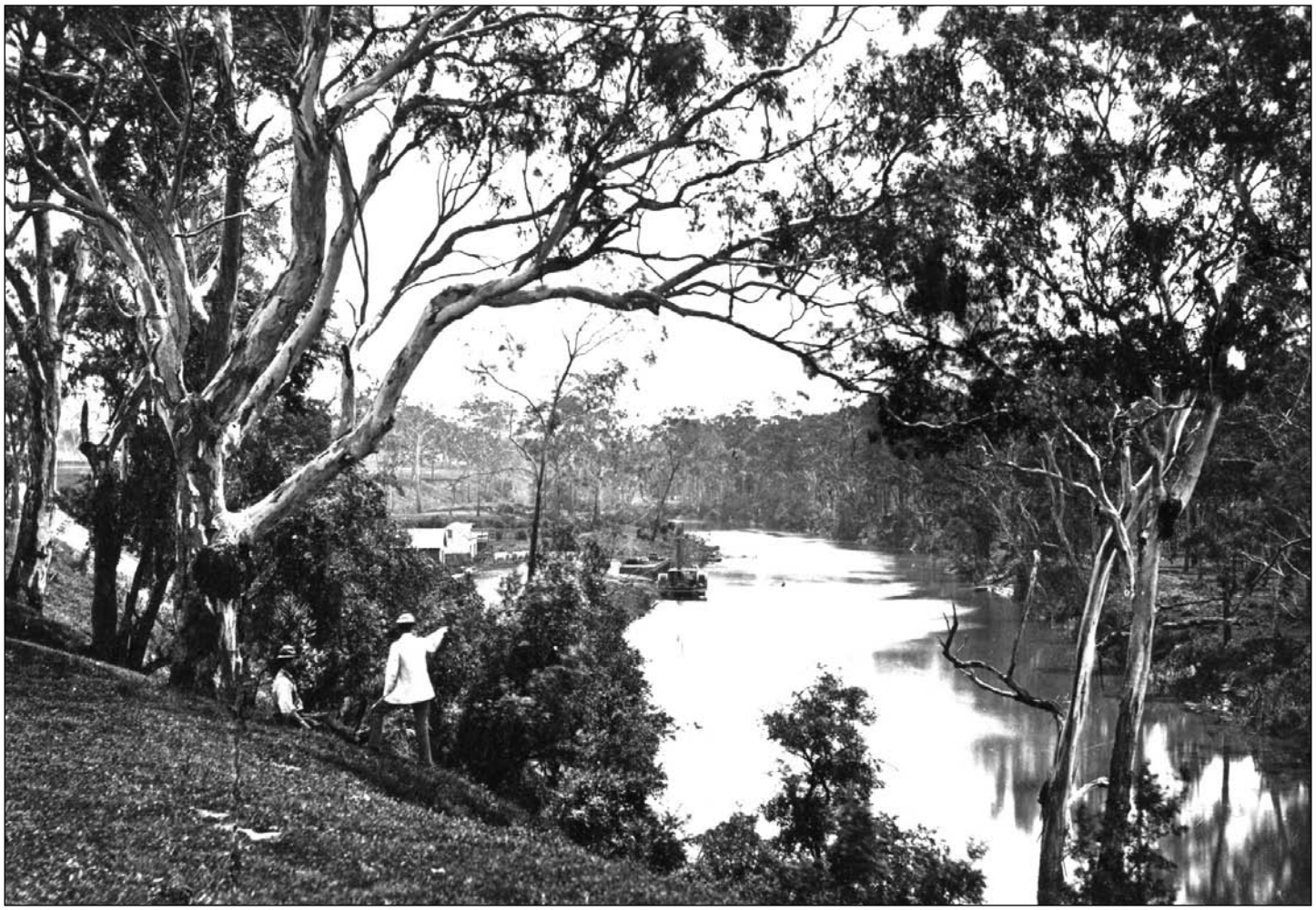
According to Nick, the samples usually indicate that water quality is good. However, he noticed that water quality deteriorated markedly after the widespread fires in the upper catchment during the 2006-07 Summer. Sediment entering the river during the major floods on the Mitchell in July 2007 and subsequent rain events has meant that it has taken over 18 months for turbidity to properly clear. Water quality also deteriorates during low water flows in Summer as the temperature of the water increases. Water quality is best during the high unregulated river flows that occur following the melting of snow in the Alps during Spring.

SUSTAINABLE USE OF NATURAL RESOURCES

The Mitchell River catchment contains many natural resources that are used to generate wealth for our community. For instance, the floodplain at Lindenow is used for intensive horticulture, the national parks for outdoor activities such as bushwalking and canoeing, and the foothills around Bairnsdale for stock grazing and timber plantations. The Mitchell contributes about half the flows to the eastern end of the Gippsland Lakes, an important estuarine system for boating, fishing and other recreational activities.

Using these natural resources to create wealth is dependent on maintaining and improving the environmental condition of the Mitchell River and its catchment. A healthy river is an important component in using our natural resources in sustainable ways for the future.

Intensive horticulture, Mitchell River floodplain.



Port of Bairnsdale, late 19th Century. (Centre for Gippsland Studies)

Environmental Water Reserves will be established for all waterways in East Gippsland.

Introduction

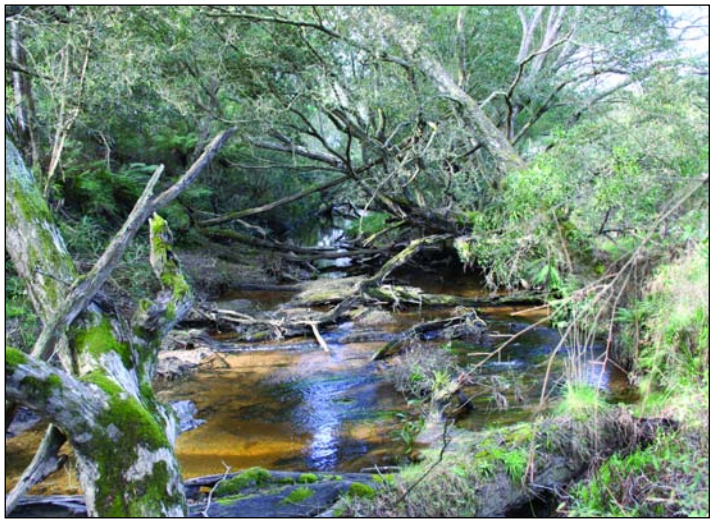
In recent years, there has been a greater realisation that a healthy river is dependent on water flows and that the regulation of rivers and the withdrawal of too much water for town supplies or farm irrigation can have detrimental effects on river health.

As a consequence, Environmental Water Reserves are being considered to ensure that sufficient water is available to maintain the health of our rivers. The information presented here explains the Authority's goal to establish meaningful Environmental Water Reserves for all waterways in East Gippsland by 2012

RIVER CATCHMENTS

A river is closely linked with its catchment and the condition of the catchment is an important factor in the health of the river. The *Victorian River Health Strategy* (Department of Natural Resources and Environment, 2002) describes three ways in which a river is linked to its catchments.

In the **longitudinal dimension**, a river changes from a small shady stream in the upper catchment to a broad turbid river along the floodplain. Sediments, nutrients and food move downstream from the upper reaches of the river to the sea. Animals such as fish move upstream and downstream.



Well wooded section of Combienbar River.

The river is also linked to the land through which it flows **(lateral dimension)**. In the upper reaches of the river, the riparian zone provides organic matter to sustain aquatic life. Lower down the river, the lateral linkages are evident when the river overflows its banks during floods, contributing sediments and nutrients to the floodplain and wetlands. This flooding triggers reproduction activities for birds, fish and other aquatic organisms.

Reed bed, Cabbage Tree Creek.

The river is also connected to groundwater systems and aquifers **(vertical dimension)**. Aquifers can contribute water to a river system during low flow events, and this can be reversed to add water to the aquifer during high river flow events.

RIVER HEALTH

River health refers to the ecological condition of a river. It is dependent on the range of different habitats along the river and the effectiveness of linkages between the river and its catchment.

For instance, the river channel has pools, riffles, debris dams, rocks and woody debris. These habitats provide the conditions for a variety of aquatic biota. Similarly the trees, shrubs and reeds along the river banks provide similar habitat for animals. For instance, caterpillars that fall from trees provide food for fish that live in the river channel.

Low flows on the Mitchell River at 'The Barrier' upstream from Bairnsdale March 2009.

Thurra River.

The *Victorian River Health Strategy* (Department of Natural Resources and Environment, 2002) defines a healthy river as 'a river which retains the major ecological features and functioning of a river prior to European settlement and which would be able to sustain these characteristics into the future'. The flow regimes, water quality and channel characteristics are such that:

- in the river and riparian zone, the majority of plant and animal species are native and the presence of exotic species is not a significant threat to the system;
- major natural habitat features are represented and maintained over time;
- native fish and other fauna can migrate up and down the river;
- there are natural linkages between the river, floodplain and associated wetlands;
- natural linkages with the sea or terminal lakes are maintained.

This list does not mean that a river needs to be in pristine condition to be 'ecologically healthy', although sections of many East Gippsland rivers are considered to be in their original, unspoiled condition. In some places, a detrimental change such as the clearing of native vegetation close to the river bank may have occurred but other important features such as naturalness of flows and channel conditions remain intact.

Bemm River.

ENVIRONMENTAL FLOWS

The flow patterns of rivers in East Gippsland are typical of many other rivers in Victoria. They are naturally variable on a seasonable basis as the accompanying table shows.

Flow component	Timing	Ecological significance
Cease to flow	Summer	River flow stops for some period of time. Bank and beds dry out, pools remain in some systems. Aquatic biota concentrated in pools. Can be an important ecological disturbance.
Low flow	Summer	Occurs most years, often for extended periods. Restricted area of in-stream habitat available. Provides limited connection between in-stream habitats. Shallow flow can promote algae growth and restricts movement of biota.
Freshes	Summer, Spring	Short periods of high flows. Critical during no flow and low flow periods. Improves water quality, especially in pools. Links in-stream habitats temporarily. Allows movement of biota and transport of food and sediment. Provides biological triggers for fish movement and spawning.
High flow	Autumn, Winter, Spring	Seasonal increase in flows, though still within bank. Lasts weeks to months. Inundates and connects all in-stream habitats. Replenishes soil moisture in the riparian zone. Allows migration and redistribution of biota. Scouring and transport of organic material and sediment.
Bank full	Winter, Spring	Flows which completely fill the channel for relatively short periods of time. Forms and maintains channel shape. Movement of sediment and organic material.
Over bank	Winter, Spring	Flows which spill out from the channel over the floodplain. Connects river and floodplain, interchange of nutrients, sediment, and organic material. Fills wetlands. Promotes breeding and regeneration on the floodplain.

Source: *Victorian River Health Strategy (2002)*.

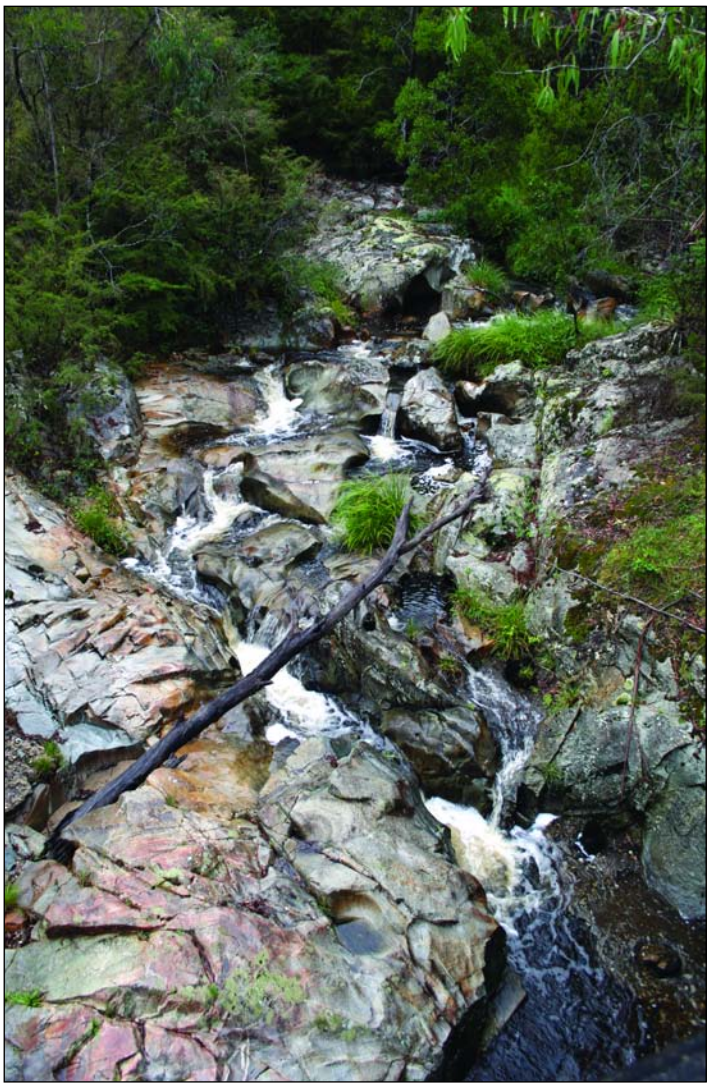
'Cease to flow' conditions, Forge Creek, March 2009.

'Over bank' conditions, Lindenow floodplain, July 2007.

These variations in flows are vital for the ecological health of a river. However, sometimes there is tension between the need for water for human consumption and to maintain the environmental condition of the river. For instance, on unregulated rivers such as most of those found in East Gippsland, the water used for irrigation could extend the summer 'low flow' period causing stress on the river.

ENVIRONMENTAL WATER RESERVE

In the Victorian Government White Paper *Our Water Our Future* (Department of Sustainability and Environment, 2004), the Environmental Water Reserve was defined as 'the share of water resources set aside to maintain the environmental values of a water system and other water services which are dependent on the environmental condition of the system'. This definition recognises the Environmental Water Reserve as a formally allocated share of water set aside for the environment.



Goongerah Creek.

Water can be 'reserved' for the environment through discrete water allocations (environmental entitlements) or through obligations placed on water entitlement holders such as urban and rural water authorities.

Discrete water allocations are granted to the environment and approved by the Minister for Environment and Climate Change. This is done on regulated rivers where weirs have altered natural flow conditions.

Snowy River

A discrete allocation has been made for the Snowy River. In 2000, the Victorian, New South Wales and Commonwealth governments agreed to return 21 per cent of the original flow to the river over 10 years, with a long term target of 28 per cent by 2012. As the first major flow agreement in Australia, this was a significant decision for river management in Australia.

Snowy River at Long Point.

The White Paper (2004) considered that the Snowy was a 'fully allocated catchment' so the Environment Water Reserve needed to be 'enhanced'. This was to be done by directing some of the water savings resulting from the upgrading of the northern Victorian irrigation systems towards improving environmental flows in the Snowy (and Murray).

Rivers other than the Snowy

Initial Environmental Water Reserves for rivers other than the Snowy were established by setting a sustainable limit on diversions during winter to ensure that environmental values of each river were protected. In East Gippsland, these were the Nicholson, Tambo and Mitchell rivers, and the rivers in the Far East.

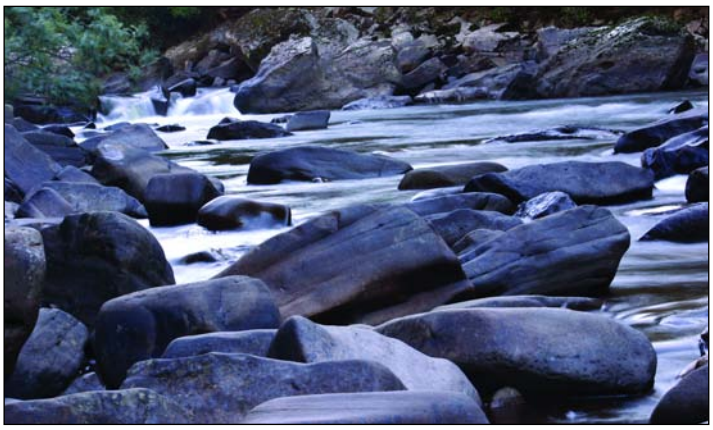
Water is also reserved for the environment through conditions placed on those licensed to withdraw water for urban supplies and farm irrigation. These conditions specify the volume of water that can be extracted under various flow conditions and the water that must be allowed to pass down the river.

For instance, the bulk entitlement to withdraw water held by East Gippsland Water specifies the volumes that can be extracted and the passing flows that must be maintained under different flow conditions. The activities of licensed irrigators are managed by Southern Rural Water using conditions such as rosters and restrictions placed on those licences.

For the rivers flowing into the Gippsland Lakes (Tambo, Nicholson, Mitchell and Avon), the amount of water currently allocated was considered to be less than the sustainable winter diversion limits and the initial Environmental Water Reserves were set by capping entitlements at their current levels plus an additional amount of 2,000 megalitres across the four catchments.

The White Paper also noted that the size of the Environmental Water Reserves to ensure the health of the Gippsland Lakes needed to be considered. A project is currently underway to consider the freshwater needs of the Gippsland Lakes.

In the Far East, the Environmental Water Reserves were established by capping entitlements at their current levels plus any additional allocation available under their sustainable winter diversion limits.



Mitchell River National Park.

Genoa River at Genoa.

ENVIRONMENTAL WATER RESERVES

SUSTAINABLE WATER STRATEGIES

The announcements in the White Paper regarding Environmental Water Reserves were regarded as the first stage in a long term water resource plan for Victoria. At the same time, it was also announced that regional Sustainable Water Strategies would be developed to 'identify and manage arising threats to the supply and quality of water' and to 'exploit emerging opportunities to improve water security and/or the health of rivers'. The Gippsland Sustainable Water Strategy Discussion Paper (Department of Sustainability and Environment 2009) was released in July 2009. It invited people in the Gippsland region to comment on how they want to prioritise their water future.

The Gippsland Sustainable Water Strategy will be guided by a Consultative Committee, comprising regional water corporations including East Gippsland Water and Southern Rural Water, as well as the East Gippsland Catchment Management Authority. The Sustainable Water Strategy will aim to secure Gippsland's water future for the next 50 years, and balance the requirements of consumptive water users with the environmental flows needed to maintain the health of our rivers.

Mueller River, Far East Gippsland.

ROLE OF THE CATCHMENT MANAGEMENT AUTHORITY

In Victoria, catchment management authorities are the caretakers of river health. They are responsible for catchment planning and coordination, and waterway, floodplain, salinity and water quality management. They are also responsible for the 'operational management' of the Environment Water Reserve 'as a key component of an integrated program for river, wetland, floodplain and aquifer restoration' (Water Act 1989, as amended).

Catchment Management Authorities are required to integrate the management of the Environment Water Reserve into river health strategies and river works programs to achieve environmental benefits while minimising adverse impacts on water users.

In the development of Sustainable Water Strategies for East Gippsland rivers, the Authority will seek to ensure that environmental flows are sufficient to maintain river health into the future.

Thurra River.

FURTHER INFORMATION

Specific information about Environmental Water Reserves in East Gippsland catchments can be found at http://www.ourwater.vic.gov.au/monitoring/accounts/map

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CATCHMENT DATA

EAST GIPPSLAND RIVERS AND STREAMS (LENGTH IN KILOMETRES)

Far East Basin

Bemm River	61
Betka River	43
Cann River	100
Cann River East Branch	24
Combienbar River	36
Errinundra River	30
Genoa River	58
Goolengook River	32
Jones Creek	10
Mackenzie River	15
Reedy Creek	32
Thurra River	80
Tonghi Creek	33
Wallagaraugh River	9
Wangarbell Creek	12
Wingan River	56
Yerrung River	34

Snowy Basin

Bendoc River	26
Brodribb River	109
Buchan River	135
Cabbage Tree Creek	43
Deddick River	64
Delegate River	41
Hospital Creek	28
Little River	35
Murrindal River	84
Sarding River	16
Snowy (Victorian section) River	161
Suggan Buggan River	48
Tingaringy Creek	16
Yalmy River	48

Mitchell Basin

Cobbannah Creek	31
Crooke River	52
Dargo River	118
Forge Creek	11
Iguana Creek	27
Mitchell River	100
Moroka River	50
Prospect Creek	41
Skull Creek	19
Thomson River	19
Tom Creek	12
Wentworth River	75
Wongungarra River	72
Wonnangatta River	147

Tambo / Nicholson Basin

Boggy Creek	75
Haunted Stream	38
Little River	28
Nicholson River	105
Stony Creek	31
Swifts Creek	17
Tambo River	336
Timbarra River	121
Waterholes Creek	10

MAJOR RIVER CATCHMENTS IN EAST GIPPSLAND (AREA INCLUDES TRIBUTARIES)

Far East Basin

Bemm River	1,133 km^2
Betka & Remote Coastal Streams	284 km^2
Cann River	1,167 km^2
Genoa River (Victorian section)	853 km^2
Thurra & Wingan Rivers	1,105 km^2

Snowy Basin

Brodribb River	1,388 km^2
Snowy River (Victorian section)	4,838 km^2

Tambo / Nicholson Basin

Nicholson River	614 km^2
Tambo River	3,019 km^2

Mitchell Basin

Mitchell River (including Wonnangatta and Dargo Rivers)	4606 km^2

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