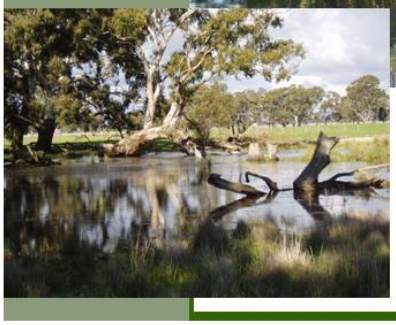
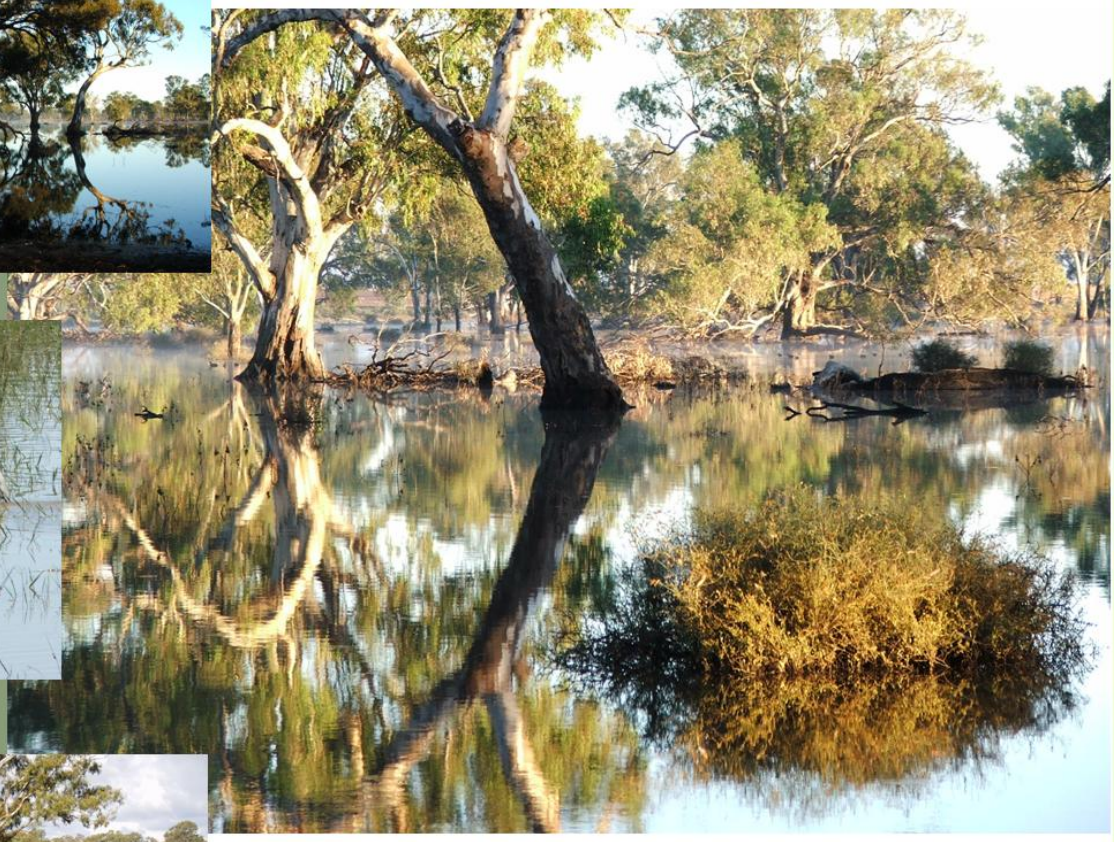
BROKEN BOOSEY AND NINE MILE CREEKS WETLAND IMPLEMENTATION PLAN.

April 2006
Report to Goulburn Broken Catchment Management Authority





Cover photographs: Tony Kubeil

Regional Ecosystem Services

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1. Introduction

1.1 Location and Planning Area

The Broken, Boosey and Nine Mile Creeks are located in north central Victoria within the Broken River Catchment and their combined total length is approximately 450 km. The creeks originate in the Warby Ranges and nearby foothills and flow north west through the riverine plains. The Boosey and Nine Mile Creeks join the Broken Creek west of Katamatite and Numurkah respectively and the Broken Creek outfalls to the Murray River below Barmah Forest. Towns along the creeks include Lake Rowan, Yundool, Tungamah, Katamatite, Wunghnu, Numurkah and Nathalia.

The Planning Area encompasses the floodplains associated with the Broken, Boosey and Nine Mile Creeks and a number of connected wetlands covering a total area of approximately 1200 km^2 (Figure 1). The floodplains are characterised by a mixture of cleared agricultural land and box-dominated grassy woodland. The wetlands within the Planning Area are predominately freshwater marshes and meadows. The larger individual wetlands include Moodies Swamp, Rowan Swamp, Black Swamp and Lannigans Swamp.

The floodplains were defined by the width of the creek's meanders as outlined in the Goulburn-Broken Catchment Wetland Systems report (Ecos, 2004). Although prior to European settlement the floodplains of these creeks would have covered a much broader area, river regulation, land clearing and the construction of flood mitigation structures such as levees have altered over bank flow patterns (Goulburn Broken CMA, 2002a). Consequently, this narrower definition of floodplain width that encompasses the riparian zone and the discrete wetlands that retain connectivity to the streams provides a practical Planning Area for the management of environmental values of the wetlands of this system.

1.2 Purpose

The Implementation Plan aims to provide a comprehensive outline of the most appropriate options for implementing initiatives to manage the environmental values of the wetlands of the Broken Boosey and Nine Mile Creeks. Specifically, the purpose of the Wetland Implementation Plan is to:

- set management goals for the Planning Area;
- identify and analyse the ecological values of the Planning Area;
- identify and analyse current and future threats to the ecological values of the Planning Area;
- describe the current condition of the ecological values of the Planning Area;
- divide the Planning Area into areas of high, medium and low conservation value based on their ecological attributes, threats and condition;
- develop management objectives based on the foregoing;
- develop strategies and actions that protect or enhance the ecological values and pursue the management objectives of the Planning Area; and
- identify knowledge gaps.

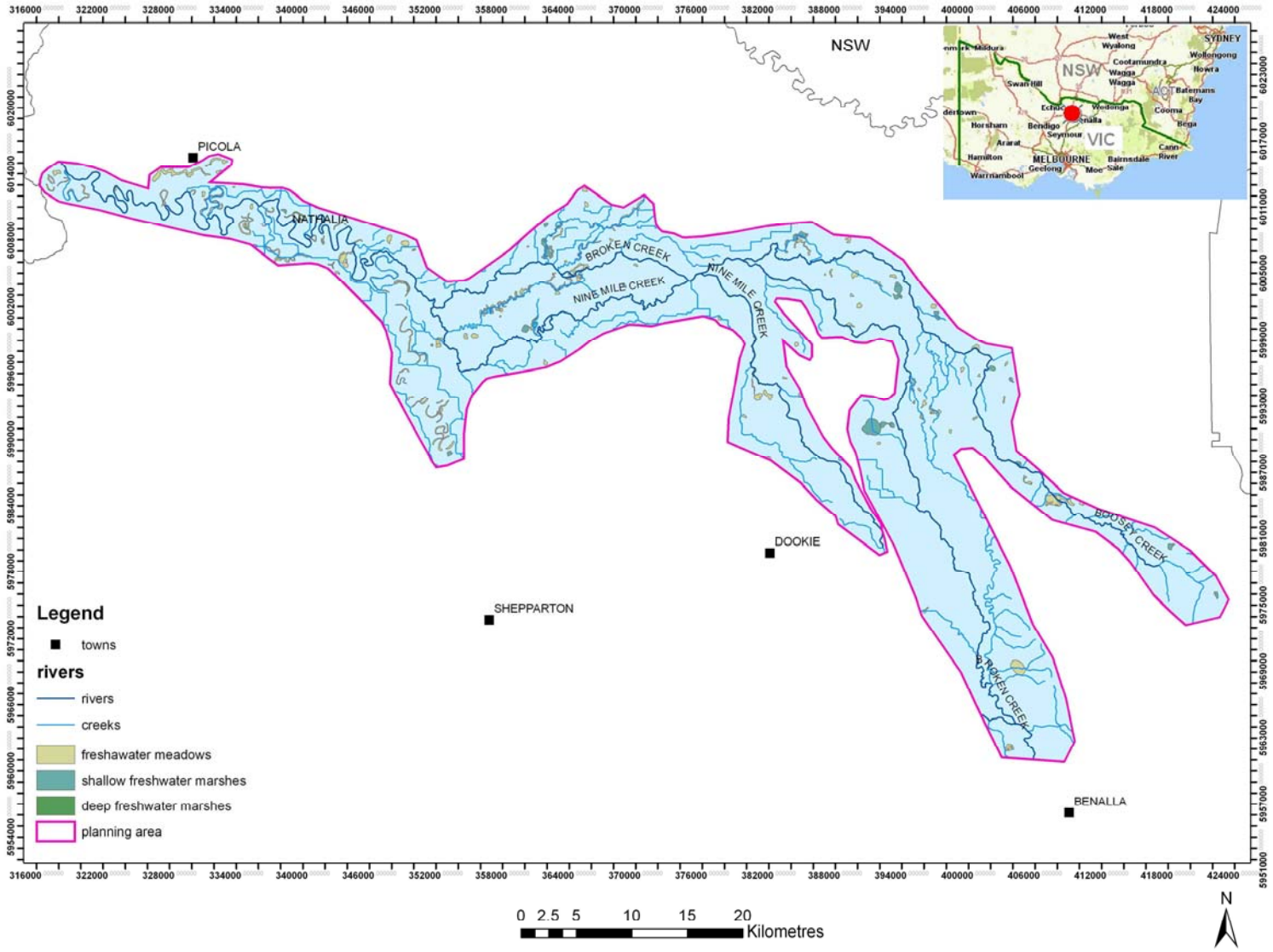

Figure 1: Planning Area.

1.3 Management Goals

The Wetland Implementation Plan for the Broken Boosey and Nine Mile Creeks is limited to the management of the ecological values of the wetland systems within the Planning Area. The management goals described here are the overarching principles, which guided the development of this plan. The Goulburn Broken Regional Catchment Strategy (2003) and the Goulbourn Broken Regional River Health Strategy (2004) form the framework for the management of environmental assets within the catchment. As such, the management goals for this Implementation Plan must flow from and be consistent with the vision and objectives set out in these two documents.

Therefore the management goals of the Wetland Implementation Plan are to:

1 maintain or improve the condition of wetlands of highest ecological value;
2 maintain or improve the condition of ecologically healthy wetlands;
3 achieve "overall improvement" in the ecological condition of remaining wetlands;
4 protect a diverse range of wetland habitats; and
5 prevent damage from future management activities.

1.4 Approach

The approach used to prepare this plan is as follows:

- management goals consistent with existing strategies and management plans were developed for the Planning Area (Section 1.3);
- legislation, policy and related management instruments which direct or otherwise influence management of the Planning Area's ecological values were examined (Section 2);
- the Planning Area's ecological values were identified and analysed (Section 3);
- current and future threats to the Planning Area's ecological values were identified and analysed (Section 4);
- the current condition of the Planning Area's ecological values were described based on existing information and field assessments (Section 5 and Appendix B);
- knowledge gaps were identified (Section 7);
- strategies and targets for the Planning Area were developed (Section 8); and
- a five year implementation plan was developed (Section 9).

Additional information on the methodology used can be found in the individual sections

1.5 Information Sources

Information used in the development of this plan was compiled from various sources (listed in full in Section 10 at the end of the document) including river health and catchment strategies, consultant reports, scientific papers in various journals and wetland and park management plans.

In addition, a number of statewide data sets and digital mapping layers were used including the:

- Flora Information System of Victoria (DSE 2006);
- Atlas of Victorian Wildlife (DSE 2006);
- Bioregional Conservation Status of Ecological Vegetation Classes;
- Modelled Ecological Vegetation Classes in 1750;
- Wetland Environments and Extent up to 1994;
- Extent of Wetlands Prior to European Settlement;
- Agricultural Landuse between 1987 – 1996;
- Tree Cover Density between 1989-1999; and
- Aerial photography.

Where available, the meta data for the data sets and digital mapping layers used is provided in Appendix C. This information was supplemented by discussions with people with an intimate knowledge of the study area and/or with key communities, species or assemblages

1.6 Limitations

The sources of information used in the development of this plan have a number of limitations. These include:

- Index of Stream Condition and Index of Wetland Condition field assessments undertaken specifically for the development of this plan were carried out in March 2006. Therefore, the data collected only provides a snapshot in time of the vegetation and some flora species that were dormant or not actively growing during this time may not have been identified.
- Not all remnant vegetation in the Planning Area has been captured by Statewide Ecological Vegetation Class mapping.
- The data contained in the Wetland Environments and Extent up to 1994 digital mapping layer was compiled between 1975 and 1994 and only includes information on wetlands greater than 1 hectare in size.
- The lack of knowledge about the distribution and characteristics of invertebrate and non-vascular plant species means that assessments are weighted towards the less cryptic elements of flora and fauna, i.e. vascular flora and vertebrate fauna.
- The data contained in the Flora Information System of Victoria and the Atlas of Victorian Wildlife comes from a combination of incidental records and systematic surveys. The data varies in accuracy, precision and reliability due to the distribution and intensity of survey efforts.
- The records of threatened species were limited to those less than or equal to 30 years old. In some cases it is possible that the Planning Area still provides suitable habitat for certain species but the nature of the distribution or biology of the species limits the likelihood of it being observed, or survey efforts for particular threatened species have been limited in the last 30 years.
- Social, economic, cultural and abiotic ecological values including geology are not considered.
- While data was available regarding the description and nature threats, there was little empirical data available concerning the impacts of threats on the Planning Area's ecological values. Therefore, the impacts of threats on the Planning Area's ecological values are often inferred from available information.
- The information sources used to develop this plan vary in their age and hence the degree to which they reflect the current situation. All attempts have been made to ensure that the information contained in this report is relevant, accurate and up-to-date.

Where appropriate, the above limitations have been identified as knowledge gaps in Section 7.

1.7 Consultation

This draft plan has been developed under the direction of a Steering Committee. The Steering Committee comprises representatives from the key agencies responsible for wetland management in the Planning Area. The committee members are:

- Goulburn Broken CMA
    - Wayne Tennant
    - Tony Kubeil
    - Simon Casanelia
    - Keith Ward

    - Dougal Gilmour (community representative on the Mid Goulburn Implementation Committee)
- Parks Victoria
    - Bruce Wehner
- Department of Primary Industries
    - Alex Sislov
- Department of Sustainability & Environment
    - Rolf Weber

The publication of this draft plan offers the broader community an opportunity for involvement in planning the future management of the Planning Area's ecological values. All submissions on the draft plan were carefully considered and taken into account in the preparation of the final plan.

1.8 Structure

This Implementation Plan is divided into nine main sections:

1 Introduction – introduces the plan, its purpose, management goals and approach.
2 Management Context – outlines the history and describes the legislative and management framework of the Planning Area.
3 Ecological Values – describes the wetland, vegetation community, flora and fauna values of the Planning Area.
4 Threats to Ecological Values – describes and analyses the key threats to the the Planning Area's ecological values.
5 Condition of Ecological Values – describes the condition of the wetlands and native vegetation within the Planning Area.
6 Conservation Value – describes the process trialled for dividing the Planning Area into areas of low, medium and high conservation value.
7 Knowledge Gaps – describes knowledge gaps in the management of the Planning Area's ecological values.
8 Strategies and Actions – presents objectives, strategies and actions developed in response to the analysis of the Planning Area's ecological values and the key threats to these values.
9 Implementation Plan – lists the priority actions together with responsibilities and timings for completion for the period 2006 – 2011.

2. Management Context

2.1 Land Tenure and Management

The Planning Area is comprised predominantly of freehold land, with smaller areas of reserve administered by state and federal legislation (Table 1). In addition, public land in the Planning Area must be managed in accordance with relevant government approved recommendations of the former Land Conservation Council (LCC) and Environment Conservation Council (ECC).

Table 1: Planning Area land tenure.

Land Tenure and Legal Status	Area (ha)	% of Planning Area
Freehold	120,000	95
National Parks Act 1975		
State Park	1150	0.9
Crown Land (Reserves) Act 1978		
Nature Conservation Reserve	2150	1.7
Bushland Reserve	800	0.6
Wildlife Reserve	240	0.2
Land Act 1958		
Public Land Water Frontage	2160	1.7

A number of management agencies are responsible for ensuring that management of the Planning Area complies with a broad range of legislative requirements. Lead management agencies and their key responsibilities are summarised in Table 2.

Table 2: Management agencies and their key responsibilities in the Planning Area.

Agency	Responsibility
Goulburn Broken Catchment Management Authority	Reporting on progress towards targets and outcomes of the Regional Catchment Strategy, including those in relation to wetlands. Works on waterways, regional drainage and floodplain management, and co-ordinating Commonwealth and State natural resource management investment.
Department of Sustainability and Environment	Provide financial, policy and strategic support for the management of public and private land. Management of flora and fauna, State Forest and Public Land Water Frontage. Management of hunting and domestic stock licensing on public land
Department of Primary Industries	Provide technical and extension support for the sustainable management of fisheries, agriculture, minerals and petroleum.
Local Government	The Planning Area includes the municipalities of Moira and the Benalla Rural City. They are responsible for land-use planning and development approvals..
Goulburn Murray Water	The creeks within the Planning Area are part of a regulated system and lie within two irrigation districts (Murray Valley and Shepparton). Goulburn Murray Water is responsible for the provision of irrigation, drainage, water supply and management of these water supply catchments.
Parks Victoria	Management of the State Park and Reserves.

In addition, landholders and the following community based organisations have an interest in the Planning Area:

- Indigenous groups
  - Bangerang Cultural Centre Cooperative
  - Rumbalara Aboriginal Cooperative
  - Yorta Yorta Nation Aboriginal Corporation
- Field and Game
  - Shepparton
- Landcare Groups
  - Broken Creek Improvement
  - Bunbartha Kaarimba
  - Burramine Tungamah
  - Invergordon District Environment
  - Kotupna
  - Kotupna, Picola
  - Muckatah
  - Naring
  - Warby Ranges
- Local Area Planning Groups
  - Bunbartha Karrimba and Zeerust
  - Invergordon
  - Muckatah Katamatite and Nariganingalook
  - Nathalia and District
  - Picola Land management Group
- Environment Groups
  - Broken Boosey Conservation Management Network
  - Broken Creek Field Naturalists
  - Goulburn Valley Environment Group
  - Trust for Nature

The successful management of the Planning Area therefore, relies on effective cooperation and partnership between the various management agencies, landholders and community based organisations

2.2 Legislative Framework

There are a number of pieces of legislation, strategies and policies that govern or guide the management of aquatic resources in the Planning Area. Management of the wetlands of the Broken Boosey and Nine Mile Creeks must occur under the ambit of relevant legislation and in a manner compatible with the directions set at international, national, State and regional levels. The key regulatory and guiding documents that have been considered in the development of this plan are summarised in Table 3.

Table 3: Key legislative, policy, strategy and management documents relevant to the management of the ecological values of wetlands in the Planning Area.

Level	Document	Summary / Relevance to the Planning Area
Regulatory Documents - Legislation		
National	Environment Protection and Biodiversity Conservation Act, 1999	Actions that may impact on nationally threatened species; populations and communities, certain migratory birds and Ramsar and World Heritage listed sites are subject to a rigorous Commonwealth assessment and approvals process.
State	Flora and Fauna Guarantee Act, 1998	Provides a management approach for the conservation of Victoria's biodiversity and of potentially threatening processes.
	Water Act, 1989	Provides for the integrated management of water resources.
	State Environment Protection Policy (Waters of Victoria) 2003	Objectives and Indicators for water quality in aquatic systems across the State. Includes specific clauses governing water allocations, vegetation protection and water conservation.
	Catchment and Land Protection Act, 1994	Promotes integrated management and protection of catchments.
	National Parks Act, 1975	Protects the natural conditions of listed national parks. Broken-Boosey State Park lies within the Planning Area and is reserved and managed under this Act.
Guiding Documents - Policy / Strategies / Agreements		
International	Ramsar Convention on Wetlands, 1971	There are no Ramsar listed sites within the Planning Area, although this system discharges into the Murray immediately downstream of the Barmah-Millewa Forest Ramsar site. See EPBC Act above also.
	The Japan-Australia Migratory Bird Agreement (JAMBA) and the China Australia Migratory Bird Agreement (CAMBA)	Bilateral agreements that aim to see those migratory birds moving between Japan and Australia and China and Australia protected. It is expected that migratory birds listed under these agreements will have been regularly recorded within the Planning Area. See EPBC Act above also.
	Convention on the Conservation of Migratory Species of Wild Animals (the 'Bonn Convention').	Australia is a signatory and as such is expected to develop actions to protect certain migratory species, and in particular those that are threatened. It is expected that migratory birds will have been regularly recorded within the wetlands of the Planning Area. See EPBC Act above also.
National	Wetlands Policy of the Commonwealth Government of Australia (1997)	This policy aims to promote the conservation, repair, and wise use of wetlands and, within the broader context of environmental management, incorporate the conservation of wetlands into the daily business of the Commonwealth Government.
	Natural Heritage Trust, and NRM program	These programs provide the primary source of funding for the protection, enhancement and restoration of natural resources in Australia.
State	White Paper – Securing Our Water Our Future (2004)	Actions plan for the sustainable use of water across the State. Although no actions specifically target the wetlands of the Planning Area, environmental flow allocations may provide some benefits.

Level	Document	Summary / Relevance to the Planning Area
	Victorian River Health Strategy (2002)	Provides the overall policy framework for the sustainable management of all rivers in Victoria, including the riparian and floodplain zones.
	Victoria's Biodiversity Strategy (1997)	Provides specific advice for the management of wetlands and their associated flora and fauna across the State.
Regional	Goulburn Broken Regional Catchment Strategy (2003)	Provides the context for the sustainable management of natural resources within the Goulburn Broken Catchment
	Goulburn Broken Regional River Health Strategy, Draft (2004)	Provides a framework for the integrated management of aquatic resources across the catchment.
	Goulburn Broken Wetland's Direction Paper, Draft (2002)	Provides strategic direction for the management of wetlands across the catchment.

Other legislation, policies and strategies relevant to the management of wetlands in the Planning Area include:

National
- Native Title Act (1993)
- Aboriginal and Archaeological Relics Preservation Act (1972)
- Aboriginal and Torres Straight Islanders Act (1984)
- National Water Quality Management Strategy (1995)
- National Strategy for the Conservation of Australia's Biodiversity (1996)
- National Local Government Biodiversity Strategy (1998)
- National Management Strategy for Carp Control (2000-2005)
- National Weeds Strategy (1999)
- National Strategy for Ecologically Sustainable Development (1992)

Murray Darling Basin
- Integrated Catchment Management in the Murray Darling Basin (2001)
- Floodplain Wetland Management Strategy for the Murray Darling Basin (1998).
- MDBC Salinity Management Strategy (2001)
- MDBC Water Quality Policy (1990)
- MDBC Native Fish Strategy 2003 – 2013.
- MDBC Algal Management Strategy (1994)

State
- Conservation, Forests and Lands Act (1987)
- Environment Protection Act (1970)
- Forests Act (1958)
- Heritage Rivers Act (1992)
- Local Government Act (1989)
- Wildlife Act (1975)
- Crown Land (Reserves) Act (1978)
- Victoria's Draft Native Vegetation Management Framework (2000)
- Victorian Flood Management Strategy (1998)
- Victorian Weed Management Strategy (2002)
- Draft Victorian Pest Management Framework (2002)
- Victorian Nutrient Management Strategy for Inland Waters (1995)

Regional

- Barmah-Millewa Forest Water Management Strategy (2000)
- Draft Goulburn Broken Native Vegetation Management Strategy (2000)
- Mid-Murray Forest Management Area Forest Management Plan (2002)
- Goulburn Eildon Fisheries Management Plan (Draft May 2001)
- Goulburn Broken Riverine Health Strategy (2004)
- Shepparton Irrigation Region Land and Water Management Plan (revised 2002)
- Goulburn Broken Dryland Salinity Management Plan (1995)
- Municipal Strategic Statements (local government planning schemes).

2.3 Catchment Setting

The Planning Area encompasses approximately 1200 km^2 in northern Victoria and is located within the Murray Darling Basin and Goulburn Broken Catchment. Broken Creek is a disbursement of the Broken River north west of Benalla and flows north west where it outfalls to the Murray River 12 km upstream of the town of Barmah in the Barmah Millewa Forest (URS, 2005). Boosey Creek and Nine Mile Creeks originate in the Warby Ranges and nearby foothills and both flow into the Broken Creek prior to its confluence with the Murray River (Figure 1).

The climate is Mediterranean with hot summers and cool wet winters. The east of the Planning Area lies within the foothills of the Great Dividing Range and has an annual rainfall of > 700 mm / year. As the creeks flow north and west they enter the drier Riverine Plain where rainfall is > 400 mm/ year (Egis, 2002).

The majority of the Planning Area lies within the Riverine Plain geomorphic unit with a surface comprising Pleistocene and Holocene sediments. The sediments originated as river and floodplain deposits and current streams probably flow along the ancestral channels of the Broken River (AWT, 2001). Alluvial deposits of clay, sand, silt and gravel dominate the geology. Topography over the Planning Area is predominantly flat and as a consequence the streams are characterised by anabranching (AWT, 2001).

Native vegetation in the Broken River Catchment has been extensively cleared for agriculture and is predominantly freehold (Table 1). Within the Planning Area, less than 2 % of pre European vegetation cover remains. The majority of the remnant vegetation is located along the creeks within the State Park and Natural Features Reserves. In addition to the loss of native vegetation, there has also been extensive loss of wetlands in the landscape, due to both public and community drainage (SKM, 1997). As a consequence, the habitat available for native fauna is severely restricted.

Broken Creek has been used as a water source for domestic and stock purposes since early European settlement (URS, 2005). Goulburn Murray Water currently regulates the creek system of the Planning Area for supply of town, stock, domestic and irrigation water. Total diversion from the creek systems is approximately 34,000 ML per annum (URS, 2005) from Casey's Weir and the East Goulburn Main Channel, as well direct extraction from the creeks themselves. This has resulted in a reversal of the seasonality of flow in these systems, with peak flows during summer and low flow during winter (Cottingham *et al*., 2001).

2.4 Past Occupation and Landuse

The land within the Planning Area has a long history of Indigenous occupation by the Yorta Yorta and Bangerang people. The creeks, wetlands and grassy woodlands of the Planning Area would have provided a diverse range of resources throughout the year, including food (fish, mussels and birds), drinking water as well as materials for

boats and tools. The 134 scar trees that have been recorded along the Broken, Boosey and Nine Mile Creeks indicate the importance of the planning area to Yorta Yorta and Bangerang people today (Parks Victoria, 2005).

Major Mitchell was the first European to travel through the Planning Area in 1836 and by mid 1838 the area had been occupied by other Europeans together with their cattle and Sheep (Robinson and Mann, 1996). Today the main towns within the Planning Area are Nathalia and Numurkah on the Broken Creek. The smaller towns of Katamatite and Tungamah are located on the Boosey Creek and Wunghnu on Nine Mile Creek. Most of the land is used for grazing, with dairying being the predominant industry. There are also areas of cereal cropping, particularly in the central part of the catchment. The Planning Area lies within the Shepparton Irrigation Region, which generates 25 % of Victoria's annual rural export earnings (URS, 2005).

3. Ecological Values

Floodplains and wetlands are at the interface between terrestrial and aquatic habitats and are highly diverse systems which support many species and provide many unique functions and processes. Globally wetlands are considered one of the most threatened ecosystems. They are highly productive systems and support a significant number of endangered species (Mitsch and Gosselink, 2000). Wetlands are prominent in the landscape and have received considerable attention in recent years due to their rapid loss through various human activities. Ecological values associated with wetlands can be viewed at several levels, at the species or population level and at the wetland ecosystem level. For example a wetland may be valued for supporting large populations of waterbirds, or other threatened species; or it may be valued for its role in improving water quality and or in flood mitigation.

Parks Victoria (2005) lists the following as natural values of The Broken-Boosey State Park and the Natural Features Reserves:

- Largest remaining example of grassy woodland in the Northern Plains.
- One of the few surviving patches of remnant vegetation in the Northern Plains landscape (Robinson and Mann, 1996).
- Approximately 30% of Victoria's endangered Plains Grassy Woodland /Gilgai Plans Woodland Wetland Mosaic EVC.
- Ecologically distinguishable by its riparian Grey Box vegetation compared to most of the Victorian rivers (Robinson and Mann, 1996).
- The only known site for the endangered Amulla and one of only two known sites in Victoria for the endangered Spiny –Fruit Saltbush.
- Broken Creek is one of the most important stream systems for Murray Cod and Freshwater Catfish (Robinson and Mann, 1996).
- Habitat for a significant number of woodland-dependent bird species associated with the Victorian Temperate Woodland Bird Community listed under the *Flora and Fauna Guarantee Act 1988* (Vic) including the Bush Stone-curlew, Brown Treecreeper and Black-Chinned Honeyeater.
- Habitat for threatened fauna including the Growling Grass Frog, Swift Parrot and Tree Goanna, and supplementary breeding ground for the threatened Brolga.

3.1 Wetlands

The wetlands of the Planning Area have been assessed at the following two scales:

- the floodplain / riparian zone associated with the creeks as a single connected wetland system; and
- the discrete wetlands within the floodplain.

The information in this section applies to the discrete wetlands within the Planning Area.

3.1.1 Wetland Category

In Victoria natural wetlands are classified into the following six categories according to water depth, duration of inundation, salinity and dominant vegetation:

- deep freshwater marshes – deep freshwater wetlands that remain flooded for most of the year but may dry occasionally;
- freshwater meadows – shallow freshwater wetlands holding water for less than four months of the year;
- permanent open freshwater wetlands – deep freshwater wetlands that hold water permanently;

- permanent saline wetlands – saline wetlands that rarely dry out, including tidal areas and saline inland lakes;
- semi-permanent saline wetlands – saline wetlands flooded for less than eight months of the year, including salt pans and slat meadows; and
- shallow freshwater marshes – shallow freshwater wetlands that usually dry out in mid-summer and refill with the onset of winter rains (Corrick and Norman, 1980).

There has been a dramatic reduction in natural wetland area since settlement. Approximately thirty-seven per cent of Victoria's wetland area has been lost, primarily as a result of drainage (NRE, 1997). The greatest losses of original wetland area have been in the freshwater meadow (33 per cent), shallow freshwater marsh (57 per cent) and deep freshwater marsh (69 per cent) categories. Of the remaining wetland area freshwater meadow and shallow freshwater marsh are the least represented categories in parks and reserves across the State.

The Planning Area includes areas of shallow freshwater marsh, deep freshwater marsh, freshwater meadow and permanent open freshwater. Table 4 summarises the historic and current number and area of wetlands found in the Planning Area.

Table 4: The historic and current number and area of wetlands in the Planning Area Note: 2001 wetland area was "not identified" (NI).

Parameter		**1788**	**1994**	**% Remaining**	**2001 Evident**
Number	Freshwater Meadow	183	119	65 %	60
	Shallow Freshwater Marsh	49	27	55 %	21
	Deep Freshwater Marsh	1	1	100%	0
	Permanent Open Water	0	20	Increase	12
	Total	**233**	**167**	**72 %**	**93**
Area (ha)	Freshwater Meadow	3251	2234	68.7%	NI
	Shallow Freshwater Marsh	1709	725	42 %	NI
	Deep Freshwater Marsh	30	30	100 %	NI
	Permanent Open Water	0	87	Increase	NI
	Total	**4990**	**3076**	**62 %**	**NI**

The Wetlands 1994 layer is based on data collected during the 1970s and 1980s and as such actually represents extent of wetland types in the 1980s. As can be seen in Table 4 there has been further change in wetland extent in the study region as evidenced by visual examining of 2001 aerial photography. This process was conducted in a conservative manner, with any evidence of wetland attributes (eg a shadow of soil type in a pasture or crop) still considered as an existing wetland. However, as this assessment was purely undertaken from remote sensing information from a single year it merely provides an indication of current numbers, rather than an absolute count.

The 1788 wetland layer indicates that there were no naturally occurring permanent open water systems in the Planning Area, it is considered that all that have been created and should therefore fall under the category of impoundments. Although the impact to wetland values and condition due to the impoundment of formerly intermittent wetlands will be noted, artificial or created wetlands and dams are excluded from this Implementation Plan.

The Planning Area contains approximately 4% of the aerial extent and 12% of the number of wetlands within the Goulburn Broken catchment (Tables 5 and 6). This

represents around 2% of the States wetlands (based on approximate figures for freshwater wetlands excluding artificial impoundments: DCE, 1992).

Table 5: Contribution of wetlands in the Planning Area to total wetland numbers in the catchment and state.

Wetland Category	Planning Area Total	Planning Area Total as a % of Catchment Total	Planning Area Total as a % of State Total
Freshwater Meadow	119	17	2
Shallow Freshwater Marsh	27	5	<1
Deep Freshwater Marsh	1	<1	<1
Total number	167	12	2

In the above table the figures are based on DCE (1992), Howell and McLennan (2002) and data from the Wetlands_1994 layer for the Planning Area. The figures exclude the wetland category Permanent Open Freshwater and the "others" category listed in Howell and McLennan (2002) as they are not considered natural. The term Catchment refers to the Goulburn Broken Catchment

Table 6: Contribution of wetlands in the Planning Area to total wetland area in the catchment and state.

Wetland Category	Planning Area Total	Planning Area Total as a % of Catchment Total	Planning Area Total as a % of State Total
Freshwater Meadow	2234	8	2
Shallow Freshwater Marsh	725	4	1
Deep Freshwater Marsh	30	<1	<1
Total area (ha)	2989	6	1

In the above table the figures are based on DCE (1992), Howell and McLennan (2002) and data from the Wetlands_1994 layer for the Planning Area. The figures exclude the wetland category Permanent Open Freshwater and the "others" category listed in Howell and McLennan (2002) as they are not considered natural. The term Catchment refers to the Goulburn Broken Catchment

3.1.2 Wetland Conservation

An overlaying of the wetlands 1994 spatial layer with the 1: 250 000 landuse layer demonstrates the low level of wetland conservation in the Planning Area (Table 7). Of the 167 wetlands within the Planning Area, only 12 are predominantly within Natural Features Reserves or other conservation management areas. Of these 10 are still visible from the aerial photography.

Table 7: Dominant Landuse for wetlands in the Planning Area, number from 1994 spatial layer (number still visible on 2001 aerial photographs).

Landuse	Freshwater Meadow	Shallow Freshwater Marsh	Deep Freshwater Marsh	Permanent Open Water
Natural Features Reserve	5 (4)	4 (3)		2 (2)
Other Conserved Areas		1 (1)		
Grazing Natural Vegetation	1 (1)			
Grazing Modified Pasture	70 (33)	16 (13)		8 (4)
Cropping	29 (18)	2 (2)		3 (2)
Irrigated Pasture	3 (2)	2 (1)		
Irrigated Cropping	5 (5)	2 (1)		3 (2)
Residential / Other	6 (2)		1 (0)	4 (4)

3.1.3 Significant Wetlands

There are no internationally (Ramsar) listed wetland sites within the Planning Area. There are also no discrete wetlands in the Planning Area listed on the Directory of Important Wetlands is Australia (Environment Australia. 2001). However, the floodplain associated with the Broken Creek (8km downstream of Benalla to the confluence with the Murray) is listed nationally. This would encompass a large number of wetlands within the Planning Area and specifically includes Moodie's Swamp.

In addition, the National Land and Water Resources Audit (NLWRA, 2002) listed the following wetlands located within the Planning Area as bioregionally significant:

- Black Swamp;
- Lanigan's Swamp;
- Purdie's Swamp;
- Rowan Swamp and
- Unnamed on the Boosey Creek (8025_971001).

Note: The NLWRA (2002) also listed the sewage ponds at Nagambie and Numurkah as bioregionally significant wetlands, but as created systems they are not included in this implementation plan.

3.1.4 Ecological Functions

Floodplain wetlands perform important functions necessary to maintain the hydrological, physical and ecological health of river systems. These functions include:

- enhancing water quality through filtering sediments and re-using nutrients;
- absorbing and releasing floodwaters;
- groundwater and aquifer recharge;
- providing organic material to rivers to maintain riverine food chains; and
- providing feeding, breeding and drought refuge sites to an array of flora and fauna, especially fish and waterbirds.

The functions the wetlands in the Planning Area perform have not been investigated in detail. However, it is expected that they would perform all of the functions outlined above. Their capacity to perform them will however, depend on their condition (Section 5).

3.1.5 Wetland connectivity

Connectivity is a fundamental concept of landscape ecology relating to the movements of organisms and energy as driven by landscape structure. The study area is considered a key terrestrial wildlife corridor providing a connection between a number of conservation reserves in the region. In particular the vegetation associated with the floodplain is considered of very high regional significance (see discussion below). The wetlands and floodplain are also essential elements in maintaining the health of their associated parent rivers and streams. Rivers, wetlands and floodplains are interconnected units of the one system; however they are often managed as separate units.

The three main elements of connectivity in river systems are:

1. longitudinal connectivity (upstream downstream in channel);
2. lateral connectivity (riparian channel interactions and floodplain channel connections); and
3. vertical connectivity (groundwater, hyperheos interconnections).

In addition to the above spatial connections, river systems have a temporal connection, which refers to when and how long different elements of aquatic

ecosystems are connected (e.g. season and duration). Altering any of these elements within a system will have a cascading effect. For example, a dam on the mainstream channel will alter longitudinal connectivity, it may alter the temporal connectivity (release of flows for irrigation etc), and this in turn will most likely affect lateral connectivity – when and how much water is delivered to the floodplain. The other key feature of connectivity in floodplain systems is that the connection between the units (wetland, river, riparian zone etc) are intermittent determined by geomorphology, climate and the natural hydrological regime.

Understanding the hydrological connectivity between floodplains, discrete wetlands on the floodplain and the main river channel is fundamental to understanding how floodplains function. Connectivity determines rates and quantities of materials delivered and transported across and back into the river. It affects functions such as nutrient cycling, transport of organic material, movements of biota and signals for breeding events and so on. Activities in the study area will have a direct affect on the downstream systems which the Broken Boosey and Nine Miles creeks catchments connect to, including Barmah Forest. Loss of lateral connectivity exacerbates the fragmentation of riparian and floodplain vegetation by interrupting the natural hydrological regime which supports the flood dependent vegetation of these systems.

The boundary of the Planning Area is not a natural geographic unit and as such connectivity to the surrounding landscape is an important aspect to consider when assessing the condition of the ecological values of the floodplain and wetlands. The floodplain of the Broken, Boosey and Nine Mile Creeks has its own intrinsic values, however this system is also of high value in the regional context.

3.2 Vegetation Communities

3.2.1 Ecological Vegetation Classes (EVCs)

Ecological vegetation classes represent the most detailed level in the hierarchy of the vegetation typology developed and used across Victoria currently. They consist of one or a number of floristic communities that exist under a common regime of ecological processes within a particular environment at a regional, state or continental scale. Ecological vegetation classes are defined at a qualitative level by both their floristic and structure and their description includes the ecological processes that characterise them (Woodgate *et al.*, 1994). To date, mapping of ecological vegetation classes has not been completed across the state and may not have included all remnant vegetation in the Planning Area. In addition, to support the management of biodiversity values a bioregional conservation status has been assigned to ecological vegetation classes in Victoria.

Prior to European settlement, an estimated 35 EVCs occurred in the Planning Area; of which only 19 have remnant patches of vegetation remaining (Table 8). In addition, the majority of remaining EVCs have significantly reduced cover. The two exceptions to this: Riverine Grassy Woodland / Riverine Sedgy Forest/Wetland Mosaic and Creekline Grassy Woodland/Red Gum Wetland Mosaic show dramatic increases (340 % and 440 %, respectively). However, this is probably due to a change in the nomenclature of EVCs (ie Creekline Grassy Woodland/Red Gum Wetland Mosaic was probably recorded for the 1750s layer as Creekline Grassy Woodland and Red Gum Wetland separately).

The Broken-Boosey State Park and the Natural Features Reserves contains the largest remnant of intact native grassy woodland vegetation in the eastern Northern Plains, and as such plays a critical role in the regional conservation of the endangered EVCs

Plains Grassy Woodland, Creekline Grassy Woodland, Plains Grassy Woodland/Gilgai Plains Woodland/Wetland Mosaic and Wetland Formation (ECC 2001 cited in Parks Victoria, 2005).

Table 8:Bioregional conservation status and area of Ecological Vegetation Classes within the Planning Area..

EVC	EVC Bioregional Conservation Status			Planning Area		
	MF*	RIV*	NIS*	Area 1750 (ha)	Area Current (ha)	% Remaining
Alluvial Terraces Herb-rich Woodland		E	E	81.15	0	0.0
Black Box Chenopod Woodland	E			40.67	7.22	17.8
Box Ironbark Forest		V	V	1517.11	54.83	3.6
Cane Grass Wetland				173.87	0	0.0
Creekline Grassy Woodland				2757.15	0	0.0
Creekline Grassy Woodland/Red Gum Wetland Mosaic				96.50	423.00	438.3
Drainage Line Complex	E	E		1520.42	38.28	2.5
Floodplain Riparian Woodland	V	V	E	184.21	36.43	19.8
Gilgai Plain Woodland/Wetland Mosaic		E	E	1307.17	6.52	0.5
Gilgai Plain Woodland/Wetland/Shrubby Riverina Plains Grassy Woodland Mosaic				6.80	0	0.0
Granitic Hills Woodland			E	905.78	259.69	28.7
Grassy Woodland	E	E	E	3788.97	12.64	0.3
Heathy Dry Forest			LC	1.46	0	0.0
Lagoon Wetland	E			29.56	3.41	11.5
Lignum Wetland	E			9.96	7.06	70.9
Pine Box Woodland	E	E		2258.44	0	0.0
Pine Box Woodland/Riverina Plains Grassy Woodland Mosaic	E	E		26382.02	152.65	0.6
Plains Grassy Wetland	E	E		825.62	0	0.0
Plains Grassy Woodland	E	E	E	36069.31	0	0.0
Plains Grassy Woodland/Floodplain Riparian Woodland Complex		E		184.40	0	0.0
Plains Grassy Woodland/Gilgai Plains Woodland/Wetland Mosaic	E	E	E	38061.56	849.42	2.2

Red Gum Wetland	E	E		1002.46	169.54	16.9
Red Gum Wetland/Plains Grassy Wetland Mosaic	E	E		937.43	83.15	8.9
Reed Swamp	V			3.28	0	0.0
Riverine Grassy Woodland/Black Box Chenopod Woodland/Wetland Mosaic	E			434.50	0	0.0
Riverine Grassy Woodland/Riverina Plains Grassy Woodland Complex	E			16.16	0	0.0
Riverine Grassy Woodland/Riverine Sedgy Forest/Wetland Mosaic	D			4.48	15.34	342.4
Rocky Outcrop Shrubland/Herbland Mosaic			D	1.91	1.91	100.0
Sand Ridge Woodland	E			293.31	0.01	0.0
Spring Soak Woodland			E	8.73	1.73	19.8
Unclassified Lunette Woodland	E	E		13.34	0	0.0
Valley Grassy Forest			E	59.29	5.20	8.8
Wetland Formation	E	E	E	320.24	1.14	0.4
TOTAL				119280	2129	1.8 %

* MF = Murray Fans; RIV = Victorian Riverina; NIS = Northern Inland Slopes

In the Goulburn Broken catchment only 30% of native vegetation remains. McLennan *et al.* (2004) state that the majority of the remaining native vegetation in the Murray Fans, Victorian Riverina, Goldfields and Central Victorian Uplands bioregions is threatened. The Victorian Riverina Bioregion is considered one of the most extensively cleared in Australia with only 7.2% of its pre-European vegetation remaining (GBMCA 2003 b – Native Veg plan).

The number of threatened and endangered EVCs for the three bioregions found in the Planning Area is shown in Table 9. Also shown is the percentage of the remaining vegetation that is reserved.

Table 9: Number of EVCs of conservation significance by bioregion. (adapted from GBCMA 2003b).

Bioregion	Number of EVCs and status	Area remaining ha	% remaining of pre European	Area in reserves	% reserved of remaining ha
Murray Fans	22E	5313	3%	540	10%
	2V	456	7%	329	72%
	2D	39144	58%	6360	16%
	1LC	2039	89%	1333	65%
Victoria Riverina	42E	11723	2%	1780	15%
	9V	3269	16%	253	8%
	2D	5719	69%	605	11%
	1LC	22	10%	15	68%
Northern Inland Slopes	19E	1342	2%	303	23%
	2V	2279	9%	291	13%
	3D	418	67%	329	79%
	3LC	5951	69%	3364	57%

E = endangered, V = vulnerable, D = Depleted, LC = Least Concern

3.2.2 Ecological Functions

The remnant native vegetation in the Planning Area adjoins, regularly influences or is influenced by the Broken, Boosey and Nine Mile Creeks and as such is either riparian (directly along the stream banks) or floodplain vegetation. Native riparian vegetation is important to the health of a waterway as it provides:

- Organic matter, a major food source for in-stream plants and animals.
- Essential in-stream habitat for many fish and invertebrates in the form of woody debris and roots.
- Stability to banks, minimising erosion.
- Shade, which protects in-stream plants and animals from temperature extremes. This is important, as many native in-stream plants and animals are sensitive to wide fluctuations in temperature. Shade can also control the growth of nuisance aquatic plants, including blue-green algae.

In addition, native riparian and floodplain vegetation traps and filters sediment and nutrients from catchment run-off, thereby helping to protect and improve water quality in wetlands and streams. Intact riparian vegetation is also an important part of the terrestrial landscape. Riparian and floodplain vegetation:

- Acts as a refuge in dry times, when it may be the only place where plants have new growth, flowers or are producing seed – so it can be an important source of food;
- Is often the only reasonably healthy remnant of native vegetation in catchments which have been largely cleared, giving it special importance to biodiversity; and
- Acts as a wildlife corridor linking habitats, especially in cleared catchments.

However, the capacity of riparian and floodplain vegetation to perform the ecological functions outlined above will depend on its width, connectivity and condition (Section 5).

3.3 Flora and Fauna Species

3.3.1 Vertebrate Fauna

A total of 433 species of vertebrate fauna have been recorded in the Goulburn Broken catchment inclusive of mammals, birds, reptiles, fish and amphibians. Of these 92 species are recognised as being threatened with extinction in Victoria and 17 threatened with extinction at a national level (Table 11). Threatened is a general term used to flag a species whose survival is considered to be at risk. In general the term threatened encompasses a number of threat categories. The categories differ at the national, state and international levels. In addition, the threat categories used at the state level for fauna (Table 10) differ to those used for flora.

Table 10: Threat categories used in Victoria (from GB CMA website accessed March 2006)

Threat Category	Definition
Extinct:	A taxon is Extinct when there is no reasonable doubt that the last individual has died.
Critically Endangered:	A taxon is Critically Endangered when it is facing an extremely high risk of extinction in the wild in the immediate future.
Endangered:	A taxon is Endangered when it is not Critically Endangered but is facing a very high risk of extinction in the wild in the near future.
Vulnerable:	A Taxon is Vulnerable when it is not Critically Endangered or Endangered but is facing a high risk of extinction in the wild in the medium-term future.
Lower Risk:	A taxon is Lower Risk - near threatened when it has been evaluated, does not satisfy the criteria for any of the threatened categories, but which is close to qualifying for Vulnerable. In practice, these species are most likely to move into a threatened category should current declines continue or catastrophes befall the species.
Data Deficient:	A taxon is Data Deficient when there is inadequate information to make a direct or indirect assessment of its risk of extinction based on its distribution or population status. Listing of taxa in this category indicates that more information is required and acknowledges the possibility that future investigation will show that a threatened classification is appropriate.

Table 11: Summary of threatened vertebrate fauna under the Victorian classification in the Goulburn Broken Catchment (from GB CMA website accessed March 2006; http://www.gbcma.vic.gov.au/default.asp?ID=120)

Threat Category1	Birds	Mammals	Reptiles	Amphibians	Fish	Total
Extinct	0	2	0	0	0	2
Critically Endangered	5	1	0	2	3	11
Endangered	19	5	2	0	1	27
Vulnerable	17	3	3	2	3	28
Lower Risk	6	2	1	0	0	9
Total Threatened	47	13	6	5	7	77
No. of species in catchment	282	51	57	24	19	433
% threatened	17%	25%	11%	17%	37%	18%
Data Deficient	6	3	1	1	4	15

Within the Planning Area there are 65 species of vertebrate fauna considered threatened at the State level (Table 12; Appendix Table A1). This equates to 71% of the regional threatened species. Of these, 39 (waterbirds, fish and amphibians) can

be considered directly dependant on the wetlands and streams of the Planning Area. The majority of the remaining threatened species, although terrestrial by habit are predominantly dependent on the vegetated habitat within the floodplain of the Broken Boosey and Nine Mile Creeks (Figure 2).

Table 12: Victorian conservation status (VROTS) of vertebrate fauna in the Planning Area. Numbers in parenthesis indicates if listed under the FFG Act.

Threat Category	Birds	Mammals	Reptiles	Amphibians	Fish*	Total
Critically endangered	3 (3)					3
Endangered	10 (10)	2 (2)	1 (1)	1 (1)		14
Vulnerable	17 (11)		1			18
Lower Risk	16 (3)	1	1			18
Total threatened	46	3	4	1	11	65

* threatened fish from McGuckin, 1997.

Table 13**:** Federal and State listed species in the Planning Area by taxon.

Threat Category	EPBC/AROTS	VROTS	Listed FFG
Birds	3	22	15
Water birds	1	26	13
Mammals	1	3	2
Amphibians	1	2	1
Reptiles		4	1
Fish	2	11	5

3.3.2 Flora

There are 2105 vascular and nonvascular plants that have been recorded within the Goulburn Broken Catchment. Of these 217 are recognised as threatened at the State level. Planning Area supports 43 plants that are considered threatened at the State level (Appendix Table A2), 20% of the threatened species at the regional level. These include the following aquatic macrophytes that are directly dependent on the wetlands and streams of the Broken, Boosey and Nine Mile Creeks:

- *Callitriche cyclocarpa*(Western Water-starwort);
- *Callitriche umbonata*(Winged Water-starwort);
- *Eleocharis pallens* (Pale spike-sedge);
- *Myriophyllum gracile var. lineare* (Slender Water-milfoil);
- *Myriophyllum porcatum* (Ridged Water-milfoil); and
- *Triglochin dubia* (Slender Water-ribbons).

In addition, the majority of the remaining threatened taxa have been recorded in the riparian zone of the streams or wetlands of the Planning Area (Figure 3).

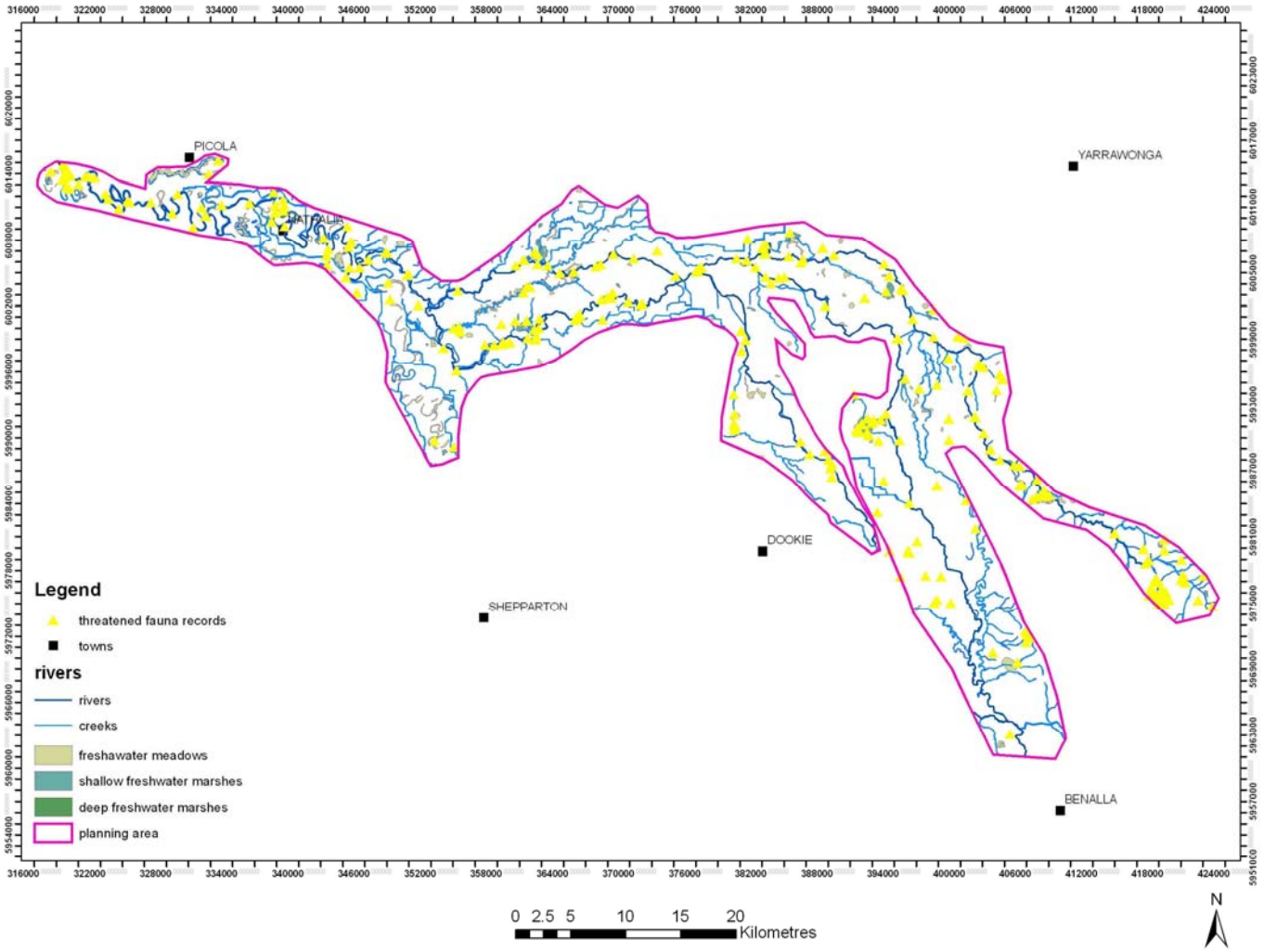

Figure 2: Threatened fauna recorded within the Planning Area.

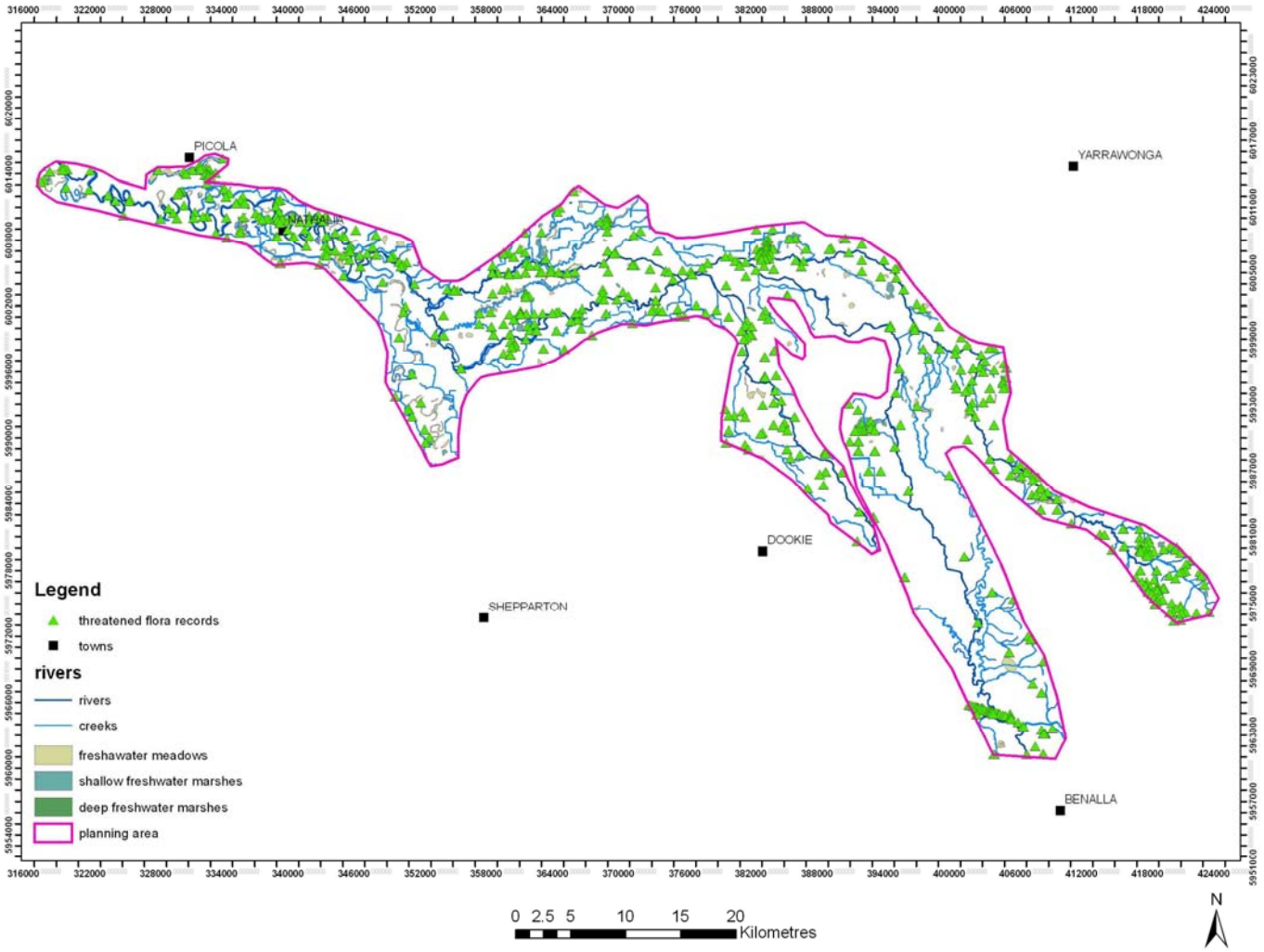

Figure 3: Threatened flora recorded within the Planning Area.

3.3.3 Ecological Functions of Flora and Fauna

Flora and fauna species perform important functions necessary to maintain the health of ecosystems. These functions include:

- pollination;
- pest control;
- dispersal of seeds and translocation of nutrients; and
- maintenance of genetic resources.

Flora and fauna species also provide for many recreational, educational and scientific pursuits.

4. Threats to Ecological Values

The Goulburn Broken Regional Catchment Strategy (2003) provides the framework for the description and assessment of threats in the region (Figure 4). This framework separates threatening activities from the threats they induce and the impacts caused to the natural assets. By identifying the activities that contribute to the threats rather than focussing on the induced threats themselves, the causes of impacts to natural assets are made clear. This in turn provides clarity for the management of natural resources by focussing management actions on tangible threatening activities. For example, erosion may be identified as a threat for wetlands in the Planning Area. However, management actions cannot be targeted at erosion without some understanding of why erosion is taking place. By identifying the threatening activities that could contribute to erosion (eg stock access and vegetation clearing) management actions can be targeted at these threatening activities and reduce the impact to the wetland.

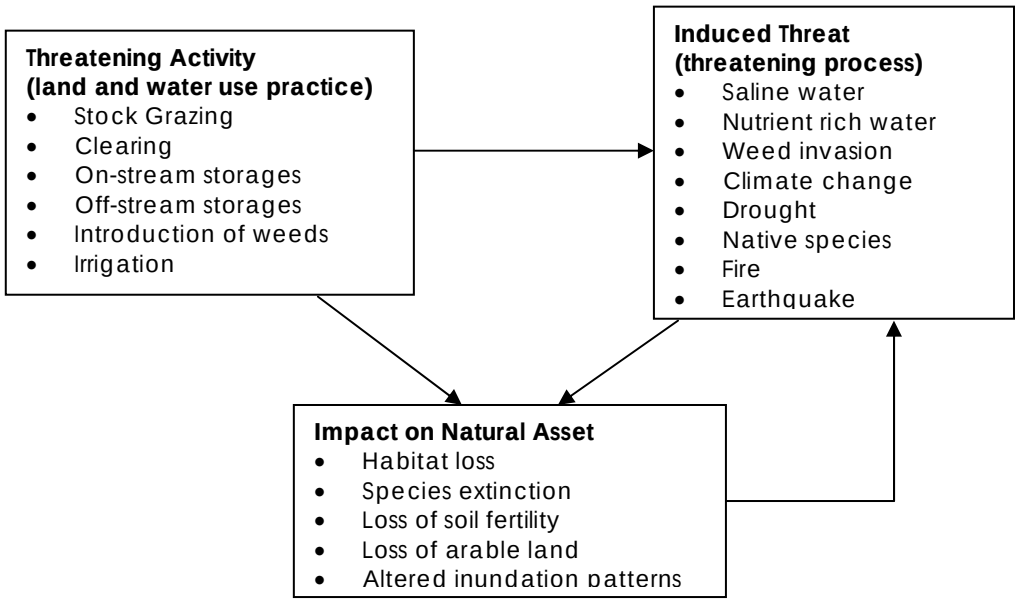

Figure 4: Relationships between threatening activities, induced threats and impacts (Goulburn Broken CMA, 2003).

4.1 Threatening Activities

Threatening Activities are land and water use practices that can have a deleterious effect on natural assets either directly, or indirectly via induced threats (Section 4.2). The Goulburn Broken Regional Catchment Strategy (2003) identifies 21 threatening activities. Those most relevant to the wetlands within the Planning Area have been described below in terms of extent and where possible, trend. Related induced threats and consequent impacts to the ecological values of wetlands in the Planning Area are also discussed.

4.1.1 Clearing (Direct Native Vegetation Removal)

Extent

According to the mapping of Ecological Vegetation Classes (EVCs), there is only 1.8% of native vegetation remaining within the Planning Area. This means that nearly 98% of the native vegetation in the Planning Area has been cleared. However, EVCs are based on floristic communities, not single strata of vegetation and it is possible that there are remnants of vegetation that are not sufficiently structurally intact to be captured in the EVC process. This is supported by the aerial photography of the Planning Area and the tree density mapping (Figure 5). These show more extensive native vegetation coverage than the EVC mapping, much of which is associated with the streams and wetlands within the area (Figure 6).

Data for tree density indicate that 0.7% of the Planning Area is covered in dense trees, 3.7 % in trees of medium density and 6 % in scattered trees. This translates to approximately 90 % of the Planning Area being totally cleared on native vegetation.

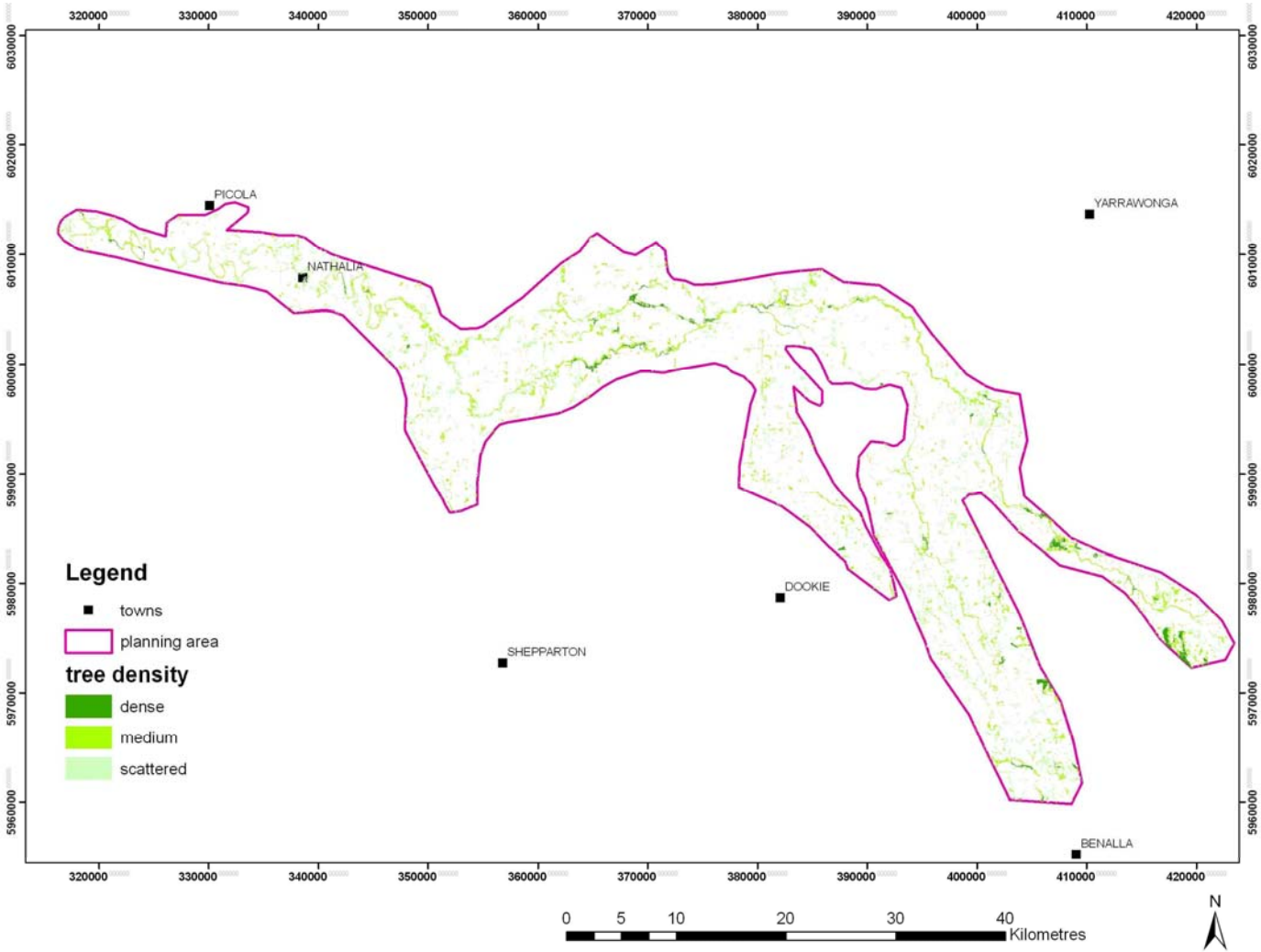

Figure 5: Tree density along the Broken, Boosey and Nine Mile Creeks (Tree Density 1: 25 000, DSE).

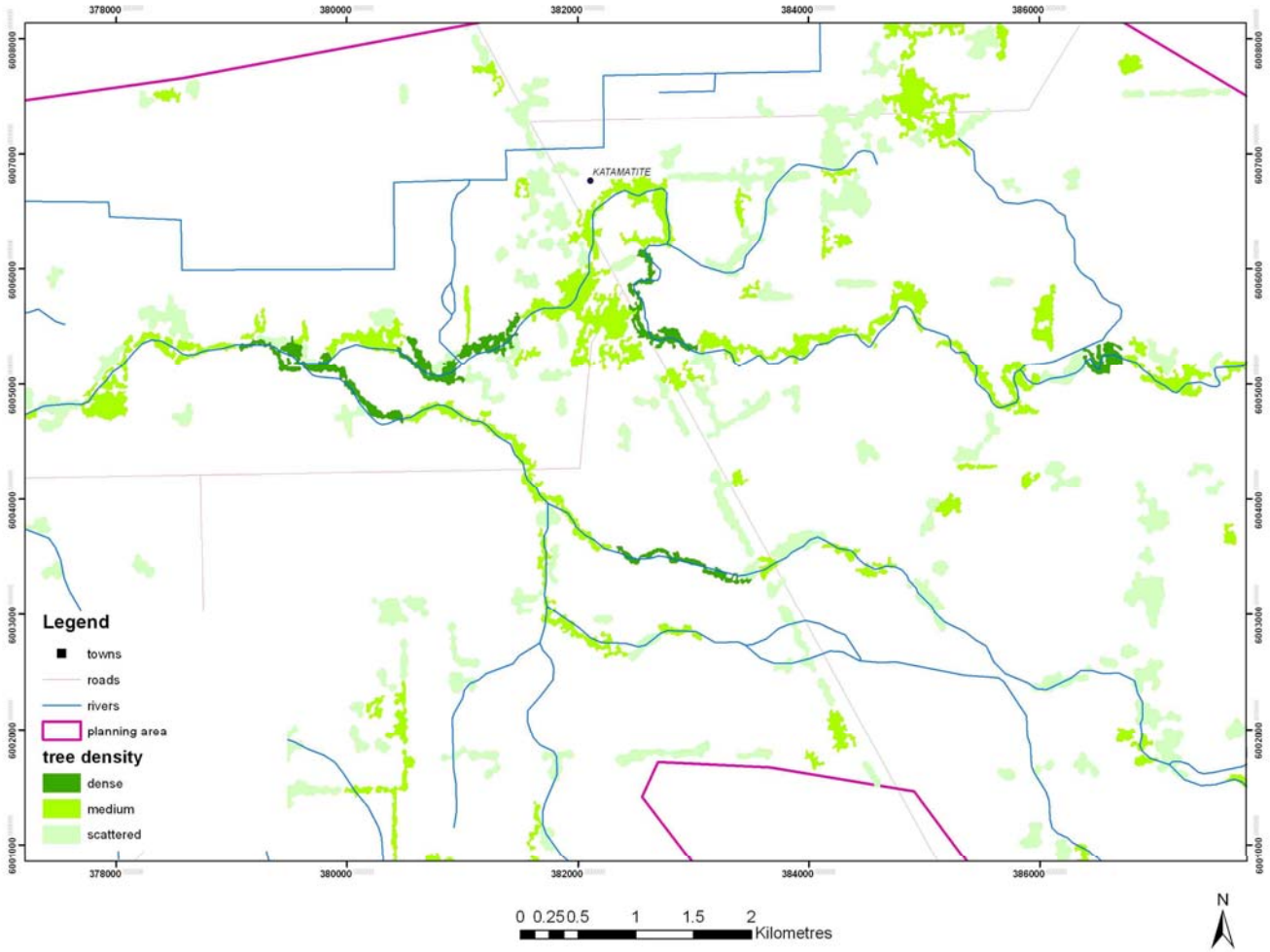

Figure 6: Tree density along the Broken and Boosey Creeks near Katamatite (Tree Density 1: 25 000, DSE).

Trend

The majority of the remaining vegetation within the Planning Area is contained within conservation areas and as such, is protected from further clearing. In addition, Victoria's Native Vegetation Management – a Framework for Action policy aims for a net gain in native vegetation through avoidance or minimisation of clearing and the use of off-sets in the event of actions that result in native vegetation loss. However, even with the protection of existing vegetation from further clearing, and the use of off-sets, there is evidence from with the Goulburn Broken Catchment that natural attrition (particularly of older hollow bearing trees) may be occurring at a faster rate than recruitment (DSE, Benalla, pers. comm.), thus threatening the remaining native vegetation in the Planning Area.

Impacts to Ecological Values

Clearing of native vegetation can lead to the following induced threats (whose impacts are discussed in section 4.2):

- Salinity – through the replacement of deep rooted, perennial vegetation with annual pasture grasses and crops, resulting in rises to the groundwater table.
- Decreased water quality – through a loss of buffer zones surrounding wetlands and subsequent increased inputs of nutrients and contaminants.
- Erosion and sedimentation– through increased velocity of run-off and loss of buffer vegetation resulting increased transport of sediments.
- Introduction of weeds – clearing of vegetation creates an opportunity for weeds to populate cleared areas and through a loss of buffer these can infiltrate into remnant vegetation patches, displacing native species.

Clearing of native vegetation also has direct impacts on the ecological values of wetlands within the Planning Area. The most obvious of these is the direct loss of wetland vegetation including threatened flora species. This represents a loss of feeding and breeding habitat for wetland fauna and potential localised species extinctions. A corresponding loss in habitat diversity is to be expected and this is reflected in the complete loss of nearly half the pre European EVCs. The effect on the viability of flora and fauna populations within the Planning Area is not known, but given the high extent of clearing severe impacts would be expected.

In addition, the pattern of clearing has resulted in linear remnant native vegetation patches along the streams of the Planning Area with isolated patches also around remaining discrete wetlands.. This may mean that fauna species, such as water birds, may not find sufficient habitat to meet all their lifecycle needs (breeding, roosting, feeding) within the Planning Area. Also, habitat fragmentations can result in changes to microclimate, barriers to faunal movements and increased opportunity (through edge effects) for the impacts of other disturbances (eg weed invasions, recreational access; predator access).

4.1.2 Stock Grazing

Extent

Approximately 45% of the Planning Area has been defined as pasture with a small fraction of this defined as grazing native vegetation (Figure 7). Grazing is permitted in the Natural Features Reserves and the Broken Boosey State Park with 17 grazing licences covering 160 ha or 16% of the reserves (Parks Victoria, 2005). However, only half of the reserves area is fenced and therefore not grazed and the remaining land is grazed either legally with a permit or illegally. Robinson and Mann (1996) stated that 82% of the remnant vegetation along the Broken, Boosey and Nine Mile Creeks was subject to grazing impacts from both licensed and illicit grazing. The RIVERS database (as cited in URS, 2005) assigned the highest threat value ranking to stock access in Broken and Nine Mile Creeks.

Ecos (2004) identified grazing as a Medium to High risk to the wetlands in the Planning Area. Approximately 1800 hectares (35 %) of the 1994 wetland aerial extent in the Planning Area has grazing as the designated primary landuse.

Trend

Although sheep and cattle are still important economic activities in the Planning Area there are now incentives for fencing of remnant vegetation and riparian zones. The Lower Broken Waterway Action Plan (SKM, 2005) identified 56 km of riparian zone along the Lower Broken Creek that requires fencing. Similarly, approximately 20km of the Boosey Creek have been identified as a high priority for fencing (SKM, 2001b). Progress towards constructing of this fencing has lead to a reduction in the area of the State Park and Natural Features Reserves that is subject to uncontrolled grazing (Parks Vic, 2005).

Investigations in other regions of Victoria have found that fencing to exclude stock, may not on its own result in improvements in native vegetation, but rather an increase in annual weeds (Tscharke, 2001). The Management Plan for the Broken Boosey State Park and associated Natural Features Reserves proposes the use of controlled grazing in accordance with the Performance Standards for Natural Features in the Shepparton Irrigation Region (Parks Victoria, 2005).

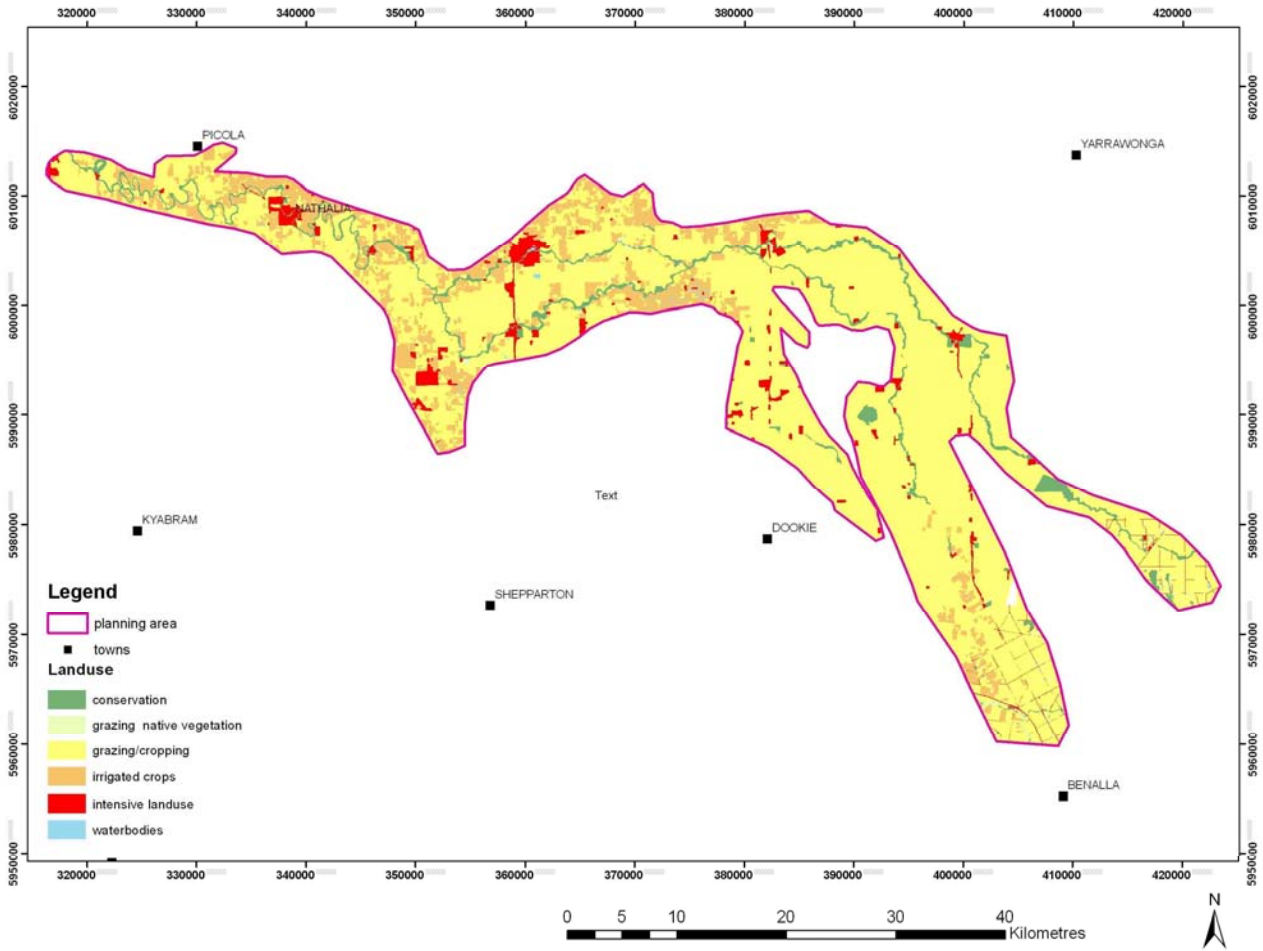

Figure 7: Landuse in the Planning Area (Landuse, 1: 250 000, DSE).

Impacts to Ecological Values

Grazing can lead to the following induced threats (whose impacts are discussed in section 4.2):

- Decreased water quality – through direct input of nutrients via faecal material and via increases in turbidity due to trampling of riparian zones.
- Erosion and sedimentation– through trampling of banks and riparian zones.

Robinson and Mann (1996) also cited the following direct impacts of grazing on the native vegetation in the Planning Area:

- significant reduction in plant biomass and litter;
- significant changes in grass species composition;
- significantly fewer shrubs;
- significantly more bare ground, pugging and active soil erosion;
- significantly less lignum; and
- significantly less regeneration of young trees.

This can lead to localised flora species extinctions (through direct ingestion and trampling) as well as loss and degradation of habitat for native fauna.

4.1.3 Cultivation Cropping and Pasture Management

Extent

Between 90 and 98% of the Planning Area has been cleared and the majority of this is now cropped or pasture for grazing (Figure 7). Only 14 of the 167 wetlands in the Planning Area (1994 layer) are contained in conservation reserves. The remaining 153 wetlands are utilised for pasture and / or cropping. Evidence from the 2002 aerial photography indicates that many wetlands (particularly fresh water meadows) have been converted to pasture or crop. There is however, no comprehensive listing of current wetland area.

Trend

Although the proportion of land within the Planning Area utilised for agricultural purposes is unlikely to change significantly in the medium term future, there have been improvements in land management practices that have lead to a decreased effect on wetlands (eg reduced chemical discharge to receiving water bodies).

Impacts to Ecological Values

Cropping and pasture management can lead to the following induced threats (whose impacts are discussed in section 4.2):

- Decreased water quality – through runoff of fertiliser and other agricultural chemicals.
- Introduction of weeds and pest animals– agricultural escapees.

Cropping and pasture management have both an effect as adjoining land use to wetland areas, and by the use of wetlands as crop beds and pasture. This can lead to habitat loss (by the removal of native vegetation, and alteration to wetland beds) and potentially localised species extinctions.

4.1.4 Irrigation and Surface Water Extraction

Extent

The streams within the Planning Area are part of a regulated river system and water is extracted from the Broken, Boosey and Nine Mile Creeks for irrigation as well as stock and domestic purposes. Water diversion entitlements total approximately 34,000 ML per year (URS, 2005). The creek systems are used for water delivery, with peak extractions during summer and autumn months. Landuse in the Planning Area while

predominantly agricultural is only 16% irrigated with 8.5% irrigated cropping and 7% irrigated pasture (Figure 7). The majority of water diversion for irrigation purposes occurs downstream of Katamatite. Water is also extracted to meet urban requirements in Tungamah, Devenish and St James and for stock and domestic purposes upstream of Katamatite.

In addition to the extraction of water, irrigation practices also lead to the discharge of drainage water to the streams and wetlands in the Planning Area. There are both government owned drainage –systems (managed by Goulburn Murray Water), private drainage schemes and roadside drainage (managed by local municipalities) that discharge to the streams in the Planning Area.

Trend

Although there have not been decreases in water diversions, there have been improvements made to the water delivery systems (eg weir upgrades) that have decreased water leakage between Numurkah and Barmah on the Broken Creek. There have also been incentive schemes and planning initiative (such as whole farm plans) that aim for more efficient water use and therefore a decrease in water diversions.

In addition the Tungamah pipeline has been approved and construction has commenced, which will result in significant water savings in the district (Goulburn Murray Water, 2006a). This will also return more natural flow patterns to the Boosey and upper Broken Creeks. The subject of environmental flows in this system is currently being investigated (GB CMA, pers. comm.).

Impacts to Ecological Values

Surface water extraction predominantly impacts the ecological values of wetlands through the following induced threats (whose impacts are discussed in section 4.2):

- Salinity – through inputs from irrigation drainage.
- Decreased water quality – through inputs from irrigation drainage.
- Erosion and sedimentation– by using the streams as delivery channels, altering natural flow patterns and leading to changed patterns of erosion and deposition not only in channel but on adjoining floodplain areas.
- Changed flow and inundation patterns – by using the streams as delivery channels and altering seasonality of flow and by extraction of large volumes of water.

4.1.5 Groundwater Extraction

Extent

Groundwater is extracted from two major aquifers in the Planning Area, the deep, freshwater Katunga system and the shallower, higher salinity Shepparton formation. Extraction for irrigation purposes occurs under licence agreements and is metered by Goulburn Murray Water, while extraction for stock and domestic purposes is freely permitted (Goulburn Murray Water, 2006b).

Trend

Historically, groundwater extraction has not been closely monitored and over extraction has lead to a decrease in groundwater levels and water quality (DPI, 2004). However, a management plan for the Katunga system has been drafted (Goulburn Murray Water, 2006b) and aims to minimise impacts to the water quality and levels of the aquifer. The Shepparton management plan (Goulburn Murray Water, 2005), however, is managed to protect the overlying landscape (agricultural and native vegetation) from the effects of rising saline groundwater. It is anticipated that through the implementation of these plans effects on groundwater levels and quality can be managed is a sustainable manner.

Impacts to Ecological Values

The wetlands within the Planning Area are surface water fed and so not likely to be significantly impacted by groundwater extraction. However, there are concerns that a lowering of the groundwater table or a change in groundwater quality may impact the deep-rooted vegetation, such as the Grey Box communities along the floodplains of the Broken, Boosey and Nine Mile Creeks (Robinson and Mann, 1996).

4.1.6 Firewood Gathering / Snag Removal

There is little information available on the removal of timber or snags from wetlands within the Planning Area. Although there is some data on large woody debris for the in-channel habitat of the Planning Area (SKM, 1997 and SKM, 2005) the only mention of the removal of timber from wetland and floodplain areas is a reference in the Broken Boosey State Park Draft Management Plan (Parks Victoria, 2005) which mentions that firewood is often inappropriately removed by campers.

Large woody debris provides habitat for native fish, amphibians and macroinvertebrates as well as providing a source of organic debris for wetland system functioning. Its removal can lead to loss of habitat for fauna as well as a disruption of ecological processes.

4.1.7 Culverts, Regulators and On-Stream Storages

Extent

There are 48 weirs along the creeks within the Planning Area (Figure 8). In addition, 32 km of the Broken and Nine Mile Creeks have been subject to modifications such as straightening and bed deepening (URS, 2005) and excavated pools (pump holes and stock watering holes) are features along the waterways of the middle and upper catchment (SKM, 1997). In addition, the inflow and outflow of a number of the discrete wetlands in the Planning Area are regulated by culverts or weirs, both government owned and managed (eg Kinnairds, Moodies Swamps) and on private property.

Trend

There have been upgrades to structures along the Broken Creek with the replacement of eight weirs on the Broken Creek downstream of Katamatite with SCADA controlled gates and fish ways. In addition, the weirs upstream of Katamatite on the Broken and Boosey Creeks are currently being de-commissioned, significantly decreasing barriers to flow and fish passage.

Impacts to Ecological Values

Culverts, regulators and on-stream storages impact significantly on the habitat value of stream environments. However, this implementation plan is concerned with the impacts to wetlands in the Planning Area. Structures that regulate water movement in streams also impact on the inundation patterns of associated wetlands (see section 4.2).

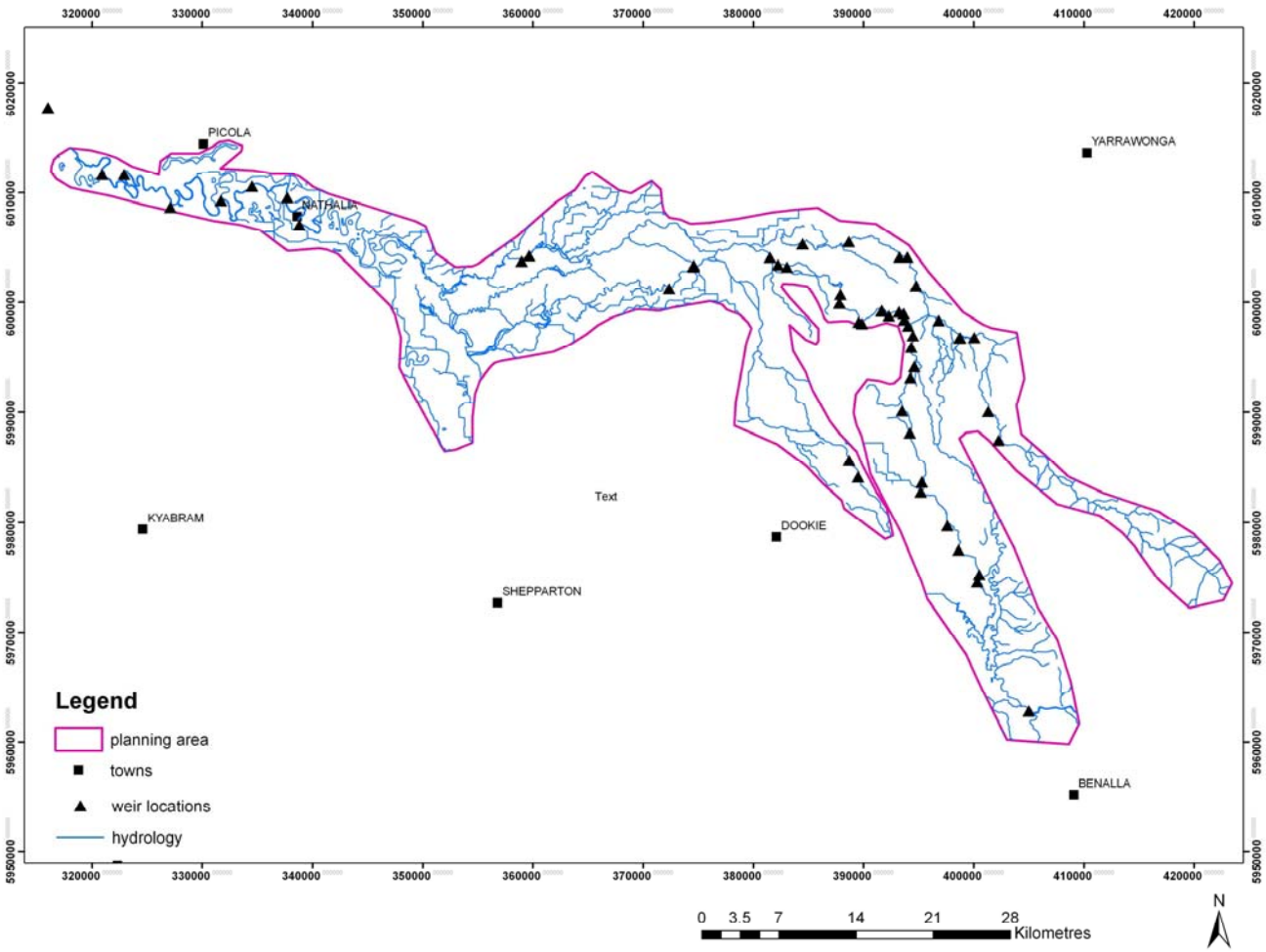

Figure 8: Locations of weirs within the Planning Area.

4.1.8 Off-stream Storages

There is no quantitative information on the numbers of dams within the Planning Area. Some of these are converted wetlands as there are now 21 permanent wetlands within the Planning Area on the Wetlands_1994 mapping, where none naturally occurred. In addition to the physical alteration of wetlands, farm dams capture overland flow that would natural find its way to the wetlands rivers and creeks. In this manner flows and flooding are reduced and natural cycles of inundation disrupted (see section 4.2).

4.1.9 Levees and Floodplain Development

Extent

There is no quantitative information on the levees and floodplain development to enable a description of current extent and trends (URS, 2005). However, the topography in the study area is relatively flat and in order to protect agricultural and urban assets, there have been a number of levees, channels, raised roadways and bridges constructed.

Trend

Although there is no comprehensive program to remove levees, there are measures in place, within the Planning Area to prevent further barriers to lateral connectivity ion the floodplain. The Floodplain Management Guidelines for Whole Farm Plans Within the Shepparton Irrigation Region (SKM, 2003b) provide best practice guidelines for the protection of floodplain habitat.

Impact to Ecological Values

Levees and floodplain development have had the effect of isolating wetlands and floodplains from the river, changing inundation patterns for floodplain and discrete wetlands and disruption to the movement of organic material to and from rivers and floodplains areas (Goulburn Broken CMA, 2002a). This can result in direct impacts to inundation dependant vegetation, a loss of wetland habitat for floodplain fauna, reduced habitat connectivity (for aquatic fauna such as native fish) and potential disruption to lifecycle cues (for example for waterbirds that rely on inundated trees for breeding).

4.1.10 Effluent Disposal

There are three sewage treatment ponds within the Planning Area, two at Numurkah and one at Nathalia. These systems have wastewater treatment facilities and although a proportion of the water is reclaimed and used for irrigation purposes, a percentage reaches the streams of the Planning Area. The remainder of the towns within the Planning Area operate on septic systems. In addition, there are approximately 10 large intensive animal production facilities and a number of dairy farms. All of these contribute to the induced threat of decreased water quality, with increased nutrient loads to aquatic environments.

4.1.11 Recreation

Recreational activities have the potential to impact on wetlands and vegetation within the Planning Area. The Broken Boosey State Park Management Plan (Parks Vic, 2005) lists a number of recreational activities that will need to be managed to minimise impacts within the reserves including:

- vehicle access (off track damage to vegetation);
- camping (litter, fire, removal of woody debris);
- fishing (litter, discarded line impacts, impacts to native fish populations);
- cycling (litter, off track damage);

- dog walking (waste, impacts to native animals);
- hunting (litter, lead shot, impacts to native birds and animals); and
- horse riding (waste, weed dispersal, off track damage to vegetation)

4.2 Induced Threats

Induced threats are processes via which threatening activities can impact indirectly on natural resources. Induced threats are often processes that would occur naturally but have been accelerated by threatening activities. Therefore, natural processes such as the effect of drought and climate change are included (Goulburn Broken CMA, 2003).

4.2.1 Salinity

Extent

Salinity has not been identified as a current problem within the Planning Area (Parks Vic, 2005; URS, 2005). The depth to groundwater mapping (Figure 9) supports this, with groundwater 10 – 20 m below the surface over 22% of the Planning Area and 5 – 10 m over 77% of the area. This is also supported by salinity measurements within the streams, which currently meet State Environment Protection Policy (SEPP) objectives (URS, 2005).

Trend

Despite the current conditions, salinity is of concern in the region, the water table on the Riverine Plains is rising and 45% of the Shepparton Irrigation Region is underlain by shallow water tables (URS, 2005). Rising groundwater tables and salinity is being addressed at the catchment scale through the Goulburn Broken Dryland Salinity Management Plan (Goulburn Broken CMA, 2002b).

Impacts to Ecological Values

Increased salinity can affect discrete wetland type, resulting in a shift from freshwater to saline wetlands with associated changes in flora and fauna species. In addition salinisation of floodplain areas can lead to a loss of floodplain flora, with deep rooted plants often the first affected. However, to date, these type of changes have not been recorded within the Planning Area.

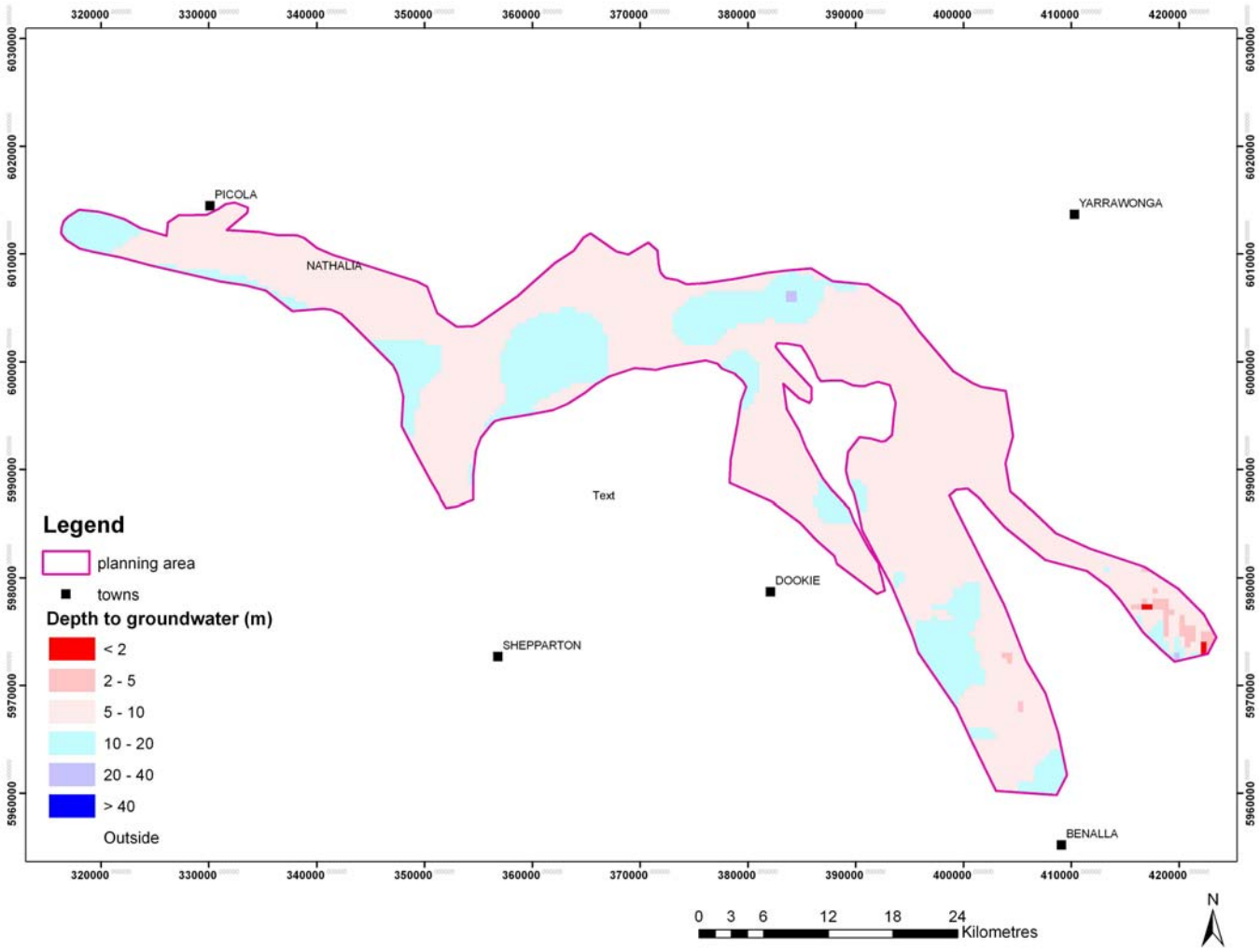

Figure 9: Depth to groundwater in the study area.

4.2.2 Water Quality

Extent

There is little direct information on the water quality within wetlands in the Planning Area. However, water quality in the streams of the Planning Area is considered a significant threat (URS, 2005). Turbidity and nutrient concentrations are extremely high and do not meet SEPP objectives. As the wetlands in the Planning Area are predominantly filled from the water in these streams it is likely that there are also nutrient and turbidity issues in some of these wetlands, particularly those that are now permanently inundated. As most of the wetlands and floodplain areas would naturally fill during times of high stream flow, it is unknown if this would represent more dilute concentrations of nutrients and suspended material in water reaching wetlands.

In addition to water quality influences from stream flow, it is likely with the high degree of grazing within wetland beds and floodplain areas combined with the low native vegetation buffer remaining in the Planning Area, would result in an increase in nutrients, suspended sediments and potentially contaminants such as pesticides and herbicides in wetland sediments. A portion of which is likely to become suspended or dissolved into the water column upon filling resulting in reduced water quality

Trend

SKM (2004) undertook a water quality trend analysis for the nutrients in the irrigation drains of the Shepparton Irrigation District, which included Broken Creek at Rices Weir. This indicated a downward trend for total nitrogen and an extreme upward trend for total phosphorus. However, there has been no survey of wetland water quality within the Planning Area and as such it is difficult to determine trends. In addition, the intermittent nature of wetlands makes water quality measurements difficult to interpret. Natural patterns of low concentrations of nutrients and salt upon filling, followed by concentration effects as wetlands dry out would be expected. Long term datasets over ranges of wetland inundation are required to determine trends. Alternatively, surrogates such as the effect on macroinvertebrates or diatoms can be used as indicators of eutrophication and or contaminants.

Impacts to Ecological Values

Decreased water quality, such as increased nutrients can lead to eutrophication, algal blooms, changes in zooplankton and macroinvertebrate communities and consequent deoxygenation and fish deaths in wetland environments. However, in intermittent wetland systems it is often difficult to separate anthropogenic effects from naturally occurring concentrations and blooms. In the absence of information on wetlands in the Planning Area, conclusions on the effects of water quality degradation cannot be made.

4.2.3 Erosion

Extent

Ecos (2004) in their assessment of risks to wetlands of the Goulburn Broken Catchment did not identify erosion as a high risk for the wetlands within the Planning Area. Similarly, bank erosion is not considered a major concern in the Broken or Nine Mile Creek systems (SKM, 1997; URS, 2005) with only minor erosion of riparian zones at stock access locations (SKM, 2005). An exception to this is the Boosey Creek upstream of the Back Creek confluence where clearing of native vegetation has lead to increased run-off and stream velocities resulting in severe bank erosion (SKM, 2001b).

Trend
With erosion not identified as a significant threat to the wetlands in the Planning Area, there is little information on trend. However, one of the major contributors to soil disturbance and erosion in wetland system is stock access, particularly cattle that will walk through wetlands during when inundated, causing deep pugging. The movement towards controlled grazing where animals would be excluded from wetland and floodplain areas during periods of inundation will help to improve the condition of wetland sediments.

Impacts to Ecological Values
Impacts of erosion on wetlands can occur in two ways – via removal or alteration of the sediment within the wetlands, or by the deposition of sediment transported in inflow water as a result of upstream erosion. Changes in sediments within a wetland due to trampling by cattle, people or vehicles can lead to a disturbance of nutrient cycling and benthic organisms. Increased sedimentation can lead to changes in bathymetry and a reduction of wetland depth or extent. There is however, little information available on these processes for wetlands within the Planning Area. Results from the wetland condition assessment (Section 5) indicated highly variable soil conditions across the wetlands assessed.

4.2.4 Changed Flow and Inundation Patterns

Extent
Irrigation practices have altered the natural flow patterns in the streams of the study area. Cottingham *et al*. (2001) reported that diversions in Broken Creek have the following effects:

- a reversal of the seasonal flow pattern (with peaks now in summer);
- an elimination of cease to flow periods (in what was once an intermittent system); and
- substantially increased flows year round (in the upper reaches).

Although overbank flows have not been substantially modified by stream regulation, structural barriers such as levees have limited the flooding of both the floodplains and many of the discrete wetlands. Conversely, a number of discrete wetlands received more water than natural, with the impoundment of discrete wetlands for use as water storages.

Trend
The Tungamah pipeline will result in a decrease in the use of the upper Broken, Boosey and Nine Mile Creeks as water delivery systems and a removal of a number of instream barriers. This will result in a more natural wetting and drying cycle in these systems and reinstatement of cease to flow periods. It is anticipated that wetlands associated with these sections of the streams will also revert to more natural patterns of inundation (SKM,2001b and 2003a).

In addition, the environmental water requirements for the Broken, Boosey and Nine Mile Creeks are currently being investigated. It is strongly recommend that the inundation requirements of the floodplain and associated discrete wetlands be included in this process.

Impacts to Ecological Values
It is the presence of water that distinguishes wetlands from terrestrial systems and wetland hydrology is likely to be the single most important determinant for wetland type and extent (Mitsch and Gosselink, 2000). Wetland hydrology is comprised of inundation frequency, duration and seasonality and it is on this basis that wetlands are classified in Victoria (Table 14). Wetland hydrology determines characteristics

such as sediment type and processes and biota. Wetland flora and fauna are generally adapted to a specific hydrological regime and pattern of inundation. Alteration of this can lead to changes in wetland type and extent as well as loss of habitat for wetland biota and ultimately localised species extinctions.

Wetland hydrology in the Planning Area was once strongly tied to the hydrology of the streams. While that may be true for the floodplain areas immediately adjacent to stream banks, many of the discrete wetlands have become isolated by levees. This may be a contributing factor in the observed loss of wetland type and extent. In addition, the increase in permanent wetlands, while providing some habitat for a limited number of fauna (such as ducks) may be having impacts to the ecological values of these wetlands. There is evidence that increasing inundation periods can lead to a decrease in plant species richness, an inhibition of the breakdown of organic matter and decreased habitat values for aquatic fauna (DSE, 2005).

The increase in permanency of the streams within the Planning Area has also raised concerns on the potential affect on floodplain vegetation. Robinson and Mann (1996) suggested that the increased duration of flow in streams has lead to an increase in waterlogged soil in adjacent areas and potentially a replacement of Grey Box communities with the more inundation tolerant River Red Gum. There is as yet no empirical evidence to support this, nor re the inundation requirements or tolerances of Grey Box well understood. As this floodplain vegetation lining the streams is the most significant native vegetation remaining in the Planning Area, and given the bioregional significance of these communities, management to ensure their long term sustainability should be afforded a high priority.

Table 14: Victorian wetland classification (Corrick and Norman, 1980). Only categories naturally occurring in the Planning Area are shown

Category	Hydrology
Freshwater Meadow	Water depth < 0.3m Inundation duration < 3months Season - inundated during winter
Shallow Freshwater Marsh	Water depth < 0.5m Inundation duration < 8months Season - fill in winter, dry by mid summer
Deep Freshwater Marsh	Water depth < 1 - 2m Inundation duration up to 2 years Season - fill in winter

4.2.5 Introduction of Weeds and Pest Animals

Extent

Remaining areas of native vegetation are surrounded by agricultural land that can act as a source of introduced flora and fauna. Flora surveys conducted along the riparian zones of Broken Boosey and Nine Mile Creeks recorded 120 weed species, 16 of which were regionally prohibited (Robinson and Mann, 1996). The most common exotic flora is introduced grasses and forbs (URS, 2005). Willows have also been identified as a pest species within the Planning Area (SKM, 1997) with extensive stands of willows recorded in the lower Broken Creek below Numurkah (SKM, 2005). An extensive survey conducted by the CMA during 2003 mapped the distribution of weeds along the waterways of the Planning Area. Major species relevant to aquatic environments were Arrowhead and willows.

Arrowhead (*Sagittaria graminea*) has been identified as a major pest species in the Planning Area with over 12 hectares of the species were recorded in Lower Broken Creek 2004 (SKM, 2005). Although native, Cumbungi (*Typha orientalis*) has been

recorded as a pest species in the creeks and azolla is considered a problem in the weir pools along the creek systems (Rees, 2006).

Terrestrial exotic fauna include rabbits and foxes, the later of which has impacted on native mammal and bird populations within the Planning Area (URS, 2005). In addition, five introduced fish species have been recorded within Broken Boosey and Nine Mile Creeks (Table 15).

Table 15: Introduced fish species recorded within the Planning Area (SKM, 1997)

Species	Broken Creek	Boosey Creek	Nine Mile Creek
Goldfish	✓	✓	
Carp	✓	✓	
Mosquito Fish	✓	✓	✓
English Perch	✓	✓	✓
Weatherloach	✓		

Trend

There is little information on the trends in weed and pest animal populations in wetlands within the Planning Area. However, there are programs in place to manage the aquatic weeds (particularly Arrowhead) in stream environments.

Impacts to Ecological Values

Introduced plants and animals can displace native species and cause substantial changes to the habitat values of a wetland. This can lead to a loss of habitat and localised species extinctions. However, the extent and severity of impacts to the ecological values of wetlands within the Planning Area is not known.

4.2.6 Drought / Climate Change

Extent and Trend

Climate change is occurring on a global scale and since 1900, Australia's average continental temperature has risen by 0.7 °C (Egis, 2002). It is predicted that this will rise up to 2 °C by 2030 with an associated decrease in rainfall (Egis, 2002).

Impacts to Ecological Values

Egis (2002) made the following predictions of impacts to biodiversity in the Goulburn Broken Catchment from climate change:

- favouring of pest animal and plant species which are opportunistic and highly adaptive;
- loss (extinction) of native species that are near their temperature or rainfall tolerances (particularly if habitat connectivity loss does not allow for migration);
- further loss of wetland and riparian habitat from decreased flooding;
- increased fragmentation and isolation of habitat; and
- loss of eucalypt species that are unable to cope with higher temperatures and lower rainfall.

In addition, as climate has a direct effect on wetland hydrology, it can be expected that changes increases in temperature (and associated increases in evaporation) together with decreases in rainfall may lead to loss of wetland extent and changes in wetland type. The wetland in the Planning Area are all naturally intermittent by nature and as many are disconnected from the streams by barriers to overland flow, may be reliant on rainfall for winter filling. Therefore a reduction in water due to climate change may have significant impacts.

5. Condition of Ecological Values

The condition of wetlands and vegetation within the Planning Area as detailed below is a product of both a desktop review of existing data and the results of a field investigation undertaken in March, 2006. A detailed field report is contained in Appendix B, which details methodology, results and interpretation of the data collected. This section contains a summary of these findings together with the results of the desktop review.

5.1 Wetlands

5.1.1 Previous investigations

There was little available information on the condition of wetlands within the Planning Area. Previous surveys and investigations were limited to the larger wetlands with conservation reserves (Kinnairds, Black, Moodie and Rowan Swamps).

DPI assessed the quality of the riparian vegetation of wetlands within the study area using a modified habitat hectares approach (DPI, in press). The results of this study (Table 16) indicate relatively low scores ranging from 6.5 to 13 out of a possible 20.

Table 16: Habitat quality scores for wetlands in the Planning Area.

Component	Black Swamp	Kinnairds	Purdies	Baxter Pit
Large trees	1	2	1	1
Canopy Cover	0.5	0.5	1	0
Understorey	2	2	2	2
Weediness	0	0	0	0
Recruitment	1	2	2	2
Organic Litter	1	1	1	0
Logs	0.5	0.5	0.5	0.5
Size	2	2	1	1
Neighbourhood	1	2	1	0
Core Area	1	1	0	0
Total Score	**10**	**13**	**9.5**	**6.5**

5.1.2 Results from Field Assessment

A total of thirteen wetlands were assessed during the field investigation (Figure 10). These included six Freshwater Meadows and seven Shallow Freshwater Marshes.

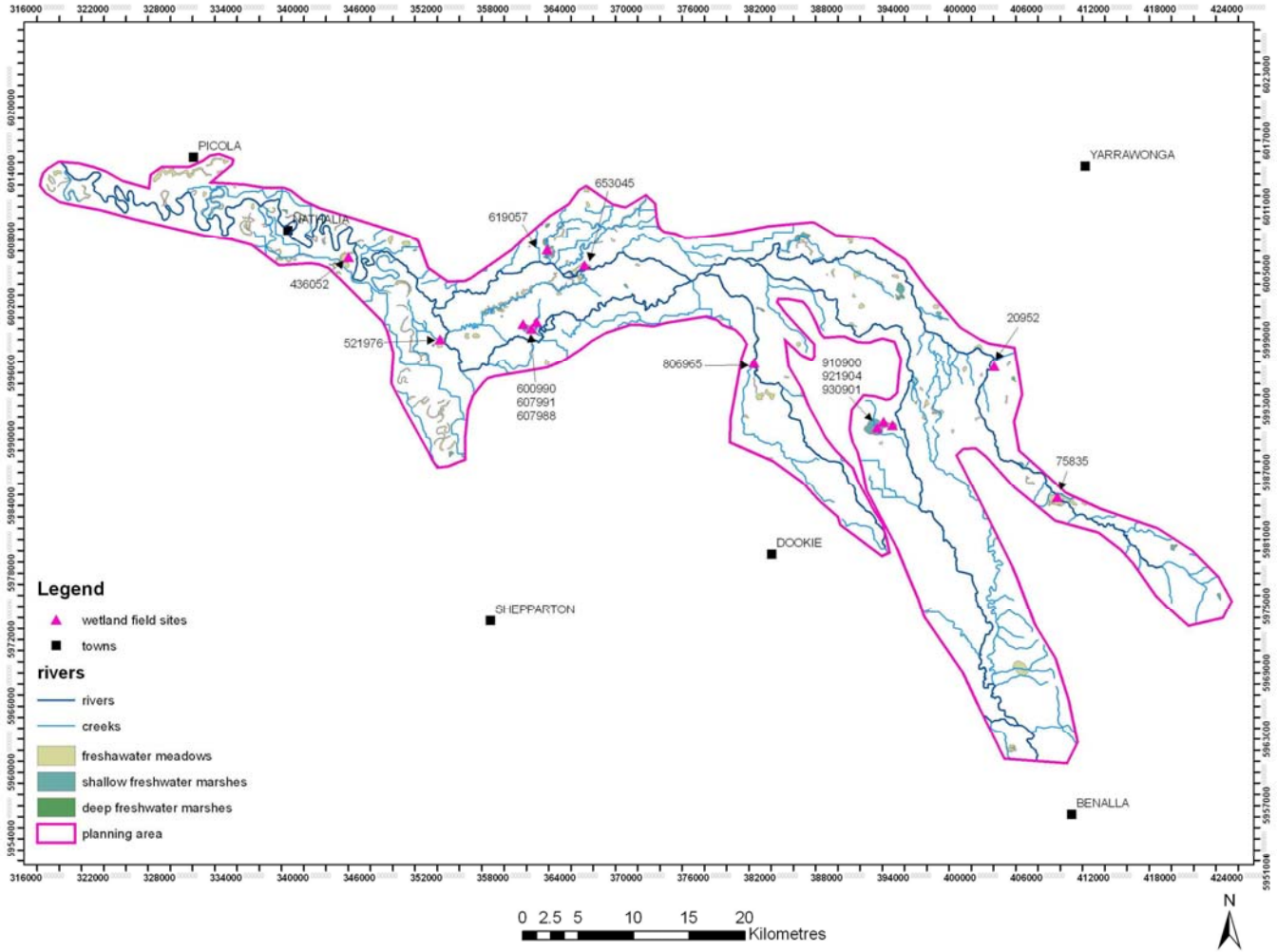

Figure 10: Locations of wetlands assessed.

Overall Condition

Scores generated in the IWC assessment are expressed as one of four categories of condition: Reference, Slightly Below Reference, Moderately Below Reference, and Well Below Reference. The thirteen wetlands generally rated quite well, according to the IWC, with four wetlands equivalent to Reference, and six being Slightly Below reference (Table 17). Although this is a positive result, there are qualifications that should be considered (see below).

Table 17: Results of IWC assessment

Category		Wetland Number & Name
Reference	4	7925 607991 Black Swamp 8025 910900 Moodies Swamp 8025 806965 8025 075835 Rowan Swamp
Slightly Below Reference	6	7925 436052 7925 619057 Kinnairds Swamp 7925 607988 7925 600990 Purdies Swamp 7925 653045 8025 020952 Lannigans Swamp
Moderately Below Reference	2	8025 921904 7925 521976
Well Below Reference	1	8025 930901
Total	13	

Note that three of the highest-condition category wetlands are all managed for conservation purposes (Table 18); in general, all of the assessed wetlands that are managed at least in part for conservation rated fairly well, being either equivalent to Reference or Slightly Below.

Sub Indices

As shown in the colour-coded summary table (Table 18), there are considerable differences between sub-indices. Catchment is consistently in poor condition, with eight wetlands being Moderately Below reference and two Well Below. It has a mean score of 9.2, which is equivalent to Moderately Below. Physical Form appears to be in consistently in better condition, being in Reference condition for 11 out of 13 wetlands; Physical Form has a mean score of 16.8 which is equivalent to Reference. Water Properties and Hydrology also rate poorly, with eight and ten wetlands respectively being Moderately Below. Their mean scores are 10.8 and 12.5, which are both equivalent to Slightly Below reference; the mean scores are pulled up because each SI also has three wetlands in Reference condition. Soils is quite variable and has a mean score of 11.1 which is equivalent to Slightly Below reference. Biota (vegetation) also appears to be in very good condition across the wetlands, being in Reference condition for seven wetlands. Biota has a mean score of 15.2, which is equivalent to Slightly Below reference. However, the interpretation of sub indices scores should be undertaken with caution (see Section 5 of Appendix B).

Table 18: Sub-Indices Scores (colour codes: green = reference; yellow = slightly below; orange = moderately below; red = well below).

Wetland	Catchment	Physical Form	Hyrdology	Water properties	Soils	Biota		OVERALL Category
436052								Slightly Below
619057								Slightly Below
607988								Slightly Below
600990								Slightly Below
607991								Reference
653045								Slightly Below
806965								Reference
910900								Reference
930901								Well Below
921904								Moderately Below
20952								Slightly Below
75835								Reference
521976								Moderately Below

Diversity of Wetland Vegetation

A total of thirteen wetland EVCs were used as benchmarks for these 13 wetlands, most for just one wetland (Table 19). Nearly all are of conservation significance.

Table 19: EVCs used as benchmarks for assessing wetland condition

EVC group	EVC Number	EVC Name	Used in this study	Status for Victorian Riverina
Wetlands	104	Lignum Wetland	1 wetland	Vulnerable
Riverine Grassy Woodlands or Forests	106	Grassy Riverine Forest	1 wetland	Depleted
Wetlands	125	Plains Grassy Wetland	1 wetland	Endangered
Wetlands	291	Cane Grass Wetland	1 wetland	Vulnerable
Wetlands	292	Red Gum Swamp	1 wetland	Endangered
Wetland	334	Billabong Wetland Aggregate	1 wetland	Endangered
	647	Plains Sedgy Wetland	1 wetland	Not Listed*
	653	Aquatic Herbland	1 wetland	Not Listed*
	810	Floodway Pond Herbland	1 wetland	Not Listed*
	815	Riverine Swampy Woodland	1 wetland	Not Listed*
Riverine Grassy Woodlands or Forests	816	Sedgy Riverine Forest	1 wetland	Endangered
Riverine Grassy Woodlands or Forests	817	Sedgy Riverine Forest / Riverine Swamp Forest complex	1 wetland	Depleted
Wetlands	819	Spike-Sedge Wetland	1 wetland	Rare

* Not listed = no status attributed.

5.2 Riparian Vegetation

5.2.1 Previous Investigations

There have been a number of investigations that have assessed the condition of the vegetation within the Planning Area, predominantly of the riparian zone (which contains the greatest amount of remnant vegetation).

Robinson and Mann (1996) conducted a comprehensive botanical survey of the riparian vegetation along the Broken Boosey and Nine Mile Creeks. Although their methodology did not measure condition according to a standardised methodology, they identified the following key sites within the Planning Area with significant remnant vegetation (based on significant species of plants or animals, patch size and structural integrity):

- Broken Creek near James Bridge (downstream of Nathalia);
- Broken Creek near Fairman's Bridge (downstream of Nathalia);
- Broken Creek near Carland's Bridge (upstream of Nathalia);
- Broken Creek near Galts Bridge (upstream of Nine Mile Creek);
- Numurkah Rifle Range;
- Wunghnu Common;
- Nine Mile Creek at Drumanure;
- Broken Boosey and Nine Mile Creeks between Dunbulbalane and Katamatite;
- Katamatite Bushland Reserve; and
- Boosey Creek between Lake Rowan and Katamatite.

Riparian vegetation has been assessed along the Broken, Boosey and Nine Mile Creeks using the Index of Stream Condition methodology. SKM (2001b) undertook assessments of riparian vegetation along the Boosey Creek using this methodology in 2001. This investigation also found vegetation in better condition on Crown Land than on unfenced private land holdings and a lack of woody understorey in most sites.

ISC assessments of riparian vegetation were undertaken across the state in 2004, this included seven sites on the Broken Creek, three on the Boosey Creek and two on Nine Mile Creek (DSE, 2005b). Results of this assessment were varied across the Planning Area (Table 20). The two reaches assessed on Nine Mile Creek and reaches 24 and 27 on the Broken scored very low overall and could probably be considered in poor condition.

Although the ISC methodology does not provide guidance for attributing condition ratings to sub indices, if the approach used for overall assessment is applied to the streamside vegetation component, none of the sites assessed would be considered "excellent" or in reference condition. The components that contributed to low scores, most often were understorey, recruitment and width. This is consistent with the observations of Robinson and Mann (1996) and SKM (2001b and 2005) who reported intact overstorey, but little or no woody understorey in vegetation condition assessments in the Planning Area.

Table 20: ISC Scores for Streamside vegetation (DSE, 2005b). Highlighting shows scores < 50% of maximum.

Site	Large trees	Understorey	Recruitment	Continuity	Canopy	Litter	Logs	Weeds	Width	Total
Maximum Score	**10**	**25**	**10**	**12.5**	**5**	**5**	**5**	**15**	**12.5**	**10**
Broken Reach 21	7	17	17	12.5	3	3	3	12	6.25	**7**
Broken Reach 22	5	8	2	9	3	3	3	10	6.25	**5**
Broken Reach 23	8	13	7	10	3	2	4	11	6.25	**7**
Broken Reach 24	0	0	0	7	0	0	0	10	12.5	**3**
Broken Reach 25	7	8	2	6	3	2	2	12	6.25	**5**
Broken Reach 26	6	12	5	3	3	4	2	13	12.5	**6**
Broken Reach 27	4	8	5	1	3	3	3	10	6.25	**4**
Boosey Reach 32	9	15	5	6	3	4	2	12	6.25	**6**
Boosey Reach 33	6	15	4	11	2	2	4	10	9	**6**
Boosey Reach 34	2	17	9	6	3	3	3	12	12.5	**7**
Nine Mile Reach 28	6	8	7	7	2	3	3	11	6.25	**5**
Nine Mile Reach 29	0	0	0	0	0	0	0	11	3	**1**

5.2.2 Results from Field Assessment

The overall condition of the riparian vegetation, as indicated by the Site Condition Score, ranged from average to good (Table 21). The condition of each of the six components making up Site condition was variable between the four sites. Only three components (Large Trees, Tree Cover and Litter) included scores that were at or close to the maximum. Conversely, Understorey and Logs were consistently low.

Table 21: Habitat Hectares scores for vegetation assessments

Site	MGA reference	Stream	Site Condition Score
A	0380756 6005179	Boosey	39 (56%)
B	0380491 6004714	Broken	39 (56%)
C	0376534 6004453	Broken	51 (73%)
D	0405885 5985947	Boosey	45 (64%)

This pattern is consistent with many riparian sites in Victoria and the results above from previous investigations within the Planning Area. Typically the overstorey of mature dominant eucalypts is present at a suitable density although often as re-growth, and hence dependent attributes such as cover and litter levels rate quite well. Conversely the understorey is clearly degraded, having lost its structural complexity and species richness and having an understorey of non-native species in its place, little to no recruitment and a lack of fallen timber. This pattern can be generally attributed to a history of stock access and timber removal, typically for firewood.

6. Conservation Value

Catchment scale analysis has identified the Planning Area as a priority within the Goulburn Broken CMA region (ECOS, 2004). However, it was initially thought that the Planning Area might be able to be divided into smaller spatial areas of high medium and low conservation value. On the recommendations of the steering committee, a spatial analysis was undertaken to divide the Planning Area into management units based on identified stream reaches. The details of this analysis are presented in Appendix D.

However, ecological values that could be considered to be of high conservation value are not located in one particular sub-section of the Planning Area. Rather, there are wetlands and vegetated sections of floodplain distributed across all streams and reaches. In addition, ecological values such as habitat and wetland connectivity need to be managed at the spatial scale of the entire Planning Area, rather than in individual reach areas.

As a consequence, it is considered that all remaining wetlands within the Planning Area should be considered as high conservation value and given the small amount of native vegetation remaining in this area, all remnant vegetation patches should be considered ecologically significant. Management actions designed to protect and where possible enhance the ecological values of wetlands along the Broken Boosey and Nine Mile Creeks are presented in Section 8.

7. Knowledge Gaps

The review and assessment undertaken for this implementation plan has revealed a number of knowledge gaps that impact on the successful management of wetlands in the Planning Area. Where appropriate, actions to address these knowledge gaps have been incorporated into the management strategies contained in Section 8.

7.1 Ecological Value

There are a number of limitations to the understanding of the ecological value of wetlands within the Planning Area, these include:

Current wetland extent

The 1994 mp layer for wetland extent was developed from aerial photography from the 1980s (see Appendix C for metadata). There have been considerable changes in the landscape since this time that could have altered both the number and extent of wetlands. Examination of the 2000 – 2004 aerial photography revealed that a number of wetlands on the 1994 data layer are no longer evident. However, the difficulties in photo interpretation, particularly when wetlands are in the dry phase means that the figures estimated for current wetland number from this cursory examination are of low reliability. A more intensive remote sensing (from multi-spectral high resolution satellite imagery) with a ground truthng component would produce a more accurate estimation of wetland extent and distribution.

Extent and value of small wetlands

Wetlands < 1 ha in size are not currently included in the mapping of wetlands in Victoria. The number and extent of these small wetlands is therefore not known, but may be significant. Silberhorn, et al, (1974 cited in Gucinski, 1978) stated that any wetland greater than 0.1 acre in size may have, depending on type and viability, significant value in terms of productivity, detritus availability, and habitat. Gucinski (1978) further stated that smaller wetlands may provide increased benefits due to the greater perimeter to area ratio.

Extent of EVCs in the Planning Area

Comparison of the EVC mapping with aerial photography and tree density mapping indicates that there are significant areas of native vegetation not covered by the EVC map layer. This discrepancy also extends to significant wetland vegetation such as lignum and cane grass which are listed as 7 ha and 0 ha respectively, according to EVC mapping, but substantially higher from field investigations (eg Moodie's Swamp is 181 ha of cane grass). In addition, EVC mapping of the Broken Boosey State Park indicates isolated patches of native vegetation, whilst the tree density layer and aerial photography show almost continuos riparian vegetation. This lack of information could impact on management and conservation efforts based on rare vegetation types and management of habitat connectivity.

Habitat value of wetlands in the Planning Area

Flora and fauna records for wetlands in the Planning Area are biased towards larger, public land systems. While faunal records for birds may indicate areas that are valuable nesting habitat, there is little information on the value of the wetlands in the Planning Area as habitat for all aspects of lifecycles. This is particularly true for native fish as there are no records of fish using inundated floodplains or wetlands in the Planning Area for breeding cycles.

7.2 Threats to Ecological Values

There is little spatial information available for the threats to wetlands in the Planning Area and in some instances knowledge gaps on not only the extent of threatening activities, but also the severity of impacts to ecological values.

Risk of rising groundwater to floodplain vegetation

Robinson and Mann (1996) and Parks Victoria (2005) state that there may be a risk of rising groundwater and associated salinity effects to the deep rooted vegetation along the floodplain. Depth to ground water mapping categories much of the Planning Area as "low risk" with respect to salinity with ground water predominantly > 10 m below the surface. However, deep rooted eucalypt trees can have roots extending beyond this depth and the risk to this vegetation, in an area where so little native vegetation remains needs to be assessed.

Wetland Hydrology

There is little information on the natural or current inundation patterns (frequency, duration and magnitude) for wetlands within the Planning Area. These wetlands are on the floodplains of the Broken, Boosey and Nine Mile Creeks, which, according to floodway mapping, extended from Broken Creek to the Murray River (Goulburn Broken CMA, 2002). An extensive network of levees, weirs, culverts, drains and channels now extends across the Planning Area altering the wetting and drying cycles of floodplain and wetland systems. Hydrology has been cited as the key driver of wetland ecology (Mitsch and Gosselink, 2000) and without knowledge on inundation requirements and the river levels required for commencement of inundation, management of these systems will be severely hampered.

Inundation requirements of the Grey Box dominated vegetation on the floodplain

Grey Box dominates the overstorey of the floodplain vegetation along the Broken Boosey and Nine Mile Creeks and the vegetation of the State Park and Natural Features Reserves. It is position above the benches in an area of reduced inundation compared to the River Red Gum community which lines the streams. However, this area has been included in this "wetland" implementation plan and it water regime which defines a wetland. As a consequence the inundation requirements or tolerance of this vegetation community must be understood if it is to be adequately managed.

Impacts of fencing on regeneration of wetland vegetation

Grazing by stock (particularly cattle) has been cited as a major threat to the wetlands within the Planning Area (Robinson and Mann, 1996; SKM 2001 and 2005; Parks Victoria, 2005). Fencing to exclude stock has been used as a management tool to decrease the impacts of tramping and grazing on wetland vegetation. However, there is little empirical evidence of the success of fencing alone on the regeneration of native vegetation and Robinson and Mann (1996) state that the use of fencing, in the absence of other management tools can lead to an increase in weed infestations. Information on the best options for the conservation and rehabilitation of wetland vegetation are required.

7.3 Condition of Ecological Values

The lack of information on the condition of wetlands within the Planning Area is perhaps the most significant knowledge gap to their management. The Index of Wetland Condition ((IWC) assessments undertaken for this project represent the most comprehensive assessment of wetland condition to date. Unfortunately < 10 % of wetland on the 1994 mapping layer were assessed. There was also a bias towards large wetlands on public land, predominantly as a result of accessibility. In addition,

this assessment was undertaken during March when wetlands were dry and as such systems dominated be aquatic herb species were probably under represented.

One of the basic processes of natural resource management is to undertake baseline sampling prior to implementing management activities and then to measure condition after actions have been completed to determine their effect. While this may be possible for the larger, publicly managed wetlands in the system, additional assessments will be required for smaller wetlands and those on private land.

In addition, while there are permanent sites established for the assessment of stream side vegetation and changes over time (through the ISC process), there is no program for the systematic assessment of floodplain vegetation. While the Sustainable Rivers Audit is developing a floodplain vegetation assessment methodology and the a pilot study of a floodplain ecological condition assessment has been undertaken on the Glenelg River (Hale *et al*, in press) there is, as yet, no standard methodology for the assessment of floodplain condition.

8. Strategies and Actions

The management goals for the Wetland Implementation Plan for the Broken, Boosey and Nine Mile Creeks are to:

1 maintain or improve the condition of wetlands of highest ecological value;
2 maintain or improve the condition of ecologically healthy wetlands;
3 achieve "overall improvement" in the ecological condition of remaining wetlands;
4 protect a diverse range of wetland habitats; and
5 prevent damage from future management activities.

These goals are consistent with the Goulburn Broken Regional Catchment Management Strategy and the Regional River Health Strategy and are to be used as guiding principles for the management of wetlands in the Planning Area. This Implementation Plan does not operate in isolation and recognises that there are a number of plans, policies and activities that are currently being undertaken which contribute to wetland management. These have been considered and incorporated into the strategies and actions below.

The Commonwealth Government has developed an Implementation Plan for Wetlands (DEH, 1997) and this has been used as a guide for formulating strategies and actions for the management of wetlands in the Planning Area. The Implementation Plan for the Broken Boosey and Nine Mile Creeks has four main strategies:

1. Managing wetlands on public land.
2. Implementing existing policies and programs.
3. Involving the community in wetland management Working in partnership with other agencies.
4. Ensuring a sound scientific basis for wetland management.

Under each of these strategies, there are actions together with the corresponding management goal (from the numbered list above). In addition, actions have been prioritised, and time frames provided for identified "high" priority actions.

Prioritisation frameworks for natural resource management can include consideration of ecological value, threat and feasibility of restoration efforts for ecosystems. The three axes, each ranging from high to low rankings can be combined to form a matrix which can be used to provide an overall priority rating (Figure 11). There are no standard rules for adapting ranking systems and the one presented below takes into consideration that the wetlands of the Broken Boosey and Nine Mile creeks have already been identified as high conservation assets, therefore a simplified matrix is proposed which includes an economic aspect and as such priorities management actions on the basis of threat, feasibility and cost of implementation.

It should be noted that, although the criteria for ranking each of the attributes is described below and the ranking of threat, feasibility and cost has been done with input from wetland ecologists and natural resource managers, this is a relatively informal way of prioritising actions. As such, this should not be taken as a replacement for a cost-benefit or risk analysis.

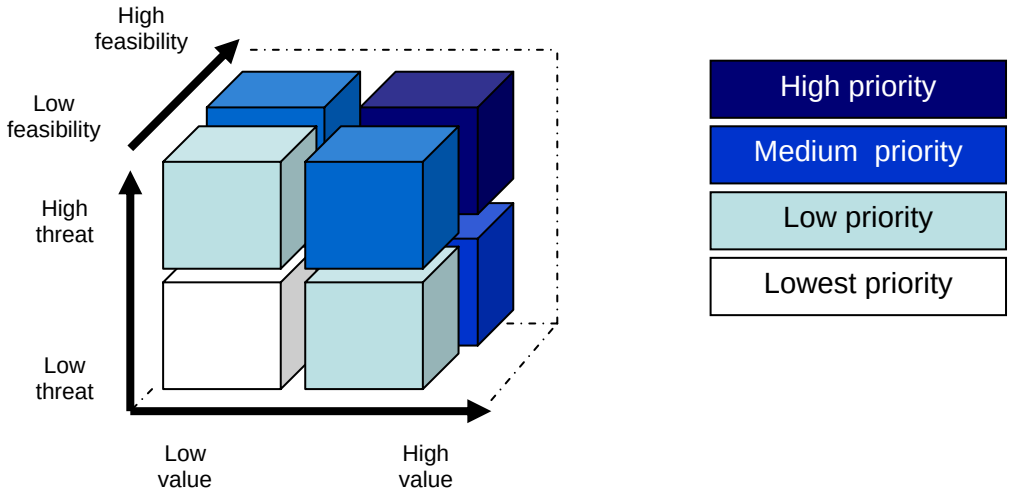

Figure 11: Matrix for the prioritisation of wetlands for restoration (Butcher and Hale, 2005, modified from Department of Environment, 2003)

Actions are assigned the following ranking according to the nature of the threat that they address and the potential impact the threat may have on the condition of a wetland over time if no action is undertaken:

- High – action addresses a direct threat to a driver of wetland ecology (hydrology, geomorphology); expected significant change in wetland type or extent within 5 years without the action;
- Medium – action addresses a direct or indirect impact to wetland ecology; expected significant change in wetland condition (but not type or extent) within 5 years in the absence of the action; and
- Low – action addresses an indirect impact to wetland ecology; expected moderate changes to wetland condition within 10 years in the absence of the action.

Feasibility is defined here as a measure of the technical or scientific capability to undertake the action. Criteria for ranking are as follows:

- High – technology or science for action well established and no impediments to implementation;
- Medium – technology or science available, but other constraints such as regional knowledge gaps, water availability impede on implementation; and
- Low –science / technical capabilities not yet available and / or potential to impact on threat or wetland condition is unknown.

Cost is defined here as a direct measure of the estimated cost of undertaking the action:

- High - > $75,000;
- Medium - $15,000 - $75,000; and
- Low < $15,000 (or included in budgets for other programs).

The final priority for a given action is a combination of each of the criteria (threat, feasibility and cost) as defined in Table 22

Table 22: Priorities for actions (high medium and low) based on threat, feasibility and cost.

Threat	Feasibility	Cost		
		Low	Medium	High
High	High	High	High	Medium
	Medium	High	High	Medium
	Low	Medium	Medium	Low
Medium	High	High	High	Low
	Medium	Medium	Medium	Low
	Low	Medium	Low	Low
Low	High	Medium	Medium	Low
	Medium	Medium	Low	Low
	Low	Low	Low	Low

Strategy 1: Managing wetlands on public land

Wetlands on public land represent the highest potential for pro-active management to preserve ecological values. There are a number of large, bioregionally significant wetlands in the Planning Area that although were assessed as being in good condition are not managed in a coordinated or proactive manner.

Action	Target / Performance Indicator	Related Goal	Responsibility	Scale	Priority			
					Threat	Feas.	Cost.	**Overall**
Develop a management plan for Rowan Swamp	Baseline assessment and plan completed	1, 2	GBCMA Parks Vic	Site specific	M	H	M	**H**
Develop a management plan for Black Swamp	Baseline assessment and plan completed	1, 2	GBCMA Parks Vic	Site specific	M	H	M	**H**
Develop a management plan for Lanigan's Swamp	Baseline assessment and plan completed	1, 2	GBCMA Parks Vic	Site specific	M	H	M	**H**
Develop a management plan for Moodie's Swamp	Baseline assessment and plan completed	1, 2	GBCMA Parks Vic	Site specific	M	H	M	**H**
Implement the Moodie's Swamp water management recommendations (SKM, 2005)	Baseline assessment and plan completed	1, 2	GBCMA GB Water	Site specific	H	H	M	**H**
Improve inundation patterns for wetlands on public lands by: • determining the environmental water requirements for wetlands • investigating the barriers to flow • Implementing work necessary to improve connectivity • Investigating water delivery options	Investigations complete and necessary works undertaken	1, 3 1, 3	GBCMA GM W Parks Vic	Planning Area	H	M	H	**M**
Undertake a comprehensive survey of wetland extent and condition on public land within the Planning Area	Survey and condition assessments of ALL wetlands on public land	1, 3	DSE GBCMA	Planning Area	H	H	H	**M**

Manage uncontrolled grazing on public wetland sites by: • identifying priority areas requiring fencing • erecting of required fencing • ensuring conditions in grazing licences are consistent with the protection of wetland values	Fencing erected and / or mechanisms in place to control grazing on public wetland sites Conditions in grazing licences are consistent with the protection of wetland values	1, 2, 3	GBCMA Parks Vic DSE	Planning Area	H	H	M	**H**
Investigate woody debris levels at wetland sites Where necessary, instigate a program to re-establish appropriate woody debris levels at wetland sites	Investigation complete and woody debris enhancement trial complete at a minimum of one wetland	1, 3	GBCMA Parks Vic DSE	Planning Area	L	M	M	**L**
Investigate habitat connectivity between wetlands on public land within the Planning Area and identify recommendations for improvement	Investigation complete	4, 5	GBCMA Parks Vic DSE	Planning Area	M	M	H	**M**
Implementation of the Broken Boosey State Park Management Plan	Final plan released	1,2	Parks Vic	Planning Area	M	H	L	**H**
	Management strategies implemented	1,2	Parks Vic	Planning Area	H	H	H	**M**

Strategy 2: Implementing existing programs

There are a number of existing management plans and actions in place that would provide benefits to wetlands in the Planning Area. The Goulburn Broken CMA needs to be responsible for the coordination of these plans to ensure maximum benefits and no negative impacts to wetlands in the Planning Area. In addition, there are a number of policies and governing the management of natural resources in the Planning Area, which guide the development of actions plans.

Action	Target / Performance Indicator	Related Goal	Responsibility	Scale	Priority			
					Threat	Feas.	Cost.	Overall
Apply the Floodplain Management Guidelines For Whole Farm Plans Within The Shepparton Irrigation Region (SKM, 2003) to management of floodplains within the entire Planning Area	Altered regulations to extend plan coverage to entire Planning Area.	5	GBCMA G-MW DSE	Planning Area	H	M	M	**H**
Undertake priority fencing identified in the Lower Broken Waterway Action Plan	Fencing complete	5	GBCMA	Lower Broken Creek	H	H	M	**H**
Undertake priority fencing identified in the Boosey Creek Stream Assessment Report	Fencing complete	5	GBCMA	Boosey Creek	H	H	M	**H**
Develop a water way action plan for Nine Mile Creek	Plan complete and actions that protect wetland vegetation identified	3	GBCMA	Nine Mile Creek	M	H	H	**M**
Develop water way action plan for the upper Broken Creek	Plan complete and actions that protect wetland vegetation identified	1	GBCMA	Broken Creek	M	H	H	**M**
Assess weed management protocols (such as those for arrowhead and willows) to ensure they do not have a negative down stream effect on wetlands	Assessment of weed management protocols. Implementation of necessary changes Education of weed control personnel	5	GBCMA G-MW DPI	Planning Area	M	H	L	**H**

Ensure the environmental flow determination for the Broken and Boosey Creeks consider floodplain and wetland inundation requirements	Floodplain and wetland inundation requirements considered in the development of the environmental flow determination for the Broken and Boosey Creeks	1, 2, 3	GBCMA	Planning Area	H	M	M	**H**
Expand the existing wetland water quality monitoring program to include significant wetlands within the Planning Area	Water quality assessments at a minimum of 5 wetlands	1, 2, 3	GBCMA DPI	Planning Area	M	M	H	**L**
Targeting wetland habitat under the Biodiversity Action Planning Process (eg rare wetland types such as Lignum and Cane grass swamps)	Significant wetland habitat within the Planning Area identified and protected	1, 4	GBCMA DSE	Planning Area	H	H	L	**H**

Strategy 3: Involving the community in wetland management, working in partnership with other agencies

There are a number of agencies responsible for the management of wetlands in the Planning Area including GBCMA, DPI, DSE, GMW, Parks Victoria as well as local councils. The activities of these agencies need to be coordinated to ensure: actions are not duplicated across agencies; benefits form actions are maximised and conflicting activities are not undertaken. In addition, involving the community in the management of natural resources is a key policy of the Goulburn Broken CMA and to ensure this is undertaken in a manner than maximises benefits careful coordination of this is also required.

Action	Target / Performance Indicator	Related Goal	Responsibility	Scale	Priority			
					Threat	Feas.	Cost.	Overall
Support community groups (LandCare, LAPs) to undertake conservation and restoration works on wetlands within the Planning Area	Funding applications by community groups for conservation and restoration works on wetlands within the Planning Area facilitated and supported	1, 2, 3, 4	GBCMA DSE DPI	Planning Area	H	M	M	**H**
Implement an education and training program in wetland ecology and management for community conservation groups and landholders	Wetland education and training program conducted for community groups and landholders	4, 5	GBCMA DSE DPI	Planning Area	H	H	M	**H**
Formation of a Broken, Boosey and Nine Mile Creek Wetland Implementation Committee to facilitate communication on actions undertaken and progress towards completion. (It is recommended that this be a "virtual committee" that does not necessarily meet in person, but rather communicates through quarterly reports.)	Quarterly communication commenced and coordinated actions through the GBCMA	5	GBCMA DSE DPI Parks Vic G-MW	Planning Area	M	H	L	**H**

Strategy 4: Ensuring a sound scientific basis for wetland management

The development of this implementation plan identified a number of key knowledge gaps that could impinge on the successful management of wetlands within the Planning Area. The following actions are designed to address these (further information on the need for each of the actions is contained in Section7). Although many of these actions have been identified as low priority (predominantly due to cost considerations) alternative avenues, such as collaboration with tertiary institutes could be sought, which would significantly lower the cost.

Action	Target / Performance Indicator	Related Goal	Responsibility	Scale	Priority			
					Threat	Feas.	Cost.	Overall
Determine the current extent of wetlands in the Planning Area	Map of current wetland extent complete	1, 2, 3, 4	GBCMA DSE	Planning Area	M	H	H	**M**
Determination of the extent of small (< 1 ha) wetlands	Map of wetland extent that includes ALL wetlands	1, 2, 3, 4	GBCMA DSE	Planning Area	M	M	H	**L**
Investigate the habitat value of wetlands in the Planning Area to native fish, amphibians and waterbirds, including an assessment of required patch size and habitat connectivity	Investigation complete	1, 2, 3, 4	GB CMA, DSE	Planning Area	H	L	H	**L**
Investigate the inundation requirements of the Grey Box dominated community along the Broken and Boosey Creeks	Investigation complete	1	GBCMA, DSE	Planning Area	H	M	H	**L**
Investigate the salinity risk to vegetation in the Planning Area	Investigation complete	5	DSE	Planning Area	M	M	H	**L**
Develop a digital elevation model (DEM) of the Planning Area to enable informed decisions about management of wetland hydrology	Model complete and available as a GIS layer	1, 2, 3	GBCMA.	Planning Area	H	H	M	**H**
Investigate the regeneration success following fencing to exclude livestock in wetlands	Investigation complete	5	DSE Parks Vic	Planning Area	M	H	H	**M**

Establish a long term monitoring program to assesses the condition of a representative sample of wetlands.	Establishment of program	1, 2, 3	GBCMA. DSE	Planning Area	H	H	M	**H**
Apply a floodplain condition assessment methodology to the floodplains wetlands in the Planning Area	Pilot testing of program	1, 2, 3	GBCMA. DSE	Planning Area	M	M	M	**M**

9. Implementation Program

An implementation program is provided below which details recommended actions for the period 2006 – 2011. It is recommended that after this time, this implementation plan for the wetlands of the Broken, Boosey and Nine Mile Creeks be reviewed, success of actions evaluated and priority actions established for the subsequent five year period. The actions identified as "high" priority in Section 8 have been incorporated into the implementation program for the wetlands in the Planning Area, together with responsibilities and time frames for completion.

Action	Responsibility	Timing
Strategy 1: Managing Wetlands on Public Land		
Develop management plans for bioregionally significant wetlands in the Planning Area (Rowan, Black, Lanigan's and Moodies Swamps)	GBCMA Parks Vic	Completion of one plan every 12 months (all completed by 2011)
Implement the Moodie's Swamp water management recommendations (SKM, 2005)	GBCMA G-MW	Completed by 2007
Manage uncontrolled grazing on public wetland sites by: • identifying priority areas requiring fencing • erecting of required fencing ensuring conditions in grazing licences are consistent with the protection of wetland values	GBCMA Parks Vic DSE	Current and ongoing
Finalisation and release of the Broken Boosey State Park Management Plan	Parks Vic	Release by December 2006
Strategy 2: Implementing Existing Programs		
Apply the Floodplain Management Guidelines For Whole Farm Plans Within The Shepparton Irrigation Region (SKM, 2003) to management of floodplains within the entire Planning Area	GBCMA G-MW DSE	2007
Undertake priority fencing identified in the Lower Broken Waterway Action Plan	GBCMA	2007
Undertake priority fencing identified in the Boosey Creek Stream Assessment Report	GBCMA	2008
Assess weed management protocols (such as those for arrowhead and willows) to ensure they do not have a negative down stream effect on wetlands	GBCMA G-MW DPI	Completed by 2007
Ensure the environmental flow determination for the Broken and Boosey Creeks consider floodplain and wetland inundation requirements	GBCMA	Completed by 2007
Target wetland habitat under the Biodiversity Action Planning Process (eg rare wetland types such as Lignum and Cane grass swamps)	GBCMA DSE	Significant wetland habitat within the Planning Area identified and protected under Biodiversity Action Plan Processes – current and ongoing

Action	Responsibility	Timing
Strategy 3: Involving the community in wetland management, working with other agencies		
Supporting community groups (LandCare, LAPs) to undertake conservation and restoration works on wetlands within the Planning Area	GBCMA DSE DPI	Support of five community conservation and restoration projects for wetlands in the Planning Area by 2011
Implement an education and training program in wetland ecology and management for community conservation groups and landholders	GBCMA DSE DPI	One education and training event held by December 2007
Formation of a Broken, Boosey and Nine Mile Creek Wetland Implementation Committee to facilitate communication on actions undertaken and progress towards completion	GBCMA DSE DPI Parks Vic G-MW	Committee established by December 2006
Strategy 4: Ensuring a sound scientific basis for wetland management		
Develop a digital elevation model (DEM) of the Planning Area to enable informed decisions about management of wetland hydrology	GBCMA	Completed by 2008
Establish a long term monitoring program that assesses the condition of a representative sample of wetlands in the Planning Area	GBCMA DSE	Minimum of five wetlands assessed each year 2007 - 20011
Additional Recommendations		
Investigation of partnerships with tertiary institutes to fund post graduate research to address key knowledge gaps identified in Section 7 and actions under Strategy 4	GBCMA	One post graduate research project funded by 2008
Review of this wetland implementation program	GBCMA	Completed by 2012

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Appendix A: Threatened Flora and Fauna

Table A1: Threatened Vertebrate Fauna Species in the Planning Area

Common Name	Species Name	VROTS Class
Barking Marsh Frog	*Limnodynastes fletcheri*	Data deficient
Growling Grass Frog	*Litoria raniformis*	Endangered
Apostlebird	*Struthidea cinerea*	
Black Falcon	*Falco subniger*	Vulnerable
Black-chinned Honeyeater	*Melithreptus gularis*	Near Threatened
Black-eared Cuckoo	*Chrysococcyx osculans*	Near Threatened
Brown Quail	*Coturnix ypsilophora*	Near Threatened
Brown Treecreeper	*Climacteris picumnus (ssp. south-east)*	Near Threatened
Bush Stone-curlew	*Burhinus grallarius*	Endangered
Diamond Dove	*Geopelia cuneata*	Near Threatened
Diamond Firetail	*Stagonopleura guttata*	Vulnerable
Grey Goshawk	*Accipiter novaehollandiae*	Vulnerable
Grey-crowned Babbler	*Pomatostomus temporalis*	Endangered
Ground Cuckoo-shrike	*Coracina maxima*	Vulnerable
Hooded Robin	*Melanodryas cucullata*	Near Threatened
Painted Honeyeater	*Grantiella picta*	Vulnerable
Red-backed Kingfisher	*Todiramphus pyrrhopygia*	Near Threatened
Red-chested Button-quail	*Turnix pyrrhothorax*	Vulnerable
Regent Honeyeater	*Xanthomyza phrygia*	Critically Endangere
Speckled Warbler	*Chthonicola sagittata*	Vulnerable
Superb Parrot	*Polytelis swainsonii*	Endangered
Swift Parrot	*Lathamus discolor*	Endangered
Turquoise Parrot	*Neophema pulchella*	Near Threatened
Barking Owl	*Ninox connivens*	Endangered
Australasian Bittern	*Botaurus poiciloptilus*	Endangered
Australasian Shoveler	*Anas rhynchotis*	Vulnerable
Azure Kingfisher	*Alcedo azurea*	Near Threatened
Baillon's Crake	*Porzana pusilla*	Vulnerable
Blue-billed Duck	*Oxyura australis*	Endangered
Brolga	*Grus rubicunda*	Vulnerable
Eastern Curlew	*Numenius madagascariensis*	Near Threatened
Freckled Duck	*Stictonetta naevosa*	Endangered
Glossy Ibis	*Plegadis falcinellus*	Near Threatened
Great Egret	*Ardea alba*	Vulnerable
Hardhead	*Aythya australis*	Vulnerable
Intermediate Egret	*Ardea intermedia*	Critically Endangere
Latham's Snipe	*Gallinago hardwickii*	Near Threatened
Lewin's Rail	*Rallus pectoralis*	Vulnerable
Little Bittern	*Ixobrychus minutus*	Endangered
Little Egret	*Egretta garzetta*	Endangered
Magpie Goose	*Anseranas semipalmata*	Vulnerable
Musk Duck	*Biziura lobata*	Vulnerable
Nankeen Night Heron	*Nycticorax caledonicus*	Near Threatened
Painted Snipe	*Rostratula benghalensis*	Critically Endangere
Pied Cormorant	*Phalacrocorax varius*	Near Threatened
Royal Spoonbill	*Platalea regia*	Vulnerable
Spotted Harrier	*Circus assimilis*	Near Threatened
Whiskered Tern	*Chlidonias hybridus*	Near Threatened
White-bellied Sea-Eagle	*Haliaeetus leucogaster*	Vulnerable

Wood Sandpiper	*Tringa glareola*	Vulnerable
Fat-tailed Dunnart	*Sminthopsis crassicaudata*	Near Threatened
Spot-tailed Quoll	*Dasyurus maculatus*	Endangered
Squirrel Glider	*Petaurus norfolcensis*	Endangered
Carpet Python	*Morelia spilota metcalfei*	Endangered
Eastern Bearded Dragon	*Pogona barbata*	Data deficient
Lace Goanna	*Varanus varius*	Vulnerable
Woodland Blind Snake	*Ramphotyphlops proximus*	Near Threatened

Table A2: Threatened Flora Species in the Planning Area

Species Name	Common Name	Class
Acacia decora	Western Silver Wattle	vulnerable
Acacia loderi	Nealie	vulnerable
Acacia notabilis	Mallee Golden Wattle	vulnerable
Allocasuarina luehmannii	Buloke	
Alternanthera nodiflora	Common Joyweed	data deficient
Alternanthera sp. 1 (Plains)	Plains Joyweed	data deficient
Atriplex spinibractea	Spiny-fruit Saltbush	endangered
Austrodanthonia richardsonii	Straw Wallaby-grass	vulnerable
Brachyscome chrysoglossa	Yellow-tongue Daisy	vulnerable
Brachyscome muelleroides	Mueller Daisy	endangered
Callitriche cyclocarpa	Western Water-starwort	vulnerable
Callitriche umbonata	Winged Water-starwort	rare
Calotis cuneifolia	Blue Burr-daisy	rare
Calotis lappulacea	Yellow Burr-daisy	rare
Cardamine moirensis	Riverina Bitter-cress	rare
Craspedia canens	Grey Billy-buttons	endangered
Cullen parvum	Small Scurf-pea	endangered
Cullen tenax	Tough Scurf-pea	endangered
Desmodium varians	Slender Tick-trefoil	data deficient
Digitaria brownii	Cotton Panic-grass	data deficient
Digitaria divaricatissima	Umbrella Grass	vulnerable
Diuris punctata var. punctata	Purple Diuris	vulnerable
Eleocharis pallens	Pale Spike-sedge	data deficient
Eremophila debilis	Winter Apple	endangered
Eryngium paludosum	Long Eryngium	vulnerable
Eucalyptus sideroxylon s.s.	Mugga	rare
Haloragis glauca f. glauca	Bluish Raspwort	data deficient
Hypoxis exilis	Swamp Star	vulnerable
Lepidium pseudohyssopifolium	Native Peppercress	data deficient
Lotus australis	Austral Trefoil	data deficient
Maireana aphylla	Leafless Bluebush	data deficient
Minuria integerrima	Smooth Minuria	rare
Myoporum montanum	Waterbush	rare
Myriophyllum gracile var. lineare	Slender Water-milfoil	endangered
Myriophyllum porcatum	Ridged Water-milfoil	vulnerable
Panicum laevinode	Pepper Grass	vulnerable
Panicum queenslandicum var. queenslandicum	Coolibah Grass	endangered
Prasophyllum sp. aff. pyriforme D	Swamp Leek-orchid	endangered
Ptilotus erubescens	Hairy Tails	
Ranunculus pumilio var. politus	Ferny Small-flower Buttercup	data deficient
Ranunculus sessiliflorus var. pilulifer	Annual Buttercup	data deficient
Sclerolaena muricata var. muricata	Black Roly-poly	data deficient
Sclerolaena muricata var. semiglabra	Dark Roly-poly	data deficient
Swainsona sericea	Silky Swainson-pea	vulnerable
Tragus australianus	Small Burr-grass	rare
Triglochin dubia	Slender Water-ribbons	rare
Tripogon loliiformis	Rye Beetle-grass	rare

Appendix B: Field Report

See attached pdf document

Appendix C: Metadata Statements

ANZLIC Report - EVC1750_100

DATASET

Title

Ecological Vegetation Classes Modelled for 1750 at 1:100,000 - Source Information

Custodian

Department of Sustainability and Environment

Jurisdiction

Victoria

DESCRIPTION

Abstract

This layer represents the supposed extent of ecological vegetation classes in 1750 as described by Biodiversity and Natural Resources (DSE). It is the source dataset for the creation of EVC1750_CMP (which is a non-restricted dataset)

Search Word(s)

FLORA

FORESTS Natural

VEGETATION Floristic

VEGETATION Structural

Geographic Extent Name(s)

Victoria

Geographic Extent Polygon(s)

DATASET CURRENCY

Beginning Date

01JAN1997

Ending Date

Current

DATASET STATUS

Progress

Complete

Maintenance and Update Frequency

Irregular

DATASET ACCESS

Stored Data Format(s)

Digital ARC/INFO Revision 7 librarian layer

Available Format Type(s)

DIGITAL - All major formats available

Access Constraints

DATA QUALITY

Lineage

Data Set Source: The EVC1750_100 dataset has been developed as part of various studies:

Box_Ironbark: EVC and floristic community mapping for Goldfields study area, with linework drawing on 1:25,000 forest stand class boundaries, updated with RFA mapping. Central Highlands: Floristic community mapping for Melbourne II LCC Review, enhanced with Central Highlands Old-growth Forest and regional Forest Agreement EVC mapping. East Gippsland: LCC Structural Vegetation and Geological mapping, updated with RFA mapping. Gippsland: EVC mapping for the Gippsland Old-growth Forest study and regional Forest Agreement. Goulburn: EVC mapping for Goulburn Broken Catchment. Grampians: EVC mapping for the Greater Grampians Floristic Vegetation Mapping Project and Western Regional Forest Agreement, updated with RFA mapping. North-East: EVC mapping for the North East Old-growth Forest study, updated with RFA mapping. Otways-Midlands: EVC mapping for the Otways-Midlands Old-growth Forest study and Western Regional Forest Agreement. Portland-Wimmera: EVC mapping for the Portland-Wimmera Old-growth Forest study and Western Regional Forest Agreement. Port Phillip/Westernport: EVC Mapping for the Port Phillip/Westernport EVC Mapping project. North-West: EVC Mapping for the North-West EVC Study undertaken by the three North-West Catchment Management Authorities (Mallee, Wimmera and North-Central CMAs

Positional Accuracy

Precision: 100m to 1K

Determination: EVC information is registered to the 1;100,000 base features. Positional accuracy is a function of pen thickness, base accuracy and nature of boundaries mapped. map errors of 0.5mm to 3mm, or 50m to 300m are possible.

Attribute Accuracy

Logical Consistency

There is a many to one relationship between the redefined item FC (floristic community) and EVC item (ecological vegetation class). This relationship is expressed in the lookup table EVC_FC.LUT.

Completeness

The dataset was completed for the State in October 2003 with the incorporation of information from the North-West Study.

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Metadata Date

May 13 2005

ANZLIC Report - TREEDEN25

DATASET

Title

Tree Cover Density

Custodian

Department of Sustainability and Environment

Jurisdiction

Victoria

DESCRIPTION

Abstract

A presence/absence tree cover dataset is derived from SPOT Panchromatic imagery (10m pixels) by a combination of digital classification and visual interpretation . The presence/absence dataset is then grouped into three density classes (Dense, Medium, Scattered) by neighbourhood and proximity cell based analysis. The raster dataset is converted to vector as a final step.

The process of grouping tree cover into density classes simplifies the representation of trees and reduces the complexity of the vector dataset. It is a particularly neat way of representing scattered tree cover. The original, ungrouped raster dataset is maintained as a separate dataset. Classifying SPOT Panchromatic imagery for vegetation can be limiting as the panchromatic image only

encompasses a small portion of the infrared part of the electromagnetic spectrum. However, the image sharpness and detail offered makes the trade off between spectral range and spatial resolution worth while for mapping tree cover at 1:25,000. Tree cover is defined as woody vegetation greater than 2 metres in height and with a crown cover (foliar density) greater than 10 percent.

Search Word(s)

FORESTS

LAND Cover

PHOTOGRAPHY AND IMAGERY Satellite

VEGETATION

Geographic Extent Name(s)

Victoria

Geographic Extent Polygon(s)

DATASET CURRENCY

Beginning Date

16NOV1989

Ending Date

01DEC1999

DATASET STATUS

Progress

In Progress

Maintenance and Update Frequency

As required

DATASET ACCESS

Stored Data Format(s)

Digital Arc/Info Revision 7.2.1 Librarian Layer

Available Format Type(s)

Digital Arc/Info and Arcview Non Digital Printed Maps

Access Constraints

DATA QUALITY

Lineage

Data Set Source: SPOT Panchromatic Imagery (10m pixels)

Positional Accuracy

The positional accuracy, determined by the geometric rectification of the source SPOT Panchromatic images, and reported as Root Mean Square Error, is up to 1.5 pixels. As the images have 10 meter pixel resolution, this translates to 15 meters.

Attribute Accuracy

Logical Consistency

All polygons are automatically generated in a raster to vector conversion. All polygons are closed and labelled consistently. All relationships between attributes are logical.

Completeness

A total of 592 map sections for zone 54 have been completed to date. A total of 203 map sections for zone 55 have been completed to date.
TREEDEN25 is a second generation derived dataset. Three density classes have been derived from a classification of SPOT Panchromatic imagery, which itself is a derived dataset. Moving from Dense through to Scattered, the TREEDEN25 boundaries are, in effect, more generalised or stylised. Dense tree cover boundaries will be tangible, physical edges of patches of dense trees and will be observable on ground. While Scattered tree cover boundaries will not necessarily be physically obvious at ground level. The Dense class : represents tree cover of approximately 80+% density. It has a minimum patch size of 5 hectares (smaller patches will be medium class). And it allows for minimum gaps in tree cover of 0.1 hectares (smaller gaps are closed over). The Medium class : represents tree cover of approximately 50-80% density. It has a minimum patch size of 1 hectare (smaller patches may fall into scattered class). And it allows for minimum gaps in tree cover of 0.25 hectares (smaller gaps are closed over). The Scattered Class : represents tree cover of approximately 10-50% density. It has a minimum patch size of 1 hectare (smaller patches are left out). And it allows for a minimum gap of 0.1 hectares
Three Levels of verification have been described for TREEDEN25 and the Level is carried as a polygon attribute. The tree cover classifications of the SPOT imagery have, in general, overestimated the occurrence of trees. Although spatially very accurate, the classifications need to be "cleaned" by a process of visual interpretation and manual editing. The notion of Levels of data has been introduced as an indicator to the data user of how much manual editing and/or field verification has been undertaken on the original tree cover classification. Its purpose is to serve as a qualification of the data. The Levels describe an evolutionary "cleaning" path, moving from an excellent starting picture (Level 1) through to the best picture achievable from the source imagery (Level 3). Level 1 data : Tree cover data has been partially (on screen) edited for obvious classification errors. Further editing can be undertaken to remove misclassifications still present in the data. The majority of the remaining errors are water bodies, wet areas and townships misclassified as tree cover. No field checking has been undertaken. Level 2 data : Tree cover has been (on screen) edited as far as practically possible to remove misclassifications and known errors. Further visual interpretation and on screen editing would not significantly impove the data. No field checking has been undertaken. Level 3 data : Tree cover has been (on screen) edited as far as practically possible to remove known errors and misclassifications, and has been checked in the field with additional editing undertaken based on field check results.

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Metadata Date

Sep 15 2004

ANZLIC Report - EVC_BCS100

DATASET

Title

EVC Bioregional Conservation Status at 1:100,000 (includes 1:25,000 data if available)

Custodian

Department of Sustainability and Environment

Jurisdiction

Victoria

DESCRIPTION

Abstract

This is a derived dataset that delineates the Bioregional Conservation Status of EVCs. The dataset is derived from a combination of both Victorian bioregions (VBIOREG100) and the extant EVC dataset (EVC_CMP100), with an assigned conservation status on the basis of unique Bioregion EVC units. The dataset underpins the implementation of Victoria's Native Vegetation Management Framework, and the preparation of Regional Vegetation Plans in addition to other biodiversity planning. The dataset requires upgrading when either of the two input datasets change.

(Note that this dataset is stored in two Spatial Data Storage Environments within DSE - Arc/Info tiled libraries and Oracle/SDE single data layer. This metadata

describes the Arc/Info dataset. The Oracle/SDE dataset is slightly different in that all non-vegetation classes are excluded from the data (ie. Bare rock, sand, non-native vegetation etc.) also the attributes include attributes expanded from Look Up Tables. These have an XX_ prefix in the name.)

Search Word(s)

VEGETATION

VEGETATION

VEGETATION

Geographic Extent Name(s)

Victoria

Geographic Extent Polygon(s)

DATASET CURRENCY

Beginning Date

01JAN2002

Ending Date

01NOV2004

DATASET STATUS

Progress

Complete

Maintenance and Update Frequency

As required

DATASET ACCESS

Stored Data Format(s)

DIGITAL Arc/Info Revision 7 Librarian layer DIGITAL Oracle/SDE

Available Format Type(s)

DIGITAL - All major formats available

Access Constraints

DATA QUALITY

Lineage

Data Set Source: The dataset is derived from a combination of both Victorian bioregions and the extant EVC dataset with an assigned conservation status on the basis of unique Bioregion EVC units. The boundaries and key attributes from both datasets are found in this derived dataset.

The key attributes, Bioregional Conservation Status (EVC_BCS) and Geographic Occurrence (EVC_GO) of EVCs, have been assigned to Bioregion/EVC combinations on the basis of an expert interpretation of statistical and spatial

information by Mr David Parkes, Biodiversity & Natural Resources, DSE with the support of other DSE staff. The source information for these two attributes is maintained in a separate database that is linked to the EVC_CMP100/VBIOREG100 combination dataset to create EVC_BCS100. The source table is maintained by Biodiversity & Natural R esources Division. The approach to assessing bioregional conservation status of vegetation types (Ecological Vegetation Classes) is described inTable 1, and the approach to assessing the geographic occurrence of vegetation types is described in Table 2, and the approach to describing Map Unit Types in the EVC layer is described in Table 3. Valid attribute values for these attributes are contained in Tables 4, 5 and 6 respectively.

Positional Accuracy

Precision: 100m to 1 km

Determination: EVC and Bioregion information is registered to the 1:100,000 base features. Positional accuracy is a function of pen thickness, base accuracy and nature of boundaries mapped. Map errors of 0.5 mm to 3 mm, or 50 m to 300 m are possible.

Attribute Accuracy

Logical Consistency

There is a logical consistency between combinations of Victorian Bioregions and EVCs and the assigned Bioregional Conservation Status (EVC_BCS) and Geographic Occurrence (EVC_GO) of EVC attributes. There is a logical consistency between bioregion numbers, codes and names, and between EVC numbers and names.

Completeness

The dataset is complete for the whole state, however will require updating when either of the two input datasets change.

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Metadata Date

May 12 2005

ANZLIC Report - WETLAND_1788

DATASET

Title

Wetlands Extent for Victoria Prior to European Settlement - Deduced

Custodian

Department of Sustainability and Environment

Jurisdiction

Victoria

DESCRIPTION

Abstract

Polygons showing the extent of wetlands in Victoria prior to European settlement. Wetlands are classified into primary categories based on water regimes.

The polygon boundaries were derived from digitizing marked up aerial photography interpretation.

Search Word(s)

WATER Wetlands

Geographic Extent Name(s)

Victoria

Geographic Extent Polygon(s)

DATASET CURRENCY

Beginning Date

01JAN1949

Ending Date

01JAN1992

DATASET STATUS

Progress

Complete

Maintenance and Update Frequency

Not Planned

DATASET ACCESS

Stored Data Format(s)

DIGITAL Arc/Info Revision 7 Librarian layer

Available Format Type(s)

DIGITAL - All major formats available

Access Constraints

DATA QUALITY

Lineage

Data Set Source: The data has been prepared primarily from standard Survey and Mapping Victoria photo runs with some local revisions based on other historical sources.

Positional Accuracy

Precision: 10m to 100m

Determination: Deductive estimate. Ad-hoc comparisons with 1:25,000 layer data and various sorts of imagery indicated good correlation in terms of shape and size but with errors of the order indicated above in terms of position and/or rotation. When resources permit, the 1:25,000 library hydrology and roads layers should be used to identify layer inconsistencies which may indicate specific wetlands which require translation, rotation or boundary modifications.

Attribute Accuracy

Logical Consistency

The Wetland Mapping System includes processes for checking: *node, label and intersect errors. *validation of category codes prior to insertion in the library.

Completeness

All wetlands with an area of 1 hectare or more should be present.

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Metadata Date

May 12 2005

ANZLIC Report - WETLAND_1994

DATASET

Title

Victorian Wetland Environments and Extent - up to 1994

Custodian

Department of Sustainability and Environment

Jurisdiction

Victoria

DESCRIPTION

Abstract

Polygons showing the extent and types of wetlands in Victoria based on photography taken during the 1970's and 80's. Wetlands are classified into primary categories based on water regimes and subdivided into sub areas based on vegetation or hydologic attributes.

The polygon boundaries were derived from digitizing marked up aerial photography interpretation.

Search Word(s)

WATER Wetlands

Geographic Extent Name(s)

Victoria

Geographic Extent Polygon(s)

DATASET CURRENCY

Beginning Date

01JAN1965

Ending Date

01JAN1994

DATASET STATUS

Progress

Complete

Maintenance and Update Frequency

Not Planned

DATASET ACCESS

Stored Data Format(s)

DIGITAL Arc/Info Revision 7 Librarian layer

Available Format Type(s)

DIGITAL - All major formats available

Access Constraints

DATA QUALITY

Lineage

Data Set Source: The data has been prepared primarily from standard Survey and Mapping Victoria photo runs with some local revisions based on other historical sources.

Positional Accuracy

Precision: 10m to 100m

Determination: Deductive estimate. Ad-hoc comparisons with 1:25,000 layer data and various sorts of imagery indicated good correlation in terms of shape and size but with errors of the order indicated above in terms of position and/or rotation. When resources permit, the 1:25,000 library hydrology and roads layers should be used to identify layer inconsistencies which may indicate specific wetlands which require translation, rotation or boundary modifications.

Attribute Accuracy

Logical Consistency

The Wetland Mapping System includes processes for checking: *node, label and intersect errors. *validation of category codes prior to insertion in the library.

Completeness

All wetlands with an area of 1 hectare or more should be present.

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Metadata Date

May 13 2005

ANZLIC Report - LANDUSE250

DATASET

Title

Agricultural Land Use

Custodian

Department of Sustainability and Environment

Jurisdiction

Victoria

DESCRIPTION

Abstract

This layer contains polygon features delineating broad agricultural land uses in Victoria and has been registered LANDMMT100, with resultant polygon slivers removed.

Search Word(s)

AGRICULTURE

LAND Use

Geographic Extent Name(s)

Victoria

Geographic Extent Polygon(s)

DATASET CURRENCY

Beginning Date

01JAN1987

Ending Date

31DEC1996

DATASET STATUS

Progress

Complete

Maintenance and Update Frequency

Irregular

DATASET ACCESS

Stored Data Format(s)

DIGITAL Arc/Info Revision 7 Librarian layer ArcSDE - mapdbdev - for NRE-map

Available Format Type(s)

DIGITAL - All major formats available

Access Constraints

DATA QUALITY

Lineage

Data Set Source: Manual interpretation of 1991 LANDSAT TM imagery was performed by Les Russell (1991) at 1: 250 000. Tree cover boundary derived from earlier study by Woodgate and Black.

Public land use categories were replaced by LANDMMT100 boundaries for public land.

Positional Accuracy

Precision: 100 m to 1 km.

Determination: Deductive Estimate

Based on a data entry scale of 1 : 250 000 and the nature of land use boundaries, errors of up to 3 mm. are possible on the map translating to positional errors on the group of 100 m. to 750 m.

(For public land polygons see PLM documentation)

Attribute Accuracy

Logical Consistency

Not applicable - only one item.

Completeness

The data set is complete for the State, although softwood plantation information requires refinement.
Not documented
Not documented

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Metadata Date

Apr 13 2006

Appendix D: Management Area Assessment

The steering committee for this project suggested that the Planning Area be divided into management areas on the basis of stream reaches already identified under the Goulburn Broken Regional Catchment Management Strategy (29003), Goulburn Broken Regional River Health Strategy (2004) and Index of Stream Condition (DSE, 2005b). Reaches are divisions of a river or stream based on similar hydrological, geomorphological and vegetation features (DSE, 2005b). As this Implementation Plan covers the wetlands associated with the Broken Boosey and Nine Mile Creek, this was considered to be valid method of dividing the Planning Area. In addition, it has the added advantage of putting wetland management within the Planning Area into the same framework as waterway management and thus increases the potential for on ground works for wetlands and waterways to be coordinated.

The Planning Area was subsequently divided into 12 management areas on the basis of river reaches (Figure A1). The management areas are labelled with the corresponding reach number, however the word reach has been replaced with MA to reflect the fact that these are two-dimensional areas, not linear stream sections. There are seven management areas on the Broken Creek (MA 21 – MA 27); three on the Boosey Creek (MA 32, MA 33 and MA 34) and two on Nine Mile Creek (MA 28 and MA 29).

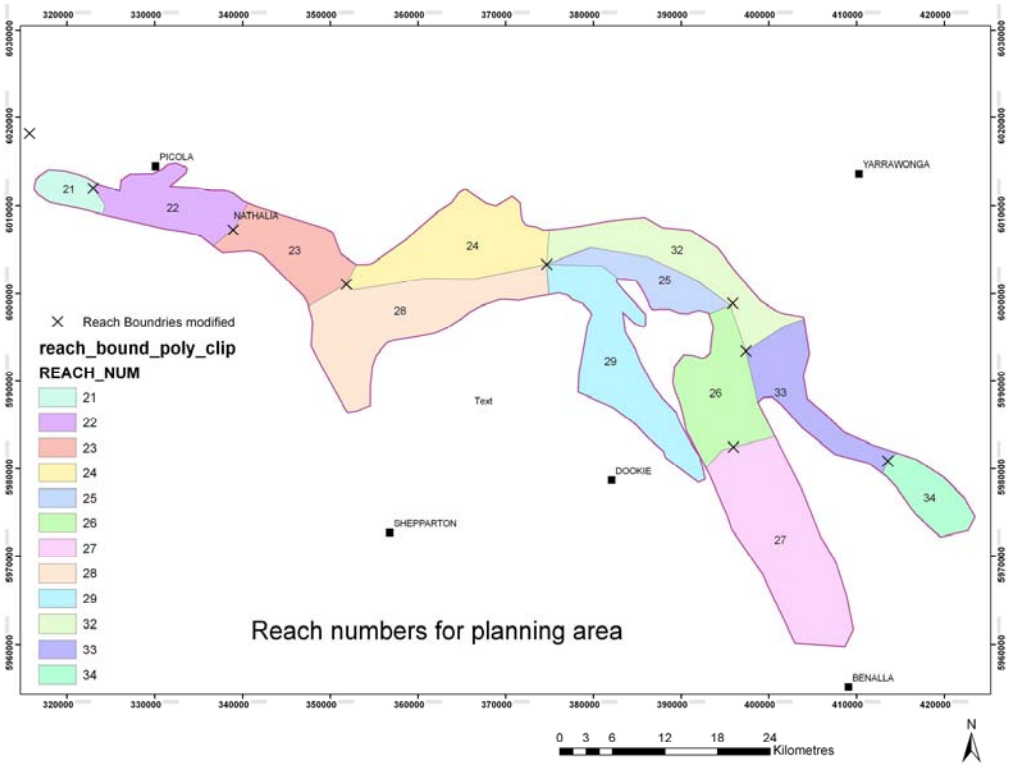

Figure A1: Management areas within the Planning Area.

The ecological values, threats and condition of the management areas are described below. However, the interpretation of this information should be considered in light of two influencing factors:

- Relative size of the management areas (Figure A2); and
- Unequal sampling effort across the Planning Area (discussed further below).

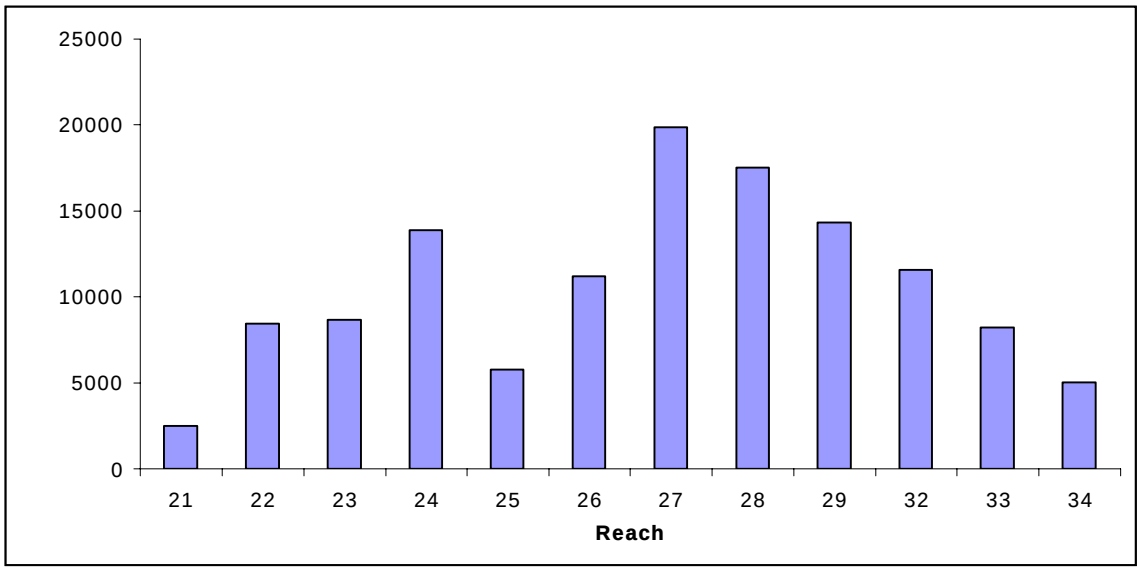

Figure A2: Size (hectares) of the management areas.

Ecological Values

Wetlands

Wetland number and extent varies considerably across the management areas (Figures A3 and A4). It should be noted that the large extent of wetland area in reserved areas in MA 26 and MA33 is the result of single large wetlands in each management area (Moodie's and Rowan's Swamps, respectively).

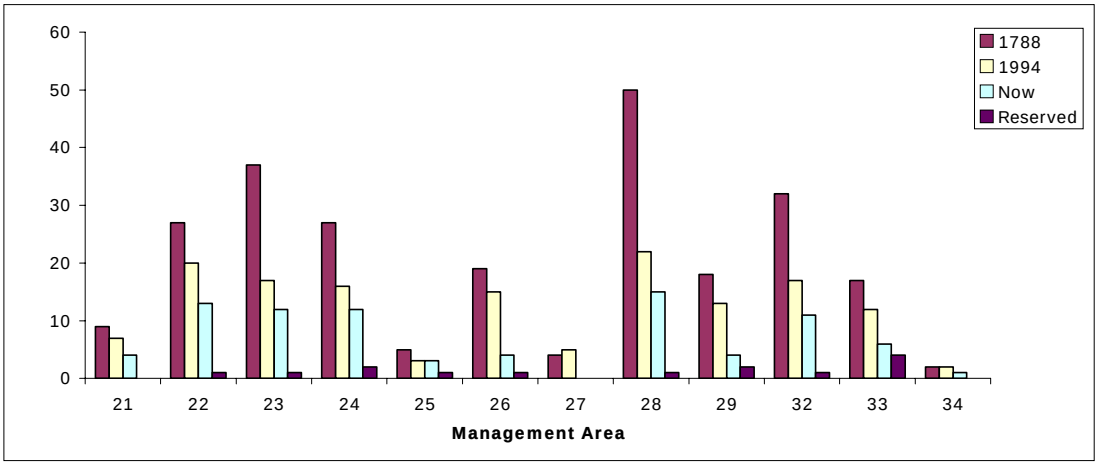

Figure A3: Number of discrete wetlands in each management area 1788, 1994, currently visible and those that are in conservation zones.

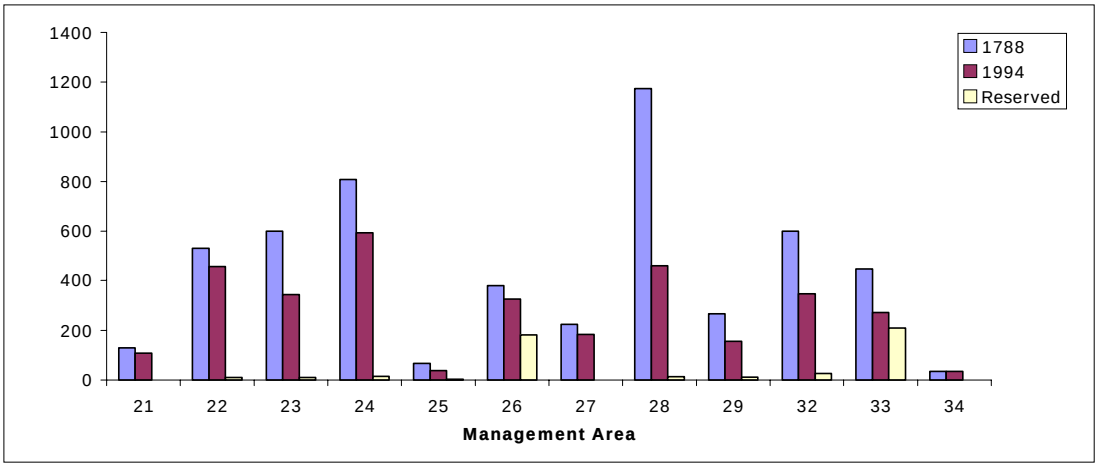

Figure A4: Wetland extent of discrete wetlands in each management area, 1788, 1994 and in conservation zones.

All management areas along the Broken Creek (MA 21 – MA 27) contain a portion of the Directory of Important Wetlands in Australia listed floodplain wetland. In addition, the following management areas contain regionally significant wetlands:

- MA 23: Green Lake;
- MA 26: Moodie's Swamp;
- MA 28: Black Swamp and Purdie's Swamp;
- MA 32: Unnamed swamp (8025_971001); and
- MA 33: Lanigan's Swamp and Rowan Swamp.

Finally, ecological value can also be considered with respect to rareness of type within a region. The following management areas contain regionally rare wetland types:

- MA 23: Lignum Swamp (only one in Planning Area; Bioregionally Vulnerable) and Reed Swamp (one of two in Planning Area);
- MA 26: Cane Grass Swamp (one of four in Planning Area; Bioregionally Vulnerable);
- MA 28: Reed Swamp (one of two in Planning Area);
- MA 29: Cane Grass Swamp (one of four in Planning Area; Bioregionally Vulnerable); and
- MA 32: Cane Grass Swamp (two of four in Planning Area; Bioregionally Vulnerable).

Vegetation

The extent of significant, wetland related EVCs across the management areas (Figure A5) shows that all management areas, to some extent, contain patches of endangered or vulnerable EVCs. However, MA 23, MA 28 and MA 33 have significantly greater aerial extent of wetland related EVCs than the other areas. This may be biased by the actual size of each management area (Figure A2). However, if a scaling factor is applied to account for variations in the size of the management area, there is little alteration to the pattern (Figure A6).

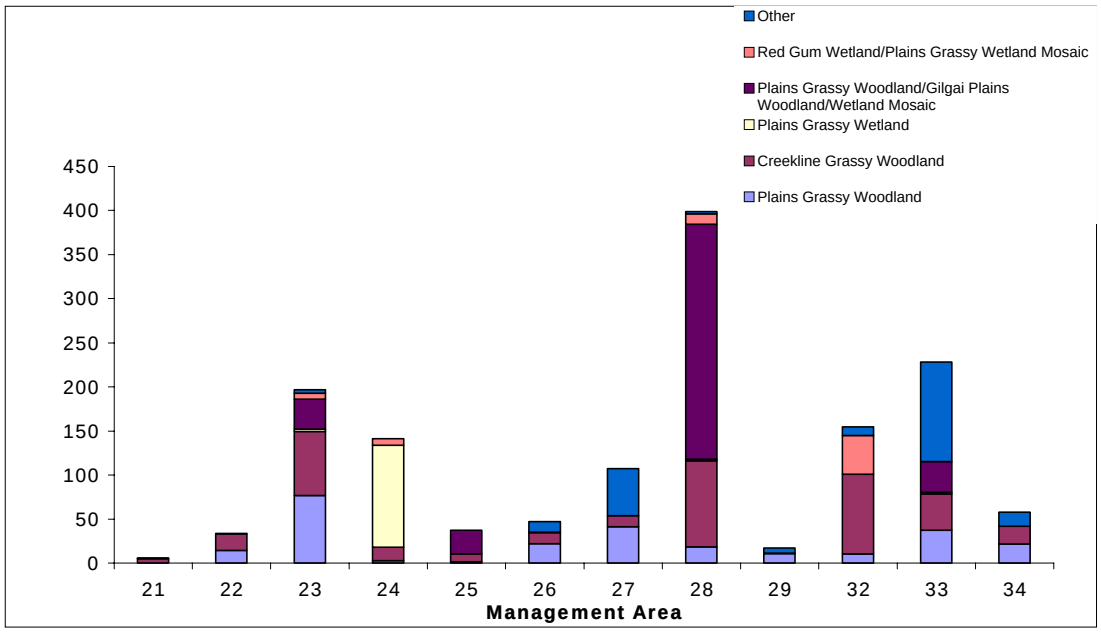

Figure A5: Area of wetland related EVCs within each management area.

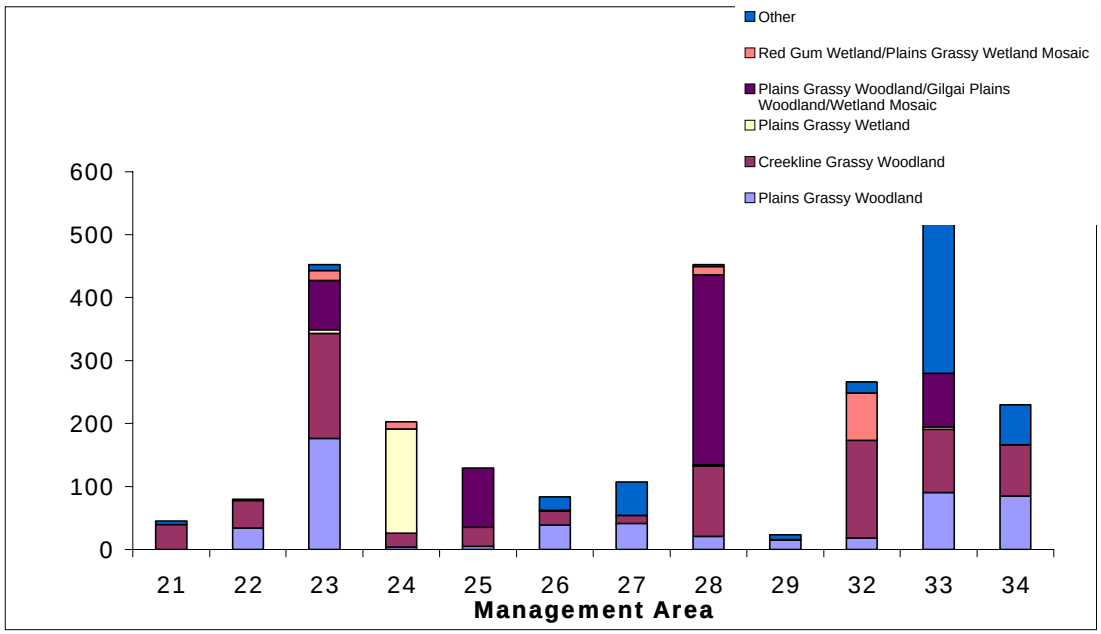

Figure A6: Relative extent of wetland related EVCs scaled to remove the bias from size of management area.

Flora and Fauna

Records of significant flora and fauna across the management areas (Figures A7 and A8) indicate that the greatest number of threatened flora taxa have been recorded in MA 33 and the highest number of threatened fauna were recorded in MA 23. However, these figures do not account for biases in sampling effort between management areas and it is likely that there have been more surveys conducted in some management areas as compared to others. In addition it has found that, particularly for bird data, taxa records are more often opportunistic and as a result of amenities at a given site, than an indication of the habitat value at a location.

In addition, the practice of identifying high value sites on the basis of species records has drawn some criticism in recent years, with the recognition that it can result in unrepresentative reserve networks (Higgins *et al.*, 2004; Wilson *et al.,* 2005; Whittaker *et al.,* 2005 and references therein). One of the problems with using indicator species (either focal/threatened or keystone taxa) is that whilst the focal species approach may identify habitat patches (sites where the species was recorded) it may not necessarily capture the number of patches required to sustain the population. Therefore the data presented here, although compatible with the approach of the Regional Catchment Management Strategy, should be interpreted with caution.

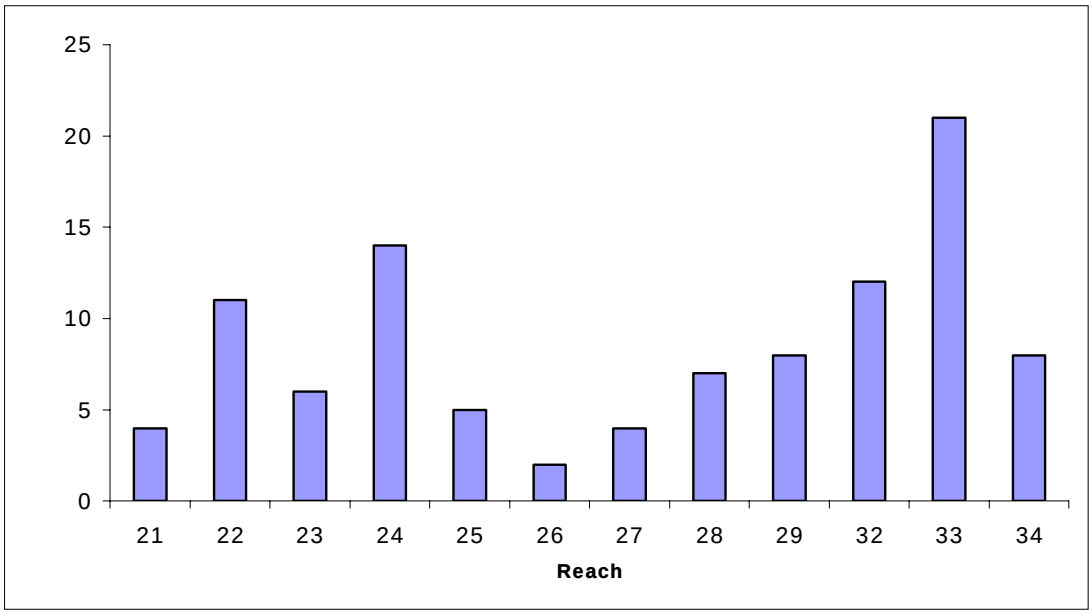

Figure A7: Number of threatened flora taxa recorded within the management areas.

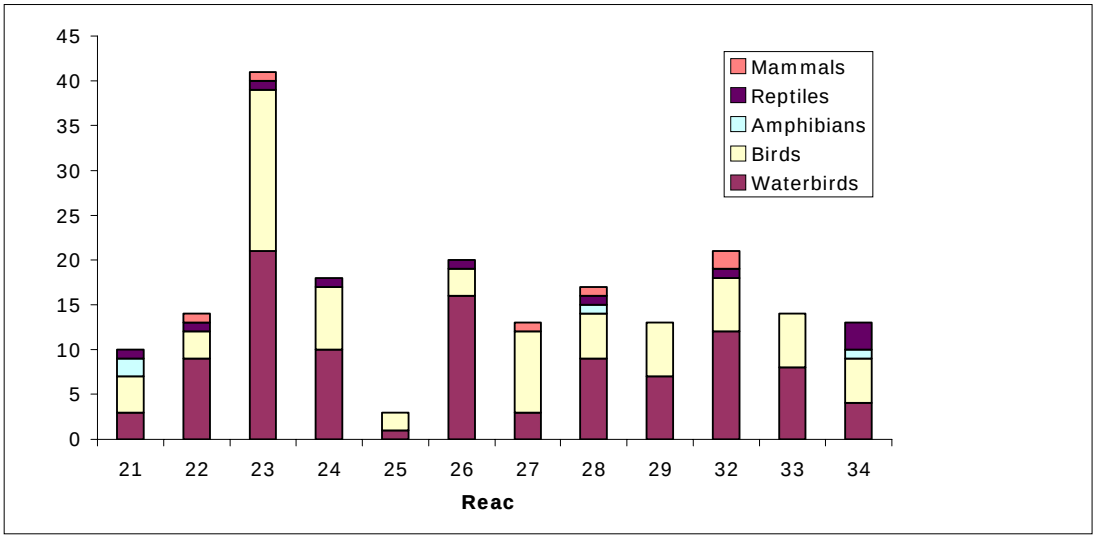

Figure A8: Number of threatened fauna species recorded within the management areas.

There is no data on the utilisation of floodplain and wetland habitat for native fish and the only recorded observations are from in-channel habitats.

Threats to Ecological Values

Threatening Activities

As mentioned previously (Section 3) threatening activities (as opposed to induced threats) are more likely to be able to be directly targeted by management. There is, however, limited spatial information on the extent and severity of threats across the Planning Area. Information presented in Section 3 for the whole of the Planning Area is not replicated here; rather, only threatening activities for which there is spatial data are described below.

Clearing

Extent of remaining native vegetation, as evidenced by tree density (Figure A9) indicates that dense or medium tree cover extends over 2 to 11 percent of the land in each management area. However, the greatest amount of dense trees is found along the mid to upper reaches of the Boosey Creek (MA 33 and MA 34).

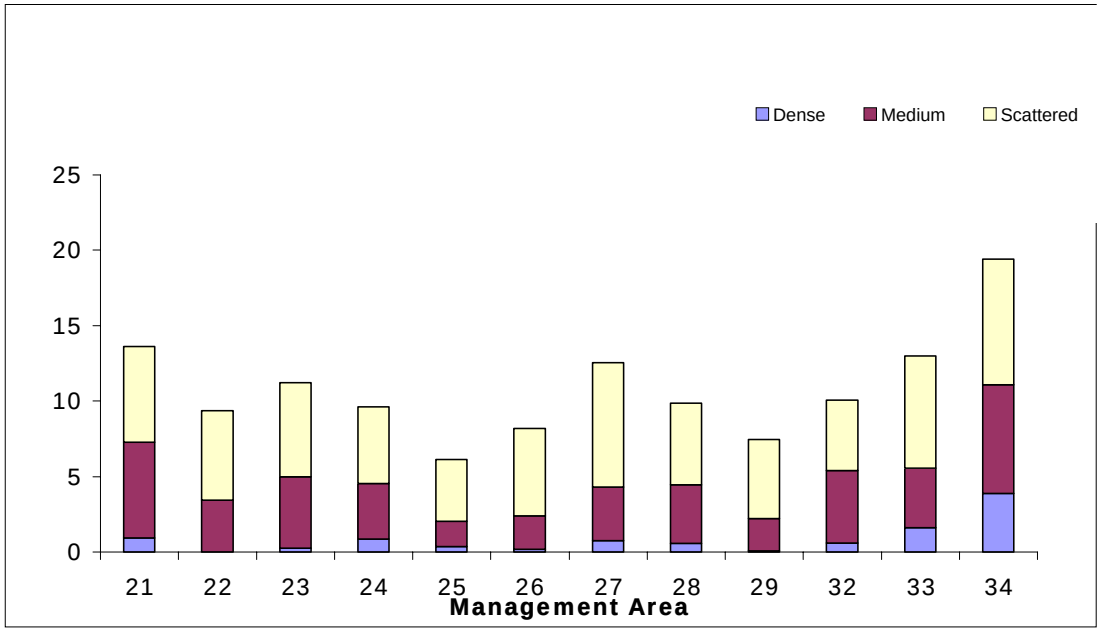

Figure A9: Tree density across the management areas.

Stock Grazing

Grazing is the predominant land use across the Planning Area, occupying between 47 and 73 percent of the total land area (Figure A10). Spatial data on fencing within the Planning Area is patchy and is not conducive to a comparison between management areas. However, the need for fencing has been identified and prioritised in the Waterway Action Plan for the Lower Broken Creek (SKM, 2005) and Boosey Creek Stream Assessment Report (SKM, 2001b). In addition, Parks Victoria (2005) identifies both the need for fencing and the need to remove some redundant fencing in the Broken Boosey State Park and associated natural features reserves.

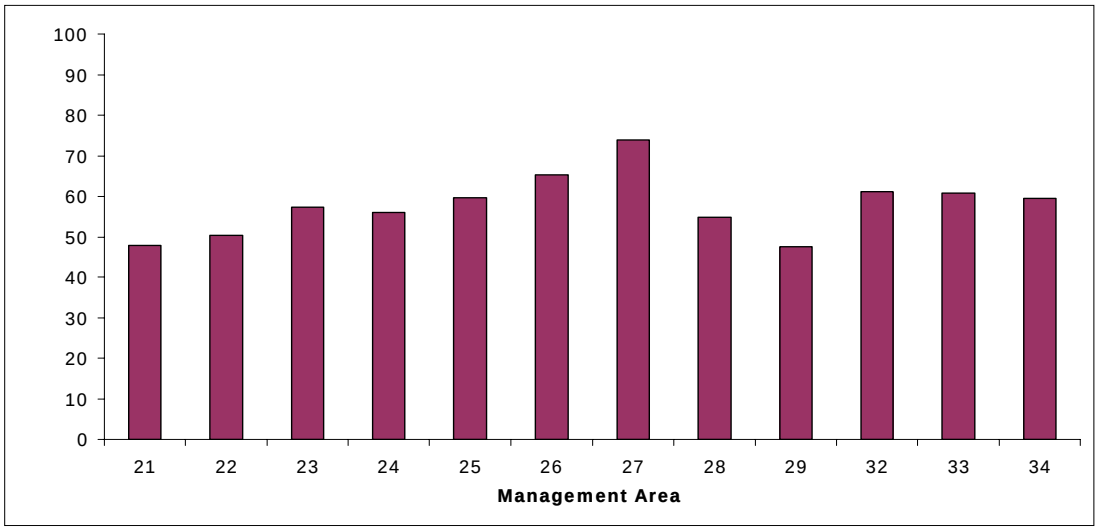

Figure A10: Grazing across the Planning Area (as a percentage of total management area extent).

Irrigation

Land subject to irrigation varies across the Planning Area (Figure A11) with management units located along the Lower Broken Creek (MA 21, - MA 24) and Nine Mile Creek (MA 28) with the highest percentage of land under irrigation. Although the impacts of irrigation on wetlands in the Planning Area have not been investigated, it is expected that changes to inundation patterns and deterioration of water quality from agricultural chemical run-off may result.

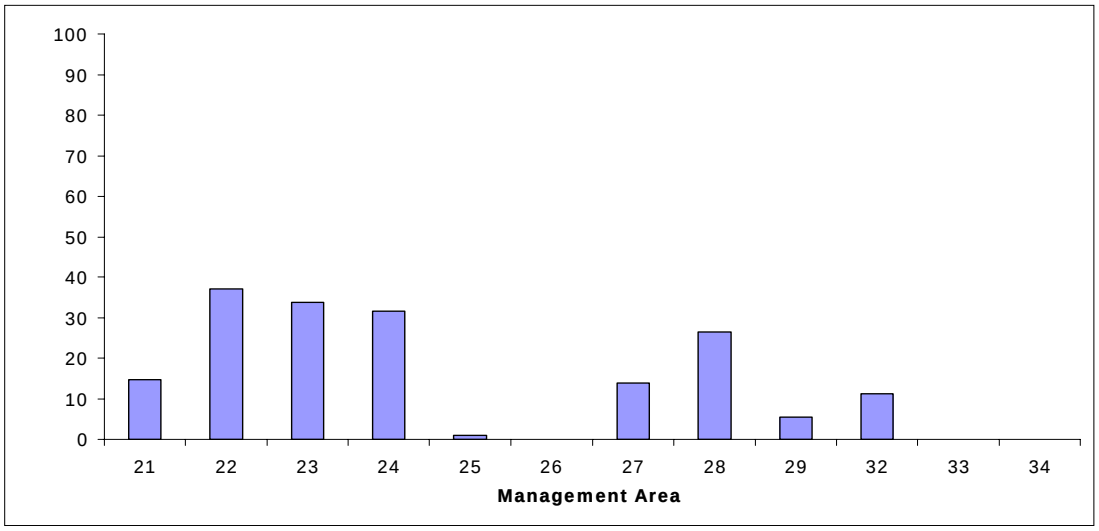

Figure A11: Irrigation across the Planning Area (as a percentage of total management area extent)

Induced Threats

Again, there is very little spatial information on induced threats. Little is known of the salinity, water quality, hydrology, and erosion of effects of drought on wetlands in the Planning Area and there is insufficient information to enable a comparison of management areas. The exception to this is the distribution of weeds across the Planning Area (Figure A12).

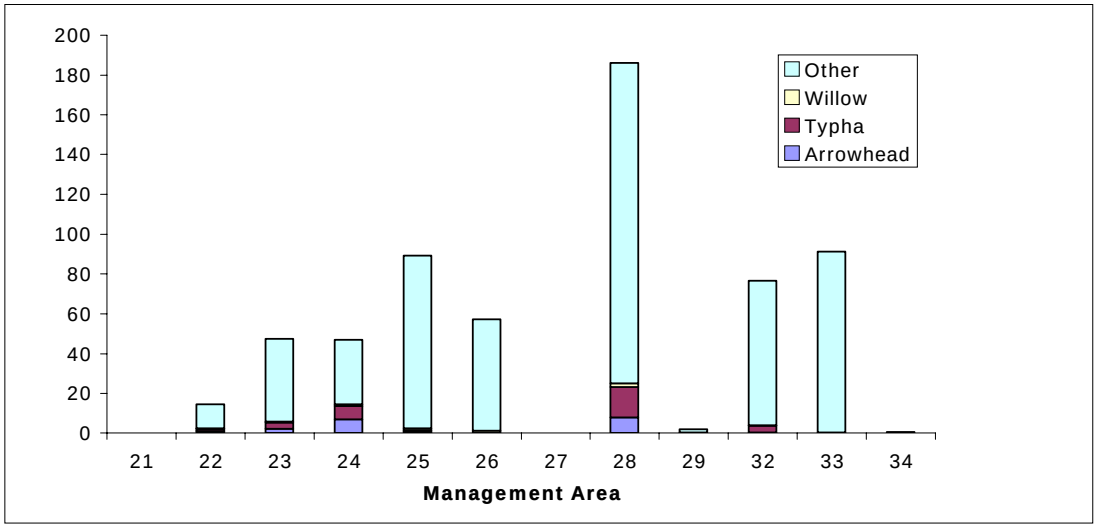

Figure A12: Extent of weeds across the Planning Area

The majority of weeds recorded were terrestrial in nature. The exceptions to this are willow, arrowhead and typha (listed as a weed due to its invasive nature). Arrowhead (*Sagittaria graminea*) however, is unlikely to be a significant threat to the floodplains and wetlands of the Planning Area, as this species requires constant, shallow inundation. As wetlands within this area are naturally intermittent, it is likely that, although a major threat to in-channel habitat, arrowhead is not a significant threat to the wetlands of the Broken, Boosey and Nine Mile Creeks.

Results of the field assessment indicated that the greatest impacts to wetland condition were from altered hydrology and surrounding landuse impacts. The major waterways within the Planning Area are regulated for irrigation, stock and domestic supply and although there is a significant knowledge gap with respect to inundation patterns of wetlands within the system, it is expected that altered stream flow patterns would also affect the filling and drying cycles of associated wetlands.

There is also a lack of data concerning water quality within wetlands in the Planning Area, but the lack of buffering vegetation surrounding a large number of wetlands and the high proportion of agricultural land use, it is likely that excessive nutrients and possibly herbicide and pesticide residues would be impacting wetlands.

Condition of Ecological Values

Wetlands

Information on the ecological condition of discrete wetlands within the Planning Area is severely limited (Section 4 and Appendix B). As a consequence, a complete comparison of wetland condition between management areas is not appropriate and this remains one of the significant knowledge gaps (Section 7).

However, an examination of the wetland sites assessed as a part of this project in March 2006 indicates that wetlands located on public land and managed for conservation were generally in good condition and all wetlands assessed as in "reference condition" were located on public land.

MA 26: Moodie's Swamp (reference condition)
MA 28: Black Swamp (reference condition)

MA 33: Lanigan's Swamp (slightly below reference condition)
Rowan Swamp (reference condition)

This does not mean that all wetlands on private property were necessarily in poor condition, and in fact the contrary was true for a number of wetland sites visited. Anecdotal evidence gathered during the field exercise, however, would suggest that access to wetlands on private property is biased towards landholders that are managing wetlands on their property, at least in part, for conservation purposes. Access to a number of wetlands was denied during the field program, often as landholders were unaware that intermittently inundated areas on their properties were classified as wetlands and a corresponding lack of understanding of the ecological value of these systems.

Vegetation

Condition of floodplain and wetland vegetation within the Planning Area has been assessed during a number of different programs. The Index of Stream Condition (DSE 2005b) assessed streamside vegetation within each reach during 2004, SKM (2005) undertook vegetation assessments at a large number of sites along the Lower Broken Creek in 2004, SKM (2001) applied the Index of Stream Condition methodology to an assessment of streamside vegetation along the Boosey Creek in 2000, and Arthur Rylah Institute undertook a large number of vegetation assessments (using habitat hectares, DSE, 2004) in the Planning Area. The results of these assessments have all been scaled to a score out of 190 for comparison (Figure A13).

Although it is difficult to detect a clear pattern from these assessments, all investigators reported better vegetation condition on public land and conservation zones than on private property.

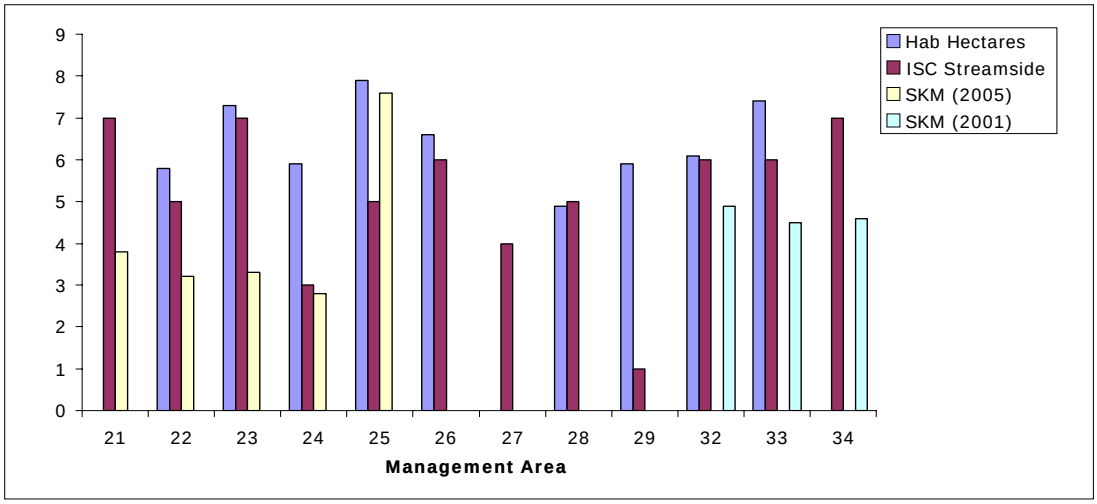

Figure A13: Vegetation condition (scaled to a score out of 10) across the Planning Area.

Conservation Value

Catchment scale analysis has identified the Planning Area as a high value asset within the Goulburn Broken CMA region (ECOS, 2004; ARI, 2002). Using the processes utilised in the Goulburn Broken Regional Catchment Management Strategy (GB CMA, 2003) and the Regional River Health Strategy (GB CMA, 2004) individual management areas and wetlands within could be identified as "high conservation value".

Based on recordings of threatened taxa, wetland number and extent, extent of significant EVCs and vegetation extent, MA 33 on the Boosey Creek would be clearly identified as of "high value". In addition, based on the criteria of bioregional significance, recorded threatened flora and fauna and wetland condition, the major wetlands managed for conservation purposes could be identified as of "high conservation value:

- Moodie's Swamp;
- Black Swamp;
- Lanigan's Swamp; and
- Rowan Swamp.

However, the identification of these systems does not take into account data limitation or sampling effort. In addition, aspects such as habitat connectivity, extent of habitat to maintain viable populations. Conservation value is often applied to species, communities and habitat which are considered to be under threat of extinction or loss and in order to focus conservation management actions (Possingham, *et al.,* 2002). Based on the catchment scale analysis which has identified the Planning Area as a high value asset within the Goulburn Broken CMA region (ECOS, 2004; ARI, 2002) all management areas should be considered as having high conservation value as well. Attempting to further rank the conservation value of the management areas within the Planning Area is hampered by data limitations and uneven sampling effort. Also there is a poor understanding of the historical pattern of disturbances at the management area scale, which is central to understanding the current condition of ecosystems (Wallington *et al.* 2005).

Current conditions are the product of a sites particular history of events, including the composition and pattern of those events (Parker and Pickett 1998, cited in Wallington *et al.,* 2005). The ongoing influence of past land-use activities on the composition, structure and function of ecosystems can last for decades and even centuries after the activity has ceased (Wallington *et al.* 2005). Thus it is important to have an understanding of the trajectory of change, including consideration of land-use, natural disturbance and natural successional processes where possible to aid in the planning process.