|  |
| --- |
| Aquatic Value Identification and Risk Assessment (AVIRA) Manual |

|  |
| --- |
| visionsofvictoria1115243-305 |

|  |
| --- |
| © The State of Victoria Department of Environment, Land, Water and Planning 2015    This work is licensed under a Creative Commons Attribution 3.0 Australia licence. You are free to re-use the work under that licence, on the condition that you credit the State of Victoria as author. The licence does not apply to any images, photographs or branding, including the Victorian Coat of Arms, the Victorian Government logo and the Department of Environment, Land, Water and Planning logo. To view a copy of this licence, visit <http://creativecommons.org/licenses/by/3.0/au/deed.en>  Printed by Riverness Pty Ltd  ABN 78 441 629 612  Suite 3, 108-110 Surfcoast Highway  Torquay VIC 3228 Australia  Web: [www.riverness.com.au](http://www.riverness.com.au)  ISBN **ISBN 978-1-74146-367-5 (pdf)**  **Accessibility**  If you would like to receive this publication in an alternative format, please telephone the DELWP Customer Service Centre on 136186, email [customer.service@delwp.vic.gov.au](mailto:customer.service@delwp.vic.gov.au) or via the National Relay Service on 133 677 [www.relayservice.com.au](http://www.relayservice.com.au). This document is also available on the internet at [www.delwp.vic.gov.au](http://www.delwp.vic.gov.au)  **Disclaimer**  This publication may be of assistance to you but the State of Victoria and its employees do not guarantee that the publication is without flaw of any kind or is wholly appropriate for your particular purposes and therefore disclaims all liability for any error, loss or other consequence which may arise from you relying on any information in this publication. |

Contents

[Aquatic Value Identification and Risk Assessment (AVIRA) Manual 1](#_Toc437955778)

[Contents 1](#_Toc437955779)

[Acknowledgements 6](#_Toc437955780)

[Acronyms 7](#_Toc437955781)

[1 Introduction 9](#_Toc437955782)

[1.1 Background 9](#_Toc437955783)

[1.2 Review of Regional River Health Strategies 9](#_Toc437955784)

[1.3 Development of the AVIRA Framework and Risk Assessment Process 10](#_Toc437955785)

[1.4 Methodology 10](#_Toc437955786)

[1.5 Report Structure 11](#_Toc437955787)

[2 AVIRA Conceptual Framework 12](#_Toc437955788)

[2.1 Defining Assets 12](#_Toc437955792)

[3 Asset Items 14](#_Toc437955793)

[3.1 Valuing Asset Items 14](#_Toc437955794)

[3.2 Defining Threats 15](#_Toc437955795)

[4 The AVIRA Software Application 16](#_Toc437955796)

[4.1 Background 16](#_Toc437955797)

[4.2 Population and Use of the AVIRA Software Application 16](#_Toc437955798)

[Part A Environmental Values 17](#_Toc437955799)

[5 Formally Recognised Significance 18](#_Toc437955800)

[5.1 International Significance - Ramsar Sites 18](#_Toc437955801)

[5.2 International Significance - East Asian-Australasian Flyway Sites 19](#_Toc437955802)

[5.3 International Significance - World Heritage Sites 20](#_Toc437955803)

[5.4 National Significance - Nationally Important Wetlands 21](#_Toc437955804)

[5.5 National Significance - Living Murray Icon Sites 21](#_Toc437955805)

[5.6 National Significance - National Heritage Sites 23](#_Toc437955806)

[5.7 State Significance - Heritage Rivers 24](#_Toc437955807)

[5.8 State Significance - Icon Rivers 25](#_Toc437955808)

[5.9 State Significance - Essentially Natural Catchments 26](#_Toc437955809)

[5.10 State Significance - Victorian Parks and Reserves 26](#_Toc437955810)

[5.11 State Significance - Victorian Heritage Sites 28](#_Toc437955811)

[6 Representativeness 30](#_Toc437955812)

[6.1 Representative Rivers 30](#_Toc437955813)

[6.2 Representative Wetlands 31](#_Toc437955814)

[6.3 Representative Estuaries 31](#_Toc437955815)

[7 Rare or Threatened Species/Communities 34](#_Toc437955816)

[7.1 Significant Fauna 34](#_Toc437955817)

[7.2 Significant Flora 40](#_Toc437955818)

[7.3 Significant EVCs 44](#_Toc437955819)

[8 Naturalness 48](#_Toc437955820)

[8.1 Aquatic Invertebrate Community Condition 48](#_Toc437955821)

[8.2 Native Fish 50](#_Toc437955822)

[8.3 Vegetation Condition 52](#_Toc437955823)

[9 Landscape Features 55](#_Toc437955824)

[9.1 Drought Refuges 55](#_Toc437955825)

[9.2 Important Bird Habitats 56](#_Toc437955826)

[9.3 Biosphere Reserves 58](#_Toc437955827)

[Part B Social Values 60](#_Toc437955828)

[10 Activity 61](#_Toc437955829)

[10.1 Recreational Fishing 61](#_Toc437955830)

[10.2 Non-Motor Boating 63](#_Toc437955831)

[10.3 Motor Boating 64](#_Toc437955832)

[10.4 Camping 65](#_Toc437955833)

[10.5 Swimming 66](#_Toc437955834)

[10.6 Beside Water Activities 67](#_Toc437955835)

[10.7 Game Hunting 69](#_Toc437955836)

[11 Place 70](#_Toc437955837)

[11.1 Heritage 70](#_Toc437955838)

[11.2 Landscape 71](#_Toc437955839)

[12 People 72](#_Toc437955840)

[12.1 Community Groups 72](#_Toc437955841)

[12.2 Use of Flagship Species 73](#_Toc437955842)

[Part C Economic Values 74](#_Toc437955843)

[13 Water 75](#_Toc437955844)

[13.1 Urban/Rural Township Water Sources 75](#_Toc437955845)

[13.2 Rural Water Sources for Production 75](#_Toc437955846)

[13.3 Water Storages 76](#_Toc437955847)

[13.4 Water Carriers 77](#_Toc437955848)

[13.5 Wastewater Discharges 78](#_Toc437955849)

[14 Power Generation 79](#_Toc437955850)

[14.1 Hydro-Electricity 79](#_Toc437955851)

[15 Other Resources 80](#_Toc437955852)

[15.1 Commercial Fishing 80](#_Toc437955853)

[15.2 Extractive Industries 81](#_Toc437955854)

[15.3 Timber Harvesting and Firewood Collection 82](#_Toc437955855)

[Part D Threats 84](#_Toc437955856)

[16 Altered Water Regimes 85](#_Toc437955857)

[16.1 River Reaches 85](#_Toc437955858)

[16.2 Wetlands 88](#_Toc437955859)

[16.3 Estuaries 89](#_Toc437955860)

[17 Altered Physical Form 92](#_Toc437955861)

[17.1 River Reaches 92](#_Toc437955862)

[17.2 Wetlands 95](#_Toc437955863)

[17.3 Estuaries 96](#_Toc437955864)

[18 Poor Water Quality 100](#_Toc437955865)

[18.1 River Reaches 100](#_Toc437955866)

[18.2 Wetlands 109](#_Toc437955867)

[18.3 Estuaries 111](#_Toc437955868)

[19 Degraded Habitats 114](#_Toc437955869)

[19.1 River Reaches 114](#_Toc437955870)

[19.2 Wetlands 118](#_Toc437955871)

[19.3 Estuaries 121](#_Toc437955872)

[20 Invasive Flora and Fauna 122](#_Toc437955873)

[20.1 River Reaches 122](#_Toc437955874)

[20.2 Wetlands 131](#_Toc437955875)

[20.3 Estuaries 133](#_Toc437955876)

[21 Reduced Connectivity 135](#_Toc437955877)

[21.1 River Reaches 135](#_Toc437955878)

[21.2 Wetlands 140](#_Toc437955879)

[21.3 Estuaries 140](#_Toc437955880)

[Part E Summary of Values and Threats 143](#_Toc437955881)

[22 Summary of AVIRA Values 144](#_Toc437955882)

[22.1 Environmental Values 144](#_Toc437955883)

[22.2 Social Values 146](#_Toc437955884)

[22.3 Economic Values 147](#_Toc437955885)

[23 Summary of AVIRA Threats 148](#_Toc437955886)

[Part F Summary of the Risk Assessment Process 150](#_Toc437955887)

[24 Risk Assessment Process for AVIRA 151](#_Toc437955888)

[24.1 Risk Management Process 151](#_Toc437955889)

[24.2 Establishing the Context 152](#_Toc437955890)

[24.3 Analysing Risks 153](#_Toc437955891)

[24.4 Risk Level 156](#_Toc437955892)

[24.5 Management Response 156](#_Toc437955893)

[References 159](#_Toc437955894)

[Appendix A - Workshop Participants 165](#_Toc437955895)

[Appendix B - List of Estuaries in AVIRA 167](#_Toc437955896)

[Appendix C - AVIRA User Manual – Version 2, November 2012 153](#_Toc437955897)

[Appendix D - AVIRA Data File Creation 179](#_Toc437955898)

[Appendix E - High Priority Victorian Parks and Reserves (A1 and A2) 195](#_Toc437955899)

[Appendix F - Representative Rivers for Victoria (Doeg 2001) 196](#_Toc437955900)

[Appendix G - Waterway Dependent Significant Fauna 198](#_Toc437955901)

[Appendix H - Waterway Dependent Significant Flora 213](#_Toc437955902)

[Appendix I - Waterway-Dependent EVCs 245](#_Toc437955903)

[Appendix J - Rules for Applying Water Quality and Aquatic Invertebrate Community Condition Data 256](#_Toc437955904)

[Appendix K - Victorian Regional Fishery Management Plans 258](#_Toc437955905)

[Appendix L - Non-Motor Boating In Victoria 262](#_Toc437955906)

[Appendix M - Motor Boating in Victoria 263](#_Toc437955907)

[Appendix N - Special Water Supply Catchment Areas in Victoria 264](#_Toc437955908)

[Appendix O - Irrigation Districts in Victoria 265](#_Toc437955909)

[Appendix P - Victorian Water Storages 267](#_Toc437955910)

[Appendix Q - Key Hydro-Electric Power Stations Operating in Victoria 270](#_Toc437955911)

[Appendix R - Eel Fishery Access Licences 271](#_Toc437955912)

Acknowledgements

The development of this report has involved the collective effort of a vast number of individuals and organisations. In particular, the author thanks the following:

* Sarina Loo, who managed the project, for her support, direction, timely advice and critical comment.
* Andrea White, who managed the implementation of AVIRA, the review of the initial report and development of this updated edition, contributed to the final form of specific metrics and developed the AVIRA manual and other supporting documents.
* The Project Steering Committee for advice, direction and decision-making:
  + Jane Doolan (Executive Director - DSE, SWE&ID)
  + Ian Rutherfurd (Director - DSE, SWE&ID)
  + Janet Holmes (Principle Policy Officer - DSE, BES)
  + Paul Wilson (Manager, Monitoring, Research and Innovation - DSE, SWE&ID)
  + Shelley Heron (Manager, Water Ecosystems - KBR)
  + Tim Doeg (consultant)
  + Nick Bond (Monash University, eWater)
  + Rhys Coleman (Team Leader, Strategic Planning & Biodiversity - Melbourne Water)
  + Greg Bain (Team Leader, Strategic Planning & Biodiversity - Melbourne Water)
  + Wayne Tennant (Manager, Strategic River Health - Goulburn Broken CMA)
  + Rex Candy (Strategy Implementation Manager - East Gippsland CMA)
  + Michelle Dickson (River Health Team Leader - East and West Gippsland CMAs)
  + Patrick Lea (Melbourne University, eWater)
  + Sarina Loo - Project Manager (Senior Policy Officer – DSE, SWE&ID)
* Phil Papas (Senior Scientist, Freshwater Ecology – DSE, ARI) and Dr Adam Pope (Deakin University) for their patience, advice and critical review as the author attempted to apply the Index of Wetland Condition and Index of Estuary Condition to AVIRA.
* All workshop participants whose specialist knowledge and experience ensured a defensible tool (a complete list of workshop participants is included in Appendix A).
* The Victorian Waterway Managers Forum whose strategic and practical knowledge ensured a usable tool.

The author also acknowledges the following individuals who contributed to the development of specific metrics:

* Leon Metzeling (Biological Program Manager, Freshwater Sciences - EPA Victoria) – Aquatic Invertebrate Community Condition and Degraded Water Quality metrics
* Adrian Moorrees (Project Manager, Actions for Biodiversity Conservation - DSE, BES) – Significant Flora and Fauna metrics
* Victoria Penko (Strategic Engagement Manager – DSE, SWE&ID) – Community Groups metric
* James Todd (Manager, Ecosystem Services Projects – DSE, BES) – Significant EVCs metric
* Tamara Boyd (State Ecological Water Manager - Parks Victoria) – Victorian Parks and Reserves metric

Acronyms

2ISC The second round of ISC assessments (undertaken in 2004)

3ISC The third round of ISC assessments (due in 2010)

ABC Actions for Biodiversity Conservation

ANRA Australian Natural Resources Atlas

ARI Arthur Rylah Institute

ASL Above Sea Level

AusRivAS Australian River Assessment System

AVIRA Aquatic Value Identification and Risk Assessment

BES Biodiversity and Ecosystem Services

BIRD Biodiversity Information Resources and Data

BMID Bacchus Marsh Irrigation District

CMA Catchment Management Authority

COAG Council of Australian Governments

CSIRO Commonwealth Scientific and Industrial Research Organisation

DAFF Department of Agriculture, Fisheries and Forestry

DEWHA Department of the Environment, Water, Heritage and the Arts

DNRE Department of Natural Resources and Environment

DPI Department of Primary Industries

DELWP Department of Environment, Land, Water and Planning

DSE Department of Sustainability and Environment

EEFAM Estuary Environmental Flows Assessment Methodology

EEMSS Estuary Entrance Management Support System

EEU Environmental Economics Unit

EPA Environment Protection Authority

EPBC Act Environment Protection and Biodiversity Conservation Act 1999

EPT Ephemeroptera, Plecoptera, Trichoptera

EVC Ecological Vegetation Class

FFG Act Flora and Fauna Guarantee Act 1988

GMW Goulburn Murray Water

HEVAE High Ecological Value Aquatic Ecosystem

IBA Important Bird Area

IBRA Interim Biogeographic Regionalisation for Australia

IEC Index of Estuary Condition

ISC Index of Stream Condition

IUCN International Union for Conservation of Nature

IWC Index of Wetland Condition

LCC Land Conservation Council

LWRRDC Land and Water Resources Research and Development Corporation

MDBC Murray Darling Basin Commission

MID Macalister Irrigation District

NLWRA National Land and Water Resources Audit

NWI National Water Initiative

RFMP Regional Fishery Management Plan

RiVERS River Values and Environmental Risk System

RRHS Regional River Health Strategy

RWS Regional Waterway Strategy

SedNet Sediment River Network Model

SEPP (WoV) State Environment Protection Policy – Waters of Victoria

SIGNAL Stream Invertebrate Grade Number - Average Level

SISC Social Index of Stream Condition

SRA Sustainable Rivers Audit

SRW Southern Rural Water

SWE&ID Sustainable Water, Environment & Innovation Division

SWSC Special Water Supply Catchment

UNESCO United Nations Educational, Scientific and Cultural Organisation

VWQMN Victorian Water Quality Monitoring Network

VRHS Victorian River Health Strategy

WES Water Entitlements and Strategies

WID Werribee Irrigation District

1. Introduction

Riverness Pty Ltd was engaged by the Department of Sustainability and Environment (DSE), now the Department of Environment, Land, Water and Planning (DELWP) to provide the framework and risk assessment processes to assist the development of an updated RiVERS decision support tool. This updated tool, named AVIRA (Aquatic Value Identification and Risk Assessment) has been used in the development of the Regional Waterway Strategies across Victoria.

* 1. Background

The Victorian Waterway Management Strategy, 2013, outlines the regional planning process for waterway management. As part of that process, Regional Waterway Strategies (RWSs) were required to be developed by Catchment Management Authorities (CMAs) by 2014.

The RWSs identify:

* regional goals for waterway management;
* high value waterways;
* a subset of priority waterways for an eight-year planning period; and
* a strategic regional work program of management activities for priority waterways to guide investment over the eight-year period.

As with the previous Regional River Health Strategies (RRHSs), the RWSs applied an asset-based approach to planning. Unlike the RRHSs, the RWSs brought together planning for rivers, estuaries and wetlands.

* 1. Review of Regional River Health Strategies

The RRHSs were completed by all nine Catchment Management Authorities (CMAs) and Melbourne Water between November 2004 and October 2006. The RiVERS decision tool was used to manage data on the values and threats to river reaches.

An analysis of values and threats allowed a risk assessment to be undertaken for each river reach, and from this management actions were then determined and prioritised. Each CMA developed its own risk assessment process outside of RiVERS, which led to some inconsistencies in the application of RiVERS.

Although the RRHSs have been successful documents for providing a framework for managing river health across the state (and particularly for prioritising management effort), it was recognised that improvements could be made.

To plan for the development of the RWSs, DSE commissioned GHD to review the current RRHSs – *Report for Review of Regional River Health Strategies* (GHD 2007). One of the key recommendations from this review was the need to improve the RiVERS database. Particular issues identified included:

* Social and economic data not as well represented in RiVERS as environmental data.
* Threat identification not as robust as value identification, with issues raised including:
  + Lack of clarity between ‘threats’ and ‘threatening processes’.
  + Use of realised threats or impacts only, with no recognition of potential threats.
  + Threats often occur in reaches upstream of the high value reach, whereas RiVERS focuses on threats to values within a reach.
  + Climate change related threats were not represented.
* RiVERS was not good at undertaking risk assessment. This is not to say that the risk assessment process in RiVERS was flawed (the module covered likelihood and consequence as well as a number of other useful variables such as trajectory), but that CMAs found it to be too time consuming to enter data. As a result, CMAs developed and utilised risk assessment spreadsheets that were automated and hence, more time efficient.
  1. Development of the AVIRA Framework and Risk Assessment Process

Based on the recommendations from GHD’s review (GHD 2007), DSE commissioned Riverness Pty Ltd to undertake a formal review of RiVERS and outline a preferred approach to the development of an improved RiVERS database - AVIRA.

In order to determine the purpose of AVIRA and present a prioritised listing of its desired functionalities, the following tasks were undertaken:

* review the purpose and use of RiVERS;
* review other natural resource management prioritisation approaches to find background for, and synergies with, the development of AVIRA; and
* seek comment and input from end-users in the purpose, scope and functionalities of AVIRA.

The final report *Determining the Purpose of RiVERS (II)* (Peters 2008) presented 20 recommendations on the purpose and functionalities of AVIRA. These recommendations guided the development of:

* the AVIRA framework and risk assessment processes, and
* the AVIRA software application.
  1. Methodology

Development of the framework included a review of the:

* Environmental Values and Threats to River Reaches;
* Social Values of Waterways; and
* Economic Values of Waterways.

and identification of:

* Environmental Values and Threats to Wetlands; and
* Environmental Values and Threats to Estuaries.

A total of seven discussion papers were drafted and subsequent expert workshops held to inform the development of the AVIRA framework and risk assessment process. The topics were:

1. Environmental Values of River Reaches
2. Threats to River Reaches
3. Environmental Values and Threats for Wetlands
4. Environmental Values and Threats for Estuaries
5. Social Values
6. Economic Values
7. Risk Assessment Processes

A list of workshop participants is provided in Appendix A.

The key outputs from the papers and workshops were:

* the development of a set of values and threats for each asset class (river reach, wetland and estuary). This included:
  + defining categories for each value type (environmental, social and economic);
  + developing a complete set of measures and metrics for each category; and
  + locating data sources to populate the metrics.
* the development of a risk assessment process to prioritise assets and threats.
  1. Report Structure

This report provides an outline of the AVIRA Framework, the AVIRA software application and then presents the waterway values, threats and risk assessment process included in AVIRA, under the following parts:

* Part A – Environmental Values
* Part B – Social Values
* Part C – Economic Values
* Part D – Threats
* Part E – Summary of Values and Threats
* Part F – Risk Assessment Process

1. AVIRA Conceptual Framework

Annett and Adamson (2008) describe a conceptual framework for an asset-based approach to natural resource management investment (refer to Figure 2.1).

Identify **broad** assets and services

Describe **broad** assets services

Identify **broad** threats to asset services

Assess risk to assets (via services)

Prioritise areas for local or site scale application

Link results to planning and investment process

Identify **specific** assets and services

Describe **specific** assets services

Identify **specific** threats to asset services

Assess risk to assets (via services)

Prioritise **specific** management of threats

Measure expected changes to specific asset services

State-wide or catchment scale application

Local or site scale application

Figure 1 - The Asset-Based Approach Conceptual Framework

The conceptual framework for AVIRA has been adapted from this framework and covers the first four stages. The first three stages are described in the following sections (and detailed in Figure 2.2 and Table 2.1). The fourth stage (risk assessment) is described in *AVIRA Risk Assessment Process* (Peters 2009) and summarised in Part F of this report.

The final two stages (covering prioritisation, planning and investment) were undertaken outside of AVIRA for the RWSs.

3. 1. Defining Assets

Assets are described as the biophysical elements of our environment that are valued by people for a variety of reasons. To determine the assets and associated values of waterways, the following asset categorisation steps have been adopted.

* + 1. Asset Classes

Aquatic asset classes can be divided into river reaches, wetlands, estuaries, groundwater and marine.

Ocean waters are considered outside the scope of AVIRA and hence are not considered any further. In addition, due to the current lack of knowledge and information regarding groundwater, this asset class will only be considered as it relates to the condition of river reaches, wetlands and estuaries.

ASSET

ITEM

Wetland Name

DELWP layer

WETLAND\_

Current

ASSET

CLASS

River Reaches

Wetlands

Estuaries

Groundwater

Marine

VALUE

TYPE

Environ.

Social

Economic

CATEGORY

* Formally Recognised Significance
* Rare or Threatened Species/Communities
* Naturalness
* Landscape Features
* Activity
* Place
* People
* Other Resources
* Water
* Power Generation

MEASURES

(EXAMPLE)

* Signif Fauna
* Signif EVCs
* Signif Flora

Figure 2 - AVIRA Conceptual Framework

1. Asset Items

Assets will be geographically identifiable as physical element of our environment, e.g. a specific area of land, a river reach or a particular wetland. AVIRA will identify assets by name and by a unique number as follows:

* River reaches (ISC Reach Number);
* Wetlands (Wetland Number from DELWP’s WETLAND\_Current layer)
* Estuaries (Estuary ID Number from DELWP’s estuary spatial layer)

River Reaches

The first round of RRHSs utilised data from the 1999 ISC. A second round of ISC assessments was undertaken in 2004; known as 2ISC and a third round of ISC assessments was undertaken in 2011; known as 3ISC. 3ISC was a substantial change from previous assessments as it used remote sensing methods to capture data for many of the sub-indices. This allowed analysis across entire river reaches, enabling a more accurate interpretation of condition than limited field inspections.

As AVIRA relies on data provided by the ISC to value river reaches and identify threats, the ISC river reaches were included as key asset items.

Wetlands

The wetlands in AVIRA include all of the wetlands assessed by the IWC in the two rounds of statewide assessments (high value wetlands and represesntative wetlands) and major water storages (see Appendix P) which were assessed as a wetland asset. CMAs were also asked to provide a list of wetlands that they would like uploaded to AVIRA, these were added in October 2012. CMAs also have the option to add wetlands individually to AVIRA, using the*Request New Wetland* tool.

Estuaries

The estuaries in AVIRA are the systems that were included in the IEC pilot program and additional estuaries identified by CMAs as being important systems. Appendix B lists the estuaries included in AVIRA and indicates if they were included in the IEC pilot program. The data collection for the IEC pilot program was delivered in January 2013. Wherever possible information collected as part of the IEC was used to inform the estuary metrics in AVIRA.

* 1. Valuing Asset Items

For each asset item described above, a valuation process can be undertaken as follows.

* + 1. Value Types

To maintain consistency with the triple bottom line approach to asset management, AVIRA considers environmental, social and economic values for each asset item.

* + 1. Categories

For each value type, categories have been determined that describe the assets key characteristics by grouping related values.

The environmental categories have been based on various approaches to determining freshwater ecosystems including:

* Draft Guidelines for Applying the Criteria for the Proposed HCVAE Assessment Process (Dunn 2007);
* Identifying and Protecting Rivers of High Ecological Value (Dunn 2000); and
* Conserving Freshwater Ecosystem Values in Tasmania, Australia: Identification and Application of Freshwater Conservation Management Priority Areas (Hardie and Davies 2007).

The social and economic categories have been adapted from the original RiVERS database.

For each asset class (river reach, wetland, estuary), these categories are the same.

* + 1. Measures

Under each category, one or more measures have been identified that represent particular waterway characteristics. For each measure (or combination of measures) a metric has been developed that assigns both descriptive and numerical values. An example is shown in Table 1.

Table 1 – Describing and valuing assets

| Value Type | Category | Measure | Metric | |
| --- | --- | --- | --- | --- |
| Descriptor | Value Score |
| Social | Activity | Recreational Fishing | Listed as a priority/key/popular fishery in a Regional Fishery Management Plan OR Rated as a ‘best fishing water’ in *A Guide to the Inland Angling Waters of Victoria* | 5 |
| Some recreational fishing occurs | 3 |
| Not known to be used for recreational fishing | 1 |
| Not suitable for recreational fishing | 0 |

For AVIRA, value scores range from 5 (very high value) to 1 (very low value). A score of 0 is sometimes used to signify ‘no value’.

* 1. Defining Threats

The threats identified for AVIRA have been categorised under the following groupings:

* Altered Water Regimes;
* Altered Physical Form;
* Poor Water Quality;
* Degraded Habitats;
* Invasive Flora and Fauna; and
* Reduced Connectivity.

Under each grouping, a number of individual threats have been identified (including, for example, changes to zero flow frequency, changes to flow seasonality, changes to bankfull flow frequency under Altered Water Regimes). The level of each of these individual threats can be quantified by specific metrics/measures. This enables an assessment of threat severity, ranging from 5 (very high threat) to 1 (very low threat). Where there is ‘no evidence’ of a threat impacting on a value a severity score of 1 is applied as a precautionary measure. Where there is evidence that there is ‘no threat’ a score of 0 is used.

1. The AVIRA Software Application
   1. Background

The AVIRA tool is a desktop application accessible from a Citrix environment using a web browser. It is developed as a plug-in to the Open Source GIS product, MapWindow.

Access to the application requires authentication on two levels: to the Citrix server and to the application itself. Users authenticate in the Citrix environment. This gives them access to the Axapta Desktop. DELWP maintain and manage access to the AVIRA software application.

The AVIRA interface is shown below. The AVIRA user manual is provided in Appendix C.

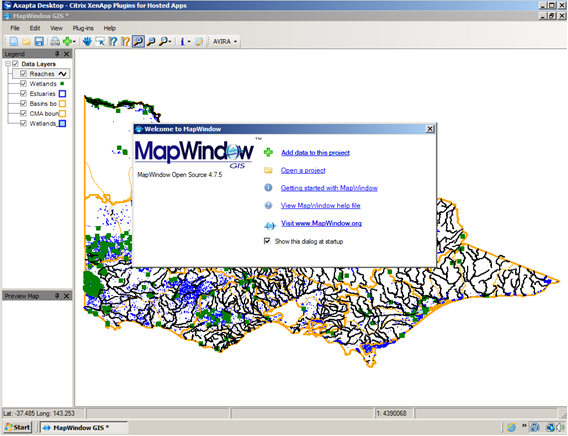


Figure 3 - AVIRA software application user interface

* 1. Population and Use of the AVIRA Software Application

AVIRA was populated within each catchment management authority region between 2011 and late 2013. Data was either provided by DELWP sourced from statewide data sets or developed by CMAs using local knowledge or data. Appendix D provides the instructions for the creation of data files for the AVIRA and the AVIRA data import file names. The data currently within AVIRA will be used as a resource during the implementation of the RWSs over the next eight years. Along with value and threats scores, significant additional information is recorded as the rationale for the score.

Part A Environmental Values

Environmental values have been grouped under the following categories:

* Formally Recognised Significance;
* Representativeness;
* Rare or Threatened Species/Communities;
* Naturalness; and
* Landscape Features.

These categories are presented in the following sections.

1. Formally Recognised Significance

This category considers waterway-related sites with international, national or state agreements; specifically:

* International Significance
  + Ramsar Sites
  + East Asian-Australasian Flyway Sites
  + World Heritage Sites
* National Significance
  + Nationally Important Wetlands
  + Living Murray Icon Sites
  + High Ecological Value Aquatic Ecosystems
  + National Heritage Sites
* State Significance
  + Heritage Rivers
  + Icon Rivers
  + Essentially Natural Catchments
  + Victorian Parks and Reserves
  + Victorian Heritage Sites

Any waterway that has been recognised as being of international, national or state significance has automatically been assigned ‘high value waterway’ status in the RWSs. Therefore, no value ratings are required (as risk assessments on status is not appropriate) and instead, a binary ‘yes or no’ rule-set has been adopted.

* 1. International Significance - Ramsar Sites
     1. Background

The Ramsar Convention on Wetlands is an inter-governmental treaty that provides the framework for international cooperation for the conservation of wetlands, one of the most threatened habitats in the world. As a contracting party to the Ramsar Convention, Australia is required to meet a number of obligations including the maintenance of the ecological character of its Ramsar sites through conservation and wise use (DNRE 2002a).

There are 57 sites in Australia that are listed under the Convention with 11 sites occurring in Victoria, namely:

* Barmah Forest;
* Corner Inlet;
* Edithvale-Seaford Wetlands;
* Gippsland Lakes;
* Gunbower Forest;
* Hattah-Kulkyne Lakes;
* Kerang Wetlands;
* Lake Albacutya;
* Port Phillip Bay and Bellarine Peninsula;
* Western District Lakes; and
* Western Port.
  + 1. Valuing Ramsar Sites

To be listed as a wetland of International Importance, or a ‘Ramsar site’, wetlands must meet one or more internationally accepted criteria in relation to their zoology, botany, ecology, hydrology or limnology and importance to waterfowl.

Therefore, only those waterways specifically listed in a Ramsar Site Strategic Management Plan as key features of a Ramsar site will be considered.

AVIRA Metric - International Significance (Ramsar Sites)

Based on the above, International Significance (Ramsar Sites) value was scored using the following metric:

| High Value Waterway | Descriptor | Data Descriptor |
| --- | --- | --- |
| Yes | International Significance – listed as a key feature of a Ramsar site | Listed |
| No | Not listed as a key feature of a Ramsar site | Not Listed |
| Data Sources:  Ramsar Site Strategic Management Plans  Australian Wetlands Database <http://www.environment.gov.au/water/publications/environmental/wetlands/database> | | |

* 1. International Significance - East Asian-Australasian Flyway Sites
     1. Background

Australia provides critical non-breeding habitat for millions of migratory waterbirds each year. Migratory waterbirds include species such as plovers, sandpipers, stints and curlews. The corridor through which these waterbirds migrate is known as the East Asian-Australasian Flyway.

To ensure their conservation, the Australian Government has fostered international cooperation through the recently launched East Asian-Australasian Flyway Partnership. Under the Flyway Partnership, the site network for shorebirds has been combined into a single network, referred to as the East Asian–Australasian Flyway Site Network.

There are 17 sites in Australia that are listed in the East Asian–Australasian Flyway Site Network with five sites occurring in Victoria, namely:

* Corner Inlet;
* Western Port;
* Port Phillip Bay (Western Shoreline) and Bellarine Peninsula;
* Shallow Inlet Marine and Coastal Park; and
* Discovery Bay Coastal Park.

These sites mainly cover wetland and coastal areas. In addition the eight bird species identified as significant within these sites have preferred habitats that are either coastal, estuarine or wetland.

* + 1. Valuing East Asian-Australasian Flyway Sites

To ensure that only those waterways providing critical non-breeding habitat for migratory waterbirds are recognised in AVIRA, only those waterways specifically listed within their respective management plans will be considered.

AVIRA Metric – International Significance (East Asian-Australasian Flyway Sites)

Based on the above, International Significance (East Asian-Australasian Flyway Sites) value was scored using the following metric:

| High Value Waterway | Descriptor | Data Descriptor |
| --- | --- | --- |
| Yes | International Significance – listed as a key feature of an East Asian-Australasian Flyway Site | Listed |
| No | Not listed as a key feature of an East Asian-Australasian Flyway Site | Not Listed |
| Data Sources:  *Corner Inlet Ramsar Site – Strategic Management Plan* (DNRE 2002)  *Western Port Ramsar Site – Strategic Management Plan* (DSE 2003)  *Port Phillip Bay (Western Shoreline) and Bellarine Peninsula Ramsar Site – Strategic Management Plan* (DSE 2003)  *Shallow Inlet Marine and Coastal Park – Park Notes* (Parks Victoria ~2008)  *Discovery Bay Parks Management Plan* (Parks Victoria 2004) | | |

* 1. International Significance - World Heritage Sites
     1. Background

Heritage includes places, values, traditions, events and experiences that capture where we've come from, where we are now and gives context to where we are headed as a community.

The World Heritage Convention aims to promote cooperation among nations to protect heritage from around the world that is of such outstanding universal value that its conservation is important for current and future generations. It is intended that, unlike the seven wonders of the ancient world, properties on the World Heritage List will be conserved for all time (DEWHA ~2008a).

* + 1. Valuing World Heritage Sites

The World Heritage List includes 878 properties forming part of the cultural and natural heritage which the World Heritage Committee considers as having outstanding universal value. These include 679 cultural, 174 natural and 25 mixed properties (UNESCO ~2009).

Australia has 17 properties currently listed on the World Heritage List with one property being in Victoria – the Royal Exhibition Building and Carlton Gardens – listed for its cultural values.

As no waterway sites are currently listed in the World Heritage List, no measure is proposed. However, should a Victorian waterway site be listed in the future, it will automatically be assigned ‘high value waterway’ status in AVIRA.

* 2. National Significance - Nationally Important Wetlands
     1. Background

In addition to the wetlands identified as internationally important, Victoria has a number of waterways of National importance as described in *A Directory of Important Wetlands in Australia* (Environment Australia 2001).

There are 159 wetlands in Victoria listed in the Directory, with a number containing more than one asset class. In summary: 21 are linked with river reaches; 19 with estuaries; and 133 with wetlands.

* + 1. Valuing Nationally Important Wetlands

The wetland classification system used in the Directory to determine nationally important wetlands is the same as that used by the Ramsar Convention in describing International importance.

Therefore, to ensure that only those waterways meeting nationally accepted criteria are recognised in AVIRA, only those waterways specifically listed as key features of the wetland sites will be considered.

AVIRA Metric - National Significance (Nationally Important Wetlands)

Based on the above, National Significance (Nationally Important Wetlands) value was scored using the following metric:

| High Value Waterway | Descriptor | Data Descriptor |
| --- | --- | --- |
| Yes | National Significance – listed as a key feature of a Nationally Important Wetland | Listed |
| No | Not listed as a Nationally Important Wetland | Not Listed |
| Data Sources:  *A Directory of Important Wetlands in Australia* (Environment Australia 2001)  Australian Wetlands Database <http://www.environment.gov.au/water/publications/environmental/wetlands/database> | | |

* 1. National Significance - Living Murray Icon Sites
     1. Background

The Living Murray was established in 2002 in response to evidence that the health of the River Murray system is in decline. The Living Murray’s first stage focuses on improving the environment at six ‘icon sites’ along the River:

* Barmah-Millewa Forest;
* Gunbower-Koondrook-Perricoota Forest;
* Hattah Lakes;
* Chowilla Floodplain and Lindsay-Wallpolla Islands;
* Lower Lakes, Coorong and Murray Mouth; and
* River Murray Channel.

The sites were chosen for their high ecological value—most are listed as internationally significant wetlands under the Ramsarconvention—and also their cultural significance to Indigenous people and the broader community (MDBC 2006a).

* + 1. Valuing Living Murray Icon Sites

Five of the Living Murray Icon Sites occur (wholly or partly) in Victoria.

Barmah-Millewa Icon Site

The Barmah-Millewa Icon Site, composed of the Barmah Forest in Victoria and the Millewa group of forests in New South Wales, is the largest River Red Gum (*Eucalyptus camaldulensis*) forest in Australia. It covers approximately 66,000 ha of floodplain between the townships of Tocumwal, Deniliquin and Echuca and contains a diverse range of wetland environments (MDBC 2006b).

Hattah Lakes Icon Site

The Hattah Lakes Icon Site encompasses the whole of the Hattah Lakes and adjoining floodplain system. The Hattah Lakes have been listed under the Directory of Important Wetlands in Australia, and 12 of the lakes have been listed under the International Ramsar Convention on Wetlands (MDBC 2006c).

Chowilla Floodplain and Lindsay-Wallpolla Islands

The Chowilla Floodplain and Lindsay–Wallpolla icon site spans South Australia, New South Wales and Victoria, with Chowilla in South Australia and New South Wales, and Lindsay–Wallpolla Islands in Victoria. The Lindsay–Wallpolla Islands include three separate anabranch systems within the Murray–Sunset National Park: Wallpolla Island, Mulcra Island and Lindsay Island. Wallpolla Island, Lindsay Island and Lake Wallawalla are listed in A Directory of Important Wetlands in Australia (Environment Australia 2001).

The Chowilla Floodplain and anabranch system falls within NSW and SA.

Gunbower-Koondrook-Perricoota Icon Site

The River Red Gum forests of Koondrook-Perricoota (NSW) and Gunbower (Victoria) cover approximately 50,000 ha of River Murray floodplains to the west of the town of Echuca. This combined forest is second only in size to the Barmah-Millewa Forest (MDBC 2006d).

River Murray Channel Icon Site

The River Murray is 2,530km long from its source in the Australian Alps to its mouth on Encounter Bay in South Australia. For some 1,880 km of its length, the river marks the boundary between New South Wales and Victoria. The length of the River Murray Channel from Hume Dam to Wellington is 2,152km (MDBC 2006e).

The longitudinal extent of the River Murray Channel Icon Site is defined as the River Murray from Hume Dam to Wellington (MDBC 2006e).

The lateral extent of the River Murray Channel Icon Site is defined as:

* the physical River Murray channel – its bed and banks, in-stream habitat, and those parts of the riparian zone that directly influence in-stream habitat condition for flora and fauna; and
* anabranches and wetlands not already included as part of another Icon Site that are affected by regulated flows or can be opportunistically managed in delivering outcomes at other Icon Sites (MDBC 2006e).

From these definitions, the entire length and width of the River Murray’s riparian zone (and floodplain) within Victoria (from Hume Dam to the South Australian border) is recognised as part of the River Murray Channel Icon Site.

AVIRA Metric – National Significance (Living Murray Icon Sites)

Based on the above, National Significance (Living Murray Icon Sites) value was scored using the following metric:

| High Value Waterway | Descriptor | Data Descriptor |
| --- | --- | --- |
| Yes | National Significance – listed as a key feature of a Living Murray Icon Site | Listed |
| No | Not listed as a key feature of a Living Murray Icon Site | Not Listed |
| Data Sources:  Living Murray Icon Site Environmental Management Plans  The Living Murray <http://www.thelivingmurray.mdbc.gov.au> | |  |

* 1. National Significance - National Heritage Sites
     1. Background

National Heritage System

The National Heritage List has been established to list places of outstanding heritage significance to Australia. It includes natural, historic and Indigenous places that are of outstanding national heritage value to the Australian nation (DEWHA ~2008a).

* + 1. Valuing National Heritage Sites

There are 27 places listed in the National Heritage List in Victoria with six listed for their natural values, namely:

* Australian Alps National Parks and Reserves - Alpine National Park;
* Australian Alps National Parks and Reserves - Avon Wilderness;
* Australian Alps National Parks and Reserves - Baw Baw National Park;
* Australian Alps National Parks and Reserves - Mt Buffalo National Park;
* Australian Alps National Parks and Reserves - Snowy River National Park; and
* Grampians National Park (Gariwerd).

AVIRA Metric – National Significance (National Heritage Sites)

Based on the above, National Significance (National Heritage Sites) value was scored using the following metric:

| High Value Waterway | Descriptor | Data Descriptor |
| --- | --- | --- |
| Yes | National Significance - key feature of a place listed in the National Heritage List | Listed |
| No | Not a key feature of a place listed in the National Heritage List | Not Listed |
| Data Source:  *Australia’s National Heritage List* http://www.environment.gov.au/topics/heritage/heritage-places/national-heritage-list | | |

* 1. State Significance - Heritage Rivers
     1. Background

In 1991, Victoria reviewed the values of all its rivers and put in place a system of heritage rivers. Eighteen river reaches were designated as Heritage Rivers because of their very high nature conservation, recreational, social or cultural value or because of a combination of these values. These rivers are protected under the *Heritage Rivers Act 1992* (DNRE 2002a).

* + 1. Valuing Heritage Rivers

Heritage Rivers have:

* One or more values of national or international significance, where those values are strongly associated with a substantial section of the watercourse; or
* An aggregation of at least four values, generally of State or greater significance, which together create a corridor of Victorian heritage status (DNRE 2002a).

The following river corridors are designated as Heritage Rivers in Victoria:

* Mitta Mitta River
* Ovens River
* Howqua River
* Big River
* Goulburn River
* Wimmera River
* Genoa River
* Bemm, Goolengook, Arte and Erinundra Rivers
* Snowy River
* Suggan Buggan and Berrima Rivers
* Upper Buchan River
* Mitchell and Wonnangatta Rivers
* Thomson River
* Yarra River
* Lerderderg River
* Aire River
* Glenelg River
* Aberfeldy River

Of these, five include estuarine reaches, namely:

* Sydenham Inlet - part of Bemm River and its tributaries, Goolengook, Arte and Errinundra Rivers;
* Snowy River estuary - part of Snowy River;
* Mitchell River estuary - part of Mitchell and Wonnangatta Rivers;
* Aire River estuary - part of Aire River; and
* Glenelg River estuary - part of Glenelg River.

AVIRA Metric – State Significance (Heritage Rivers)

Based on the above, State Significance (Heritage Rivers) value was scored using the following metric:

| High Value Waterway | Descriptor | Data Descriptor |
| --- | --- | --- |
| Yes | State Significance - forms part of a Heritage River | Listed |
| No | Does not form part of a Heritage River | Not Listed |
| Data Source:  *Rivers and Streams Special Investigation: Final Recommendations* (LCC 1991) | | |

* 1. State Significance - Icon Rivers
     1. Background

Of the existing Heritage Rivers, two particularly stand out because of their:

* high level of conservation value;
* high level of naturalness of flow;
* relative intactness of the entire river system; and
* significance for larger systems.

These are the Ovens River and the Mitchell River.

* + 1. Valuing Icon Rivers

The Ovens and Mitchell rivers represent the only two large rivers in Victoria that are in good condition and relatively intact throughout their entire river systems. Because of this, both provide vital inputs into larger scale systems – the Mitchell River to the Gippsland Lakes and the Ovens River to the Murray-Darling system (DNRE 2002a).

For these reasons, the VRHS (DNRE 2002a) recognised the Ovens and Mitchell Rivers as river systems of very high value.

Therefore, the Ovens and Mitchell Rivers were rated as High Value Waterways of State Significance in AVIRA.

AVIRA Metric – State Significance (Icon Rivers)

Based on the above, State Significance (Icon Rivers) value was scored using the following metric:

| High Value Waterway | Descriptor | Data Descriptor |
| --- | --- | --- |
| Yes | State Significance – listed as an Icon River in the VRHS | Listed |
| No | Not listed as an Icon River | Not Listed |
| Data Source:  *Victorian River Health Strategy* (DNRE 2002) | | |

* 1. State Significance - Essentially Natural Catchments
     1. Background

In addition to the Heritage Rivers describes in Section 3.8, the Land Conservation Council (LCC) Rivers and Streams Special Investigation (1991) identified 26 Essentially Natural Catchments. These catchments were considered important and were afforded protection under the *Heritage Rivers Act 1992*.

* + 1. Valuing Essentially Natural Catchments

An essentially natural catchment is one with no urbanisation, clearing, intensive agriculture, mining, extractive industries, water diversions, river engineering works, or roads parallel and immediately adjacent to streams (DNRE 2002a). As such, the physical and biological processes are essentially unimpaired, giving them high ecological value.

AVIRA Metric – State Significance (Essentially Natural Catchments)

Based on the above, State Significance (Essentially Natural Catchments) value was scored using the following metric:

| High Value Waterway | Descriptor | Data Descriptor |
| --- | --- | --- |
| Yes | State Significance – ≥50% of the waterway lies within an Essentially Natural Catchment | >=50% within ENC |
| No | <50% of the waterway lies within an Essentially Natural Catchment OR Waterway does not lie within an Essentially Natural Catchment | <50% within ENC |
| Data Source:  *Rivers and Streams Special Investigation: Final Recommendations* | | |

Note: Some waterways will not be linked to ISC reaches.

* 1. State Significance - Victorian Parks and Reserves
     1. Background

There are a number of park types in Victoria including:

* Gardens;
* Heritage Properties and Historic Places;
* Marine and Coastal Parks/Marine Reserves. An area of coastal, intertidal or subtidal land that because of its natural environment or the nature of the waters that cover it, is of conservation or scientific significance.
* National Parks. An extensive area of land of nationwide significance because of its outstanding natural environments and features, scenic landscapes and diverse land types.
* State Parks. An area of land containing natural environments and features, scenic landscapes and one or more land types complementing those found in national parks to provide a system representing the major land types of the State.
* Wilderness Parks. A large area with landforms and native plant and animal communities relatively unaltered or unaffected by the influence of the European settlement of Australia.
* Wildlife Sanctuaries;
* Metropolitan Parks;
* Reserves;
* Reservoir Parks;
* Regional Parks. An area of land containing indigenous or non-indigenous vegetation readily accessible from urban centres or major tourist routes and capable of providing opportunities for informal recreation for large numbers of people.
* Marine National Parks. Highly protected areas which represent the range of marine environments in Victoria, in which no fishing, extractive or damaging activities are allowed.
* Marine Sanctuaries. Smaller, highly protected area designated to protect their special values, in which no fishing, extractive or damaging activities are allowed. These areas complement Marine National Parks.

Parks Victoria currently undertakes planning and objective setting for environmental management across this network using the Levels of Protection framework. A key principle of the framework is that protected area planning and management is conducted in a bioregional context with the value, and hence priority, of biodiversity attributes assessed on the basis of:

* conserving the range of ecosystems and existing biotic diversity;
* the occurrence of attributes that depend on a particular park for their security;
* conserving ecosystem structure and function through addressing high risk threats; and
* higher ecological viability and integrity of populations.

This framework uses this basis to assess the relative contribution a park (or area of a park) makes to biodiversity conservation in a landscape (Victorian bioregional) context. This allows parks to be classified (or grouped) according to composition and representation of attributes classified at the ecological vegetation class and species scale.

Data used in this process is currently available for terrestrial parks.

* + 1. Valuing Victorian Parks and Reserves

Using the framework described above, Parks Victoria has prioritised all parks and reserves into six Park Groups:

* A1 - 20 parks
* A2 - 27 parks and reserves
* B - 106 parks and reserves
* C - 249 parks and reserves
* D - 495 parks and reserves
* E - 1922 reserves

The highest priorities are those parks and reserves in Park Groups A1 and A2 (refer to Appendix E).

To determine which waterways within these Park Groups should be considered as key features, it is recommended that CMAs and Melbourne Water consult with regional Parks Victoria staff (using the waterways cited in park management plans as a preliminary list).

AVIRA Metric – State Significance (Victorian Parks and Reserves)

Based on the above, State Significance (Victorian Parks and Reserves) value was scored using the following metric:

| High Value Waterway | Descriptor | Data Descriptor |
| --- | --- | --- |
| Yes | State Significance - key feature of a park or reserve listed within Park Groups A1 or A2 \* | Park A1 or A2 |
| No | Not a key feature of a park or reserve listed within Park Groups A1 or A2 | Not Park A1 or A2 |
| Data Sources:  Parks Victoria MS Access Database  Parks Victoria Management Plans, Parks Notes, etc.  Local knowledge | | |

\* Some waterways will not be linked to ISC reaches.

* 1. State Significance - Victorian Heritage Sites
     1. Background

Places and objects included in the Heritage Register are generally considered to be of 'state-wide' significance. In other words, of importance to the understanding of Victorian history.

The types of places included on the Victorian Heritage Register include:

* buildings and places;
* objects;
* gardens and trees;
* cemeteries;
* precincts;
* archaeological places and relics; and
* shipwrecks, relics and protected zones.
  + 1. Valuing Victorian Heritage Sites

There are 1,783 places listed in Victoria. Of these places, no attempt has been made to identify the number with waterways listed as key features. Therefore, it is recommended that the CMAs and Melbourne Water access the Heritage Victoria website to determine which places are relevant to their management regions and, of these, only consider those places listed for their natural values and where waterways are identified as a key feature (i.e.cited in the place title or described within a corresponding management plan).

AVIRA Metric – State Significance (Victorian Heritage Sites)

Based on the above, State Significance (Victorian Heritage Sites) value was scored using the following metric:

| High Value Waterway | Descriptor | Data Descriptor |
| --- | --- | --- |
| Yes | State Significance - key feature of a place listed in the Victorian Heritage Register | Listed |
| No | Not a key feature of a place listed in the Victorian Heritage Register | Not Listed |
| Data Source:  *Victorian Heritage Database* <http://vhd.heritage.vic.gov.au/vhd/heritagevic> | | |

1. Representativeness

Representativeness is a critical component for ecosystem and species conservation and a foundation of the Comprehensive, Adequate and Representative (CAR) approach to conservation planning (Dunn 2007).

DNRE (2002a) stated that one of the major values to be considered in the regional river health planning process was the need to have a series of representative rivers across the State i.e.rivers in an ecologically healthy condition that can be used to represent the major river classes that once occurred naturally across Victoria.

The same could be said for wetlands and estuaries.

The following sections detail approaches to determining representative river reaches, wetlands and estuaries for Victoria.

* 1. Representative Rivers
     1. Background

The *Rivers and Streams Special Investigation: Final Recommendations* (LCC 1991) identified 16 river catchment types for Victoria based on geomorphic and hydrologic criteria. For each river catchment type, a representative river was identified based on factors such as how ‘typical’ they were and their condition compared with others of that type.

Since 1991, there has been a considerable increase in our understanding of river ecology and considerably more data on riverine and terrestrial biodiversity. Doeg (2001) reviewed the LCC approach and updated the major river types for Victoria based on land type and system, fish and aquatic invertebrate communities, and terrestrial biodiversity. Ecologically healthy rivers (or rivers as close as possible to ecologically healthy) were then nominated within each type as being representative. This work resulted in the classification of 19 river types and the identification of 21 representative rivers for Victoria (covering 59 river reaches) (refer to Appendix F).

* + 1. Valuing Representative Rivers

Based on Doeg (2001), the VRHS (DNRE 2002a) contains a list of representative rivers for the major river types in Victoria. These representative rivers were identified as an interim list and are open for review in light of new knowledge.

AVIRA Metric – Representative Rivers

Based on the above, Representative River value was scored using the following metric:

| Value | Descriptor | Data Descriptor |
| --- | --- | --- |
| Listed | Listed as a Representative River in the VRHS | Listed |
| Not Listed | Not listed as a Representative River in the VRHS | Not Listed |
| Data Source:  *Victorian River Health Strategy* (DNRE, 2002a)  Doeg (2001) | | |

* 1. Representative Wetlands
     1. Background

The first criterion for determining nationally important wetlands in Australia is that a wetland is a good example of a wetland type (i.e.wetlands that are unique or representative) occurring within a biogeographic region in Australia (Environment Australia 2001).

The Interim Biogeographic Regionalisation for Australia (IBRA) is used as the framework for applying this criterion. Bioregions are large, geographically distinct areas of land with common characteristics such as geology, landform patterns, climate, ecological features and plant and animal communities. There are 28 bioregions currently described for Victoria.

The *Directory of Important Wetlands in Australia* has identified 132 wetland sites in Victoria as meeting this criterion (refer to Table 11.3 in Environment Australia, 2001 p94).

Victoria has used a wetland classification system commonly known as the Corrick system since the late 1970s. The Corrick system was developed between 1976 and 1982, and applied to the wetlands in the previous wetland spatial layer (Wetland 1994).

A new Victorian wetland classificiation system will be consistent with the Australian National Aquatic Ecosystem (ANAE) Classification Framework and is due to be completed in 2014. The updated system was required to:

* facilitate consistent reporting at the national level;
* incorporate better information about wetlands; and
* overcome limitations of the Corrick system.

There are two steps involved in developing a list of representative wetlands for Victoria

1. The new classification system and typology must be finalised and applied to all Victorian wetlands
2. Condition information must be available across the state
   * 1. Valuing Representative Wetlands

Further work is required once the new classification system and typology is finalised and applied to Victorian wetlands, to determine the best examples (i.e. wetlands of sufficiently good condition) of the different wetland types.

Whilst good progress has been made on wetland classification and condition assessment in Victoria, a system for identifying representative wetlands has not been determined. Therefore this metric was not accessed in AVIRA at this time.

* 1. Representative Estuaries
     1. Background

Classification

Classifying estuaries into different categories can aid condition assessments and enable the preparation of realistic management plans and restoration activities.

Barton (2003) reviewed a number of existing approaches to estuary classification in Australia. This review revealed that estuary classifications were commonly defined with reference to physical and salinity characteristics. However, the lack of available data for most Victorian estuaries (particularly salinity characteristics) limited the number that could be classified.

As a result, Barton (2003) proposed a ‘working’ classification for Victorian estuaries where the salinity regime and inland extent is not known. This classification was based on:

1. whether the estuary is known to be intermittently closed or permanently open;
2. whether it connects with the sea into a open oceanic coast with high wave energy and micro-tides, or into an embayment or sheltered coast with low wave energy and meso-tides; and
3. the four of the five biological regions defined by Metzeling et al (2004). These incorporate a lot of the variability in flow and water quality in fresh waters and so provide a useful third level of hierarchy.

This classification was further refined by Barton (2006), based on whether the estuary was in an embayment or open coast and for the latter, the direction of the coastline (refer to Figure 4).

Figure 4 - Classification of Victoria's Estuaries (from Barton (2006))

Condition

As for estuary classification, a number of approaches to assessing the condition of estuaries have been developed e.g.Edgar et al 1999, NLWRA 2002, Arundel et al 2008.

The NLWRA (2002) assessed the condition of estuaries across Australia using a number of variables, including: catchment natural cover; land use; catchment hydrology; tidal regime; floodplain; estuary use; pests and weeds; and estuary ecology.

Sixty-three estuaries were assessed by the NLWRA in Victoria with the following results:

* near pristine – 13;
* largely unmodified – 20;
* modified – 24;
* extensively modified – 4; and
* not assessed – 2.

The IEC is designed to evaluate the condition of Victorian estuaries. The IEC identified six themes for assessing estuarine condition (refer to Arundel et al 2008):

* **Physical form**. The physical structure of an estuary includes depth, bed, banks and the presence of structures that alter connectivity to marine and freshwater and connectivity of the estuary to riparian areas and any associated wetlands.
* **Hydrology**. The hydrological regime of an estuary includes timing and volume of freshwater, marine and groundwater inputs, these in turn affect stratification patterns in the estuary.
* **Water quality**. The naturalness of water quality includes parameters such as dissolved oxygen, nutrients, suspended matter, salinity and temperature.
* **Sediment**. The sediment of an estuary includes features of sediment quality such as nutrients, toxicants and dissolved oxygen; and aspects of physical structure such as particle size, erosion, sedimentation and sediment transport.
* **Flora**. The flora of an estuary includes microphytes and macrophytes associated with the water column and sediment in the subtidal, intertidal and riparian areas. This theme also includes microbial communities.
* **Fauna**. The fauna of an estuary includes fish and birds as well as meiofauna and macrofauna associated with the sediment, water column and plants.
  + 1. Valuing Representative Estuaries

Whilst good progress has been made on estuary classification and condition assessment in Victoria, a system for identifying representative estuaries has not been determined. Therefore this metric was not accessed in AVIRA at this time.

1. Rare or Threatened Species/Communities

Protection of biodiversity has focussed in a significant way on rare and threatened species (Dunn, 2000).

It is vital we maintain and sustain our biodiversity for a number of reasons:

* biodiversity provides us with many natural products including food, medicines and timber;
* ecosystems underpin many of our natural resources and provide services such as clean water, healthy soil and pollination of crops; and
* many people find enjoyment from the range of leisure activities undertaken in the natural environment (CSIRO ~2008).

This category considers species and communities identified as rare or threatened at an international, national or state level; specifically:

* Significant Fauna;
* Significant Flora; and
* Significant EVCs.

The following sections detail approaches to measuring and valuing rare or threatened species/communities in Victoria.

* 1. Significant Fauna
     1. Background

There are number of international, national and state approaches to listing significant fauna. The following provides an overview of these approaches for the hierarchical metric to value significant fauna.

Actions for Biodiversity Conservation

The traditional approach to priority setting for threatened species is based on the conservation status of a species alone i.e.critically endangered species tends to take precedence over vulnerable species, and so on.

More recently, however, DSE has reassessed the approach to prioritising threatened species and developed a system known as the Actions for Biodiversity Conservation (ABC). The ABC requires priorities to be set between locations for a species and between actions at each location. A high priority location is one which is most likely to persist in the long-term, usually because the population of the species concerned is large, healthy and/or genetically diverse or because the habitat it occupies is secure, extensive and/or in good condition (DSE 2007a).

IUCN Red List

The International Union for Conservation of Nature (IUCN) Red List of Threatened Species provides taxonomic, conservation status and distribution information on taxa that have been globally evaluated using the IUCN Red List Categories and Criteria. This system is designed to determine the relative risk of extinction, and the main purpose of the IUCN Red List is to catalogue and highlight those taxa that are facing a higher risk of global extinction (i.e.those listed as Critically Endangered, Endangered and Vulnerable).

EPBC Act 1999

The EPBC Act provides a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities and heritage places (DEWHA ~2008b).

The EPBC Act website contains a database that provides information about species and ecological communities listed under the EPBC Act*.*

Advisory Lists of Threatened Fauna in Victoria

The advisory lists of threatened vertebrate and invertebrate fauna that are considered threatened, poorly known, near threatened or extinct in Victoria is maintained by the Department of Environment, Land, Water and Planning. The advisory list also identifies *Flora nd Fauna Guarantee Act 1988* threatened status. This information is provided in Appendix H.

Waterway dependent significant fauna species are identified in Appendix H. Only waterway dependent species are included in the significant fauna measures within AVIRA. These waterway dependent species were identified through expert advice and were defined as any animal species that relied, for at least some part of their lifecycle on rivers, wetlands or estuaries. There were some species included that are not strictly dependent on waterways, but whose habitat now only occurs in remnants surrounding waterways. The buffer used in the GIS query associated with the dataset for significant flora is included in Appendix G.

* + 1. Valuing Significant Fauna

Measure 1 - Actions for Biodiversity Conservation

| Descriptor | Data Descriptor |
| --- | --- |
| High priority threatened species are associated with the waterway (as determined by ABC database) | High Priority |
| Medium priority threatened species are associated with the waterway (as determined by ABC database) | Medium Priority |
| Low priority threatened species are associated with the waterway (as determined by ABC database) | Low Priority |
| No fauna surveys have been undertaken post 1980 | No data |

Measure 2 – IUCN Red List

| Descriptor | Data Descriptor |
| --- | --- |
| Supports waterway dependent species listed under the IUCN Red List as Extinct, Extinct in the Wild, Critically Endangered or Endangered | Endangered |
| Supports waterway dependent species listed under the IUCN Red List as Vulnerable | Vulnerable |
| Supports waterway dependent species listed under the IUCN Red List as Data Deficient | Data Deficient |
| Supports waterway dependent species listed under the IUCN Red List as Near Threatened | Near Threatened |
| No species listed under the IUCN Red List are known to occur | None Known |
| No fauna surveys have been undertaken post 1980 | No Data |

Measure 3 – EPBC Act 1999

| Descriptor | Data Descriptor |
| --- | --- |
| Listed under the EPBC Act as Presumed Extinct or Endangered | Endangered |
| Listed under the EPBC Act as Vulnerable | Vulnerable |
| Not listed under the EPBC Act | None Known |
| No fauna surveys have been undertaken post 1980 | No data |

Measure 4 – Advisory List of Threatened Vertebrate Fauna in Victoria (DEPI 2013)

| Descriptor | Data Descriptor |
| --- | --- |
| Listed under the *Advisory List of Threatened Vertebrate Fauna in Victoria* as Extinct, Regionally Extinct, Extinct in the Wild, Critically Endangered or Endangered | Endangered |
| Listed under the *Advisory List of Threatened Vertebrate Fauna in Victoria* as Vulnerable | Vulnerable |
| Listed under the *Advisory List of Threatened Vertebrate Fauna in Victoria* as Data Deficient | Data Deficient |
| Listed under the *Advisory List of Threatened Vertebrate Fauna in Victoria* as Near Threatened | Near Threatened |
| Not listed under the *Advisory List of Threatened Vertebrate Fauna in Victoria* | None Known |
| No fauna surveys have been undertaken post 1980 | No data |

Measure 5 – Draft Advisory List of Threatened Invertebrate Fauna in Victoria (DEPI 2009)

| Descriptor | Data Descriptor |
| --- | --- |
| Listed under the *Advisory List of Threatened Invertebrate Fauna in Victoria* as Extinct, Regionally Extinct, Extinct in the Wild, Critically Endangered or Endangered | Endangered |
| Listed under *Advisory List of Threatened Invertebrate Fauna in Victoria* as Vulnerable | Vulnerable |
| Listed under the *Advisory List of Threatened Invertebrate Fauna in Victoria* as Data Deficient | Data Deficient |
| Listed under the *Advisory List of Threatened Invertebrate Fauna in Victoria* as Near Threatened | Near Threatened |
| Not listed under the *Advisory List of Threatened Invertebrate Fauna in Victoria* | None Known |
| No fauna surveys have been undertaken post 1980 | No data |

Based on the above, Significant Fauna value was scored using two metrics:

* Significant Fauna (Invertebrates); and
* Significant Fauna (Vertebrates).

The ABC database has been utilised as the primary measure to value significant fauna in AVIRA. However, as the ABC database is still being developed, not all threatened species have been recorded and ranked. In these instances, the other measures will be utilised to identify fauna significance.

AVIRA Metric – Significant Fauna (Invertebrates)

| Value Score | Descriptor |
| --- | --- |
| 5 | Supports high priority waterway-dependent threatened species (as determined by ABC database)  IF NOT LISTED IN ABC THEN  Supports waterway-dependent species listed under the IUCN Red List as Extinct, Extinct in the Wild, Critically Endangered or Endangered OR Supports waterway-dependent species listed under the EPBC Act as Critically Endangered or Endangered OR Supports waterway-dependent species listed under the *Advisory List of Threatened Invertebrate Fauna in Victoria* as Extinct, Regionally Extinct, Extinct in the Wild, Critically Endangered or Endangered |
| 4 | Supports medium priority waterway-dependent threatened species (as determined by ABC database)  IF NOT LISTED IN ABC THEN  Supports waterway-dependent species listed under the IUCN Red List as Vulnerable OR Supports waterway-dependent species listed under the EPBC Act as Vulnerable OR Supports waterway-dependent species listed under the Advisory List of Threatened Invertebrate Fauna in Victoria as Vulnerable |
| 3 | Supports low priority waterway-dependent threatened species (as determined by ABC database)  IF NOT LISTED IN ABC THEN  Supports waterway-dependent species listed under the IUCN Red List as Data Deficient OR Supports waterway-dependent species listed under the Advisory List of Threatened Invertebrate Fauna in Victoria as Data Deficient |
| 2 | Supports waterway-dependent species listed under the IUCN Red List as Near Threatened OR Supports waterway-dependent species listed under the Advisory List of Threatened Invertebrate Fauna in Victoria as Near Threatened |
| 1 | Not known to support waterway-dependent threatened species |
| no data | No fauna surveys have been undertaken post 1980 |
| Data Sources:  ABC database - DSE  IUCN Red List <http://www.iucnredlist.org>  EPBC Species <http://www.environment.gov.au/epbc/index.html>  *Advisory List of Threatened Invertebrate Fauna in Victoria* (DSE 2009a) <http://www.dse.vic.gov.au/__data/assets/pdf_file/0016/103390/Advisory_List_of_Threatened_Invertebrate_Fauna_2009_FINAL_Sept_2009.pdf> | |

In addition, to more adequately assess impacts to specific invertebrate fauna, this metric was used to value three distinct faunal groups as follows:

| Significant Fauna - River | Significant Fauna - Wetland | Significant Fauna- Estuary |
| --- | --- | --- |
| Invertebrates – Aquatic | Invertebrates |  |
| Invertebrates – Riparian |  |  |

AVIRA Metric – Significant Fauna (Vertebrates)

| Value Score | Descriptor |
| --- | --- |
| 5 | Supports high priority waterway-dependent threatened species (as determined by ABC database)  IF NOT LISTED IN ABC THEN  Supports waterway-dependent species listed under the IUCN Red List as Extinct, Extinct in the Wild, Critically Endangered or Endangered OR Supports waterway-dependent species listed under the EPBC Act as Presumed Extinct or Endangered OR Supports waterway-dependent species listed under the *Advisory List of Threatened Vertebrate Fauna in Victoria* as Extinct, Regionally Extinct, Extinct in the Wild, Critically Endangered or Endangered |
| 4 | Supports medium priority waterway-dependent threatened species (as determined by ABC database)  IF NOT LISTED IN ABC THEN  Supports waterway-dependent species listed under the IUCN Red List as Vulnerable OR Supports waterway-dependent species listed under the EPBC Act as Vulnerable OR Supports waterway-dependent species listed under the Advisory List of Threatened Vertebrate Fauna in Victoria as Vulnerable |
| 3 | Supports low priority waterway-dependent threatened species (as determined by ABC database)  IF NOT LISTED IN ABC THEN  Supports waterway-dependent species listed under the IUCN Red List as Data Deficient OR Supports waterway-dependent species listed under the Advisory List of Threatened Vertebrate Fauna in Victoria as Data Deficient |
| 2 | Supports waterway-dependent species listed under the IUCN Red List as Near Threatened OR Supports waterway-dependent species listed under the Advisory List of Threatened Vertebrate Fauna in Victoria as Near Threatened |
| 1 | Not known to support waterway-dependent threatened species |
| no data | No fauna surveys have been undertaken post 1980 |

Data Sources:

ABC database - DSE

IUCN Red List <http://www.iucnredlist.org>

EPBC Species <http://www.environment.gov.au/epbc/index.html>

*Advisory List of Threatened Vertebrate Fauna in Victoria* (DSE 2007b) <http://www.dse.vic.gov.au/DSE/nrenpa.nsf/LinkView/996B0477753A4204CA256DD4007F1CA5DFEF2E4B890BDECECA256DDD0015D632>

In addition, to more adequately assess impacts to specific vertebrate fauna, this metric was used to value 18 distinct faunal groups as follows:

| Significant Fauna - River | Significant Fauna - Wetland | Significant Fauna - Estuary |
| --- | --- | --- |
| Fish – Migratory | Fish | Fish – Resident |
| Fish – Non-migratory | Birds | Fish – Dependent |
| Birds – Riparian | Amphibians | Birds |
| Birds – Waterway | Reptiles – aquatic | Reptiles |
| Amphibians | Reptiles – riparian |  |
| Reptiles – aquatic | Mammals |  |
| Reptiles – riparian |  |  |
| Mammals |  |  |

* 1. Significant Flora
     1. Background

As for fauna, a number of Victorian flora species have been listed as threatened under various international, national and state lists. The list of waterway dependent significant flora is provided in Appendix H.

As with significant fauna, only waterway dependent species are included in the significant flora measures within AVIRA. Waterway dependent species were identified through expert advice and were defined as any plant species that relied, for at least some part of their lifecycle on rivers, wetlands or estuaries. There were some species included that are not strictly dependent on waterways, but whose habitat now only occurs in remnants surrounding waterways. The buffer used in the GIS query associated with the dataset for significant flora is included in Appendix H.

* + 1. Valuing Significant Flora

Measure 1 - Actions for Biodiversity Conservation

| Descriptor | Data Descriptor |
| --- | --- |
| High priority threatened species are associated with the waterway (as determined by ABC database) | High Priority |
| Medium priority threatened species are associated with the waterway (as determined by ABC database) | Medium Priority |
| Low priority threatened species are associated with the waterway (as determined by ABC database) | Low Priority |
| No flora surveys have been undertaken post 1980 | No data |

Measure 2 – IUCN Red List

| Descriptor | Data Descriptor |
| --- | --- |
| Listed under the IUCN Red List as Extinct, Extinct in the Wild, Critically Endangered or Endangered | Endangered |
| Listed under the IUCN Red List as Vulnerable | Vulnerable |
| Listed under the IUCN Red List as Data Deficient | Data Deficient |
| Listed under the IUCN Red List as Near Threatened | Near Threatened |
| Not listed under the IUCN Red List | None Known |
| No flora surveys have been undertaken post 1980 | No data |

Measure 3 – EPBC Act 1999

| Descriptor | Data Descriptor |
| --- | --- |
| Listed under the EPBC Act as Presumed Extinct or Endangered | Endangered |
| Listed under the EPBC Act as Vulnerable | Vulnerable |
| Not listed under the EPBC Act | None Known |
| No flora surveys have been undertaken post 1980 | No data |

Measure 4 – Advisory List of Rare or Threatened Plants in Victoria

| Descriptor | Data Descriptor |
| --- | --- |
| Listed under the *Advisory List of Threatened Plants in Victoria* as Presumed Extinct or Endangered | Endangered |
| Listed under the *Advisory List of Threatened Plants in Victoria* as Vulnerable | Vulnerable |
| Listed under the *Advisory List of Threatened Plants in Victoria* as Poorly Known | Poorly Known |
| Listed under the *Advisory List of Threatened Plants in Victoria* as Rare | Rare |
| Not listed under the *Advisory List of Threatened Plants in Victoria* | None Known |
| No flora surveys have been undertaken post 1980 | No data |

Using the same approach as significant fauna, the ABC database will be utilised as the primary measure to value significant flora in AVIRA with other measures utilised where species are not currently recorded or ranked on the ABC database.

In addition, to ensure that only those species dependent on waterways are identified a buffer was used in a GIS query around waterways to encompass the pre 1750 riparian, floodplain, wetland and/or estuarine EVCs associated with each waterway.

AVIRA Metric – Significant Flora

| Value Score | Descriptor |
| --- | --- |
| 5 | Supports high priority waterway-dependent threatened species (as determined by ABC database)  IF NOT LISTED IN ABC THEN  Supports waterway-dependent species listed under the IUCN Red List as Extinct, Extinct in the Wild, Critically Endangered or Endangered OR Supports waterway-dependent species listed under the EPBC Actas Presumed Extinct or Endangered OR Supports waterway-dependent species listed under the *Advisory List of Rare or Threatened Plants in Victoria* as Presumed Extinct or Endangered |
| 4 | Supports medium priority waterway-dependent threatened species (as determined by ABC database)  IF NOT LISTED IN ABC THEN  Supports waterway-dependent species listed under the IUCN Red List as Vulnerable OR Supports waterway-dependent species listed under the EPBC Act as Vulnerable OR Supports waterway-dependent species listed under the *Advisory List of Rare or Threatened Plants in Victoria* as Vulnerable |
| 3 | Supports low priority waterway-dependent threatened species (as determined by ABC database)  IF NOT LISTED IN ABC THEN  Supports waterway-dependent species listed under the IUCN Red List as Data Deficient OR Supports waterway-dependent species listed under the *Advisory List of Rare or Threatened Plants in Victoria* as Poorly Known |
| 2 | Supports waterway-dependent species listed under the IUCN Red List as Near Threatened OR Supports waterway-dependent species listed under the *Advisory List of Rare or Threatened Plants in Victoria* as Rare |
| 1 | Not known to support waterway-dependent threatened species |
| no data | No flora surveys have been undertaken |
| Data Sources:  ABC database - DSE  IUCN Red List <http://www.iucnredlist.org>  EPBC Species <http://www.environment.gov.au/epbc/index.html>  *Advisory List of Rare or Threatened Plants in Victoria* (DSE 2005a) <http://www.dse.vic.gov.au/DSE/nrenpa.nsf/LinkView/996B0477753A4204CA256DD4007F1CA5DFEF2E4B890BDECECA256DDD0015D632> | |

In addition, to more adequately assess impacts to flora in specific landscape settings, this metric will be used to value four flora groups as follows:

| Significant Flora - River | Significant Flora - Wetland | Significant Flora - Estuary |
| --- | --- | --- |
| Aquatic | Wetland dependent flora | Aquatic |
| Terrestrial |  | Terrestrial |

* 1. Significant EVCs
     1. Background

Vegetation is typically described by reference to one or more of its attributes i.e.floristic composition, structure and important environmental determinants. In Victoria, the principal unit for vegetation circumscription and mapping for land-use planning and management is the Ecological Vegetation Class (EVC) (Parkes et al 2003).

Appendix I provides a list of waterway dependent EVCs linked to river reaches, wetlands and estuaries.

* + 1. Valuing Significant EVCs

Victoria’s Native Vegetation Management Framework (DNRE 2002c) states that the conservation significance of vegetation should be determined according to:

* the conservation status of vegetation types present;
* the quality of the vegetation;
* the conservation status of species present (and the potential habitat value);
* the strategic location in the local landscape; and
* other recognised criteria (e.g.commitments under international conventions).

Based on the above, two measures were selected to describe and value riparian, wetland and estuarine EVCs:

* conservation status; and
* condition.

The other determinants were excluded from further assessment as they form part of other categories (i.e.Formally Recognised Significance) or metrics (i.e.Significant Flora and Fauna) within AVIRA.

Measure 1 – Conservation Status

Assessment of the conservation status of vegetation types is traditionally based on the broad concepts of inherent rarity, degree of threat and importance for supporting other significant features. These concepts have been used to assign a conservation status for each combination of EVC and bioregion in Victoria (DNRE 2002c).

| Descriptor | Data Descriptor |
| --- | --- |
| Endangered | Endangered |
| Vulnerable | Vulnerable |
| Depleted | Depleted |
| Rare | Rare |
| Least Concern | Least Concern |

For the purposes of valuing waterways within AVIRA, the existence of a significant EVC is deemed to be more important than its size. Therefore, where a river reach, wetland or estuary supports more than one EVC, the EVC with the highest status was used.

Measure 2 – Condition

For riparian EVCs, vegetation quality was assessed using the Streamside Zone Sub-Index of 3ISC. This sub-index uses a value score system (ranging from 0 to 10) as follows:

Riparian Vegetation Condition

| Descriptor | Data Desciptor |
| --- | --- |
| Excellent Condition (9-10) | 3ISC Streamside Zone Score |
| Good Condition (7-8) |
| Moderate Condition (5-6) |
| Poor Condition (3-4) |
| Very Poor Condition(0-2) |

For wetland EVCs, vegetation quality is assessed using the IWC Biota Sub-Index. This sub-index uses a value score system (ranging from 0 to 20) as follows:

Wetland Vegetation Condition

| Descriptor | Data Descriptor |
| --- | --- |
| Excellent Condition (17-20) | IWC Biota Score |
| Good Condition (13-16) |
| Moderate Condition (9-12) |
| Poor Condition (5-8) |
| Very Poor Condition(0-4) |

These values score systems were used to describe the EVC condition for riparian and wetland EVCs.

For estuarine EVCs, work is underway to develop a state-wide approach to assessing the quality of estuarine vegetation (as per wetlands and rivers); however at this stage no information is available.

AVIRA Metric – Significant EVCs

Based on the rule sets for conservation status and habitat scores detailed in Victoria’s Native Vegetation Management Framework (DNRE 2002c), three metrics have been developed to score significant EVC value.

AVIRA Metric –Significant Riparian EVCs

| Conservation Status | Streamside Zone Sub-Index Score | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| 0 - 2 | 3 - 4 | 5 - 6 | 7 - 8 | 9 - 10 | no data |
| Endangered | 4 | 4 | 5 | 5 | 5 | 5 |
| Vulnerable | 3 | 4 | 4 | 5 | 5 | 4 |
| Depleted | 3 | 4 | 4 | 4 | 5 | 3 |
| Rare | 1 | 3 | 3 | 3 | 4 | 2 |
| Least Concern | 1 | 1 | 1 | 1 | 3 | 1 |
| Not Applicable\* | 0 | 0 | 0 | 0 | 0 | 0 |
| Data Sources:  EVC Benchmarks <http://www.dse.vic.gov.au/DSE/nrence.nsf/LinkView/43FE7DF24A1447D9CA256EE6007EA8788062D358172E420C4A256DEA0012F71C>  3ISC Streamside Zone Sub-Index | | | | | | |

\* Riparian vegetation described as cleared or heavily modified i.e.EVC 58 (cleared/disturbed) or EVC 997 (private land).

AVIRA Metric –Significant Wetland EVCs

| Conservation Status | Biota Sub-Index Score | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| 0 - 8 | 9-13 | 14-16 | 17-18 | 19-20 | no data |
| Endangered | 4 | 4 | 5 | 5 | 5 | 5 |
| Vulnerable | 3 | 4 | 4 | 5 | 5 | 4 |
| Depleted | 3 | 4 | 4 | 4 | 5 | 3 |
| Rare | 1 | 3 | 3 | 3 | 4 | 2 |
| Least Concern | 1 | 1 | 1 | 1 | 3 | 1 |
| Not Applicable\* | 0 | 0 | 0 | 0 | 0 | 0 |
| Data Sources:  EVC Benchmarks <http://www.dse.vic.gov.au/DSE/nrence.nsf/LinkView/43FE7DF24A1447D9CA256EE6007EA8788062D358172E420C4A256DEA0012F71C>  IWC Biota Zone Sub-Index | | | | | | |

\* Wetland vegetation described as cleared or heavily modified i.e.EVC 58 (cleared/disturbed) or EVC 997 (private land).

AVIRA Metric –Significant Estuarine EVCs

| Value Score | Descriptor | Data Descriptor |
| --- | --- | --- |
| 5 | Endangered | Endangered |
| 4 | Vulnerable | Vulnerable |
| 3 | Depleted | Depleted |
| 2 | Rare | Rare |
| 1 | Least Concern | Least Concern |
| 0 | Not Applicable\* |  |
| Data Source:  EVC Benchmarks <http://www.dse.vic.gov.au/DSE/nrence.nsf/LinkView/43FE7DF24A1447D9CA256EE6007EA8788062D358172E420C4A256DEA0012F71C>  Estuarine Vegetation Sub-Index Score to be developed | | |

\* Estuarine vegetation described as cleared or heavily modified i.e.EVC 58 (cleared/disturbed) or EVC 997 (private land).

1. Naturalness

This category uses the condition of specific waterway-dependent flora and fauna to act as surrogates for the naturalness of a particular waterway. Three naturalness values have been determined for AVIRA:

* Aquatic Invertebrate Community Condition;
* Native Fish; and
* Vegetation Condition.

These values are discussed in the following sections.

* 1. Aquatic Invertebrate Community Condition
     1. Background

River Reaches

Aquatic invertebrates are small animals, generally less than 1 cm long, and include mayfly and dragonfly nymphs, beetles, snails, worms, shrimp, and the like. They are very abundant in streams, occurring in all aquatic habitats. They can be found burrowed in mud, in or on woody debris (snags), on the surface of stones in fast flowing riffles and among macrophyte beds. As well as being important in their own right, invertebrates are critical to stream ecosystem functioning, both in the processing of energy, and as a food supply to yabbies, fish, platypus, and some birds (Metzeling et al 2004).

The Environment Protection Authority (EPA) Victoria has an extensive database of aquatic invertebrates covering the entire State, which has been crucial in delineating five bioregions across Victoria and developing biological objectives for each of these regions. These objectives have been designed to maintain the quality of the better sites in the regions and set goals for improvement for other sites within the regions.

To develop biological objectives, Metzeling et al (2004) chose five aquatic macro-invertebrate indicators under three categories:

* diversity
  + number of families;
* biotic indices (indicators of disturbance)
  + SIGNAL (Stream Invertebrate Grade Number - Average Level)
  + EPT (Ephemeroptera, Plecoptera, Trichoptera)
* community composition
  + number of key families
  + Australian River Assessment System (AusRivAS)

Wetlands

Victoria has a wide variety of inland lakes (defined by EPA Victoria as wetlands with >70% open water) including billabongs, volcanic lakes, sand-dune lakes and reservoirs. Some of these lakes have naturally high salinities and animal and plant communities that make them very different from lakes elsewhere in the world (EPA Victoria ~2008a).

EPA Victoria's lakes project aims to develop a better understanding of how Victoria’s lakes work and develop guidelines to help protect them. The guidelines are being developed through detailed studies of five lakes in the western district of Victoria – Bullen Merri, Purrumbete, Surprise, Colac and Modewarre. The project will set the course for future environmental condition assessment of Victorian lakes and support the evaluation and ongoing management of these ecosystems (EPA Victoria ~2008a).

At present, interim biological objectives have only been developed for lakes. These objectives will be released in 2009 and although trialled in a number of lakes, will require further verification. There are currently no plans to revise the State Environment Protection Policy – Waters of Victoria (SEPP (WoV) to incorporate them. There are no biological objectives for other wetland types at this stage.

Estuaries

Estuaries may be permanently or periodically open to the sea with salinities that vary from almost fresh to very saline. Environmental condition may be stable over long periods of time or change frequently or rapidly. Estuaries are, therefore, complex and highly variable environments that often appear to be unpredictable (EPA Victoria ~2008b).

In 2011, EPA Victoria released Environmental Water Quality Guidelines for Victorian Riverine Estuaries (EPA Victoria 2011). The guidelines include requirements for water quality parameters, including oxygen stress and nutrient and sediment impacts, which have sufficient data for analysis and good understanding of impact. However, at this stage, there are inadequate data and understanding to set biological guidelines for riverine estuaries. Therefore, there is no metric for Aquatic Invertebrate Community Condition (Estuaries) in AVIRA.

* + 1. Valuing Aquatic Invertebrate Community Condition

As biological objectives have only been developed for river reaches, it is currently not possible to adopt numeric values for aquatic invertebrate community condition for wetlands or estuaries.

However, provision should be made in AVIRA for inclusion of these values if/when the appropriate studies and guidelines are completed.

Appendix J outlines the rules for applying the Aquatic Invertebrate Community Condition measure to river reach assets within AVIRA.

AVIRA Metric – Aquatic Invertebrate Community Condition (River Reaches)

| Value Score | Descriptor | Data Descriptor |
| --- | --- | --- |
| 5 | Meets all biological objectives for rivers and streams \* | Meets All |
| 4 | Fails to meet 1 objective where 4 indicators are used for rivers and streams \* | Fails 1 from 4 |
| 3 | Fails to meet 1 objective where 3 indicators are used for rivers and streams \* | Fails 1 from 3 |
| 1 | Fails to meet 2 or more objective for rivers and streams \* | Fails 2 or More |
| no data | No aquatic invertebrate surveys have been undertaken and/or assessed | No Data |
| Data Source:  *Biological Objectives for Rivers and Streams – Ecosystem Protection* (Metzeling et al 2004) | | |

\* Indicators are AusRivAS, SIGNAL, EPT, No. of Families and No. of Key Families. The use of multiple indicators was deemed desirable as it improves the robustness and reliability of the assessment.

* 1. Native Fish
     1. Background

As part of the development of the RiVERS database, DSE’s Arthur Rylah Institute (ARI) developed the following datasets:

* native freshwater fish observed v expected (based on collected fish data (observed) and expert opinion on species distribution (expected); and
* proportion native freshwater fish (based on the number of native fish (observed) compared with the number of exotic fish (observed).

More recently, the Murray Darling Basin Commission (MDBC) has identified 13 fish indicators as part of the Sustainable Rivers Audit (SRA).

* + 1. Valuing Native Fish

River Reaches

Based on the SRA, the following subset of indicators may be considered useful in valuing native fish for river reaches:

* Native Freshwater Fish Observed/Expected;
* Species Richness (the total species richness (native and alien) at each site to a predicted maximum species richness (native and alien));
* Percentage Native Freshwater Fish Biomass (the proportion of the total biomass (weight) caught that has been contributed by native species of fish);
* Percentage Native Freshwater Fish Abundance (the proportion of individual fish caught in each site that were native species); and
* Percentage Native Freshwater Fish Species (the proportion of fish species in each site that were native species).

ARI combined the five SRA scores to produce a single fish index score.

Wetlands

A similar approach to the above is recommended for wetlands, but is yet to be developed or applied.

Estuaries

While some estuaries have been surveyed for fish, there is currently no established sampling protocol or regular monitoring. These need to be developed to standardise sampling and allow comparison of estuaries (Arundel et al 2008).

In addition, Arundel et al (2008) state that Victorian fish assemblage data needs to be examined before an expected pattern of distribution of fish trophic guilds (i.e.estuarine use and feeding mode) can be established.

Therefore, it is proposed to develop a metric for estuarine fish following collection, collation, analysis and review of Victorian data for the IEC.

AVIRA Metric – Native Fish

The single index score, produced from combining the five SRA scores was used for the following metric:

| Value Score | Descriptor | Data Descriptor |
| --- | --- | --- |
| 5 | Fish Index Score 80 – 100 (Good) | Fish Index Score |
| 4 | Fish Index Score 60 – 79 (Moderate) |
| 3 | Fish Index Score 40 – 59 (Poor) |
| 2 | Fish Index Score 20 – 39 (Very Poor) |
| 1 | Fish Index Score 0 – 19 (Extremely Poor) |
| no data | No native fish surveys have been undertaken and/or assessed | -1 |
| Data Source:  SRA data  ARI developed Fish Index Score (based on the SRA methodology) | |  |

* 2. Vegetation Condition
     1. Background

River Reaches

Riparian land with intact vegetation is vitally important to the health of a waterway because it provides:

* organic matter to a river – a major food source for aquatic fauna;
* a supply of woody debris within the river, which forms key habitat areas for many fish and invertebrates;
* a source of shade in upland areas which influences water temperature and light penetration producing suitable conditions for aquatic flora and fauna; and
* assistance in bank stabilisation, reducing erosion in many areas.

Wetlands

Wetland biota depend on wetlands for all or part of their lifecycle. They include phytoplankton, wetlands plants (e.g.herbs, ferns, shrubs, trees), aquatic invertebrates, vertebrates (such as fish, amphibians, birds, mammals and reptiles) and micro-organisms (e.g.fungi, diatoms and microbes) (DSE 2006b).

Estuaries

Important habitat types identified as habitat extent indicators in the national State of the Environment reporting (see Ward et al 1998) were:

* **Algal beds**. Subtidal beds of macroalgae are important elements of shallow waters in estuaries. Apart from their intrinsic floral values as a diverse suite of species, algal beds have important ecological roles such as harbouring many species of fauna.
* **Intertidal reef areas**. Intertidal reefs are key aspects of Australia’s coastal environment; hosting a substantial diversity of flora and fauna that are adapted to withstand the harsh salt-enriched and desiccating environment.
* **Intertidal sand/mudflat areas**. Intertidal sand and mudflats are important habitats for species of fish, crustaceans and some species of seagrasses; and they support other important species such as migratory wading birds that are the subject of a number of international agreements.
* **Mangrove areas**. Mangrove habitats are important elements of estuaries. They are species-rich habitats, and they shelter numerous species of fish and invertebrates.
* **Saltmarsh areas**. As habitat, saltmarshes are presumed to be highly productive, to have important roles as fish nurseries and to support other species of aquatic fauna. They are very important feeding and roosting areas for birds, including migratory waders covered by international agreements and locally rare species (including the Orange-bellied Parrot (Neophema chrysogaster) in Victoria).
* **Seagrass areas**. Seagrasses are highly valued for their intrinsic biodiversity.

The vegetation of estuaries is largely a function of inundation in relation to vertical elevation, made more complex by variable salinity. The Estuary Entrance Management Support System (EEMSS) project (Arundel 2006) identified 14 EVCs from the sub-group ‘estuaries’ (refer to Table 6.1).

Table 6.1- Estuarine EVCs

| EVC Name | EVC Number |
| --- | --- |
| Coastal saltmarsh | EVC 009 |
| Estuarine wetland | EVC 010 |
| Brackish sedgeland | EVC 013 |
| Mangrove shrubland | EVC 140 |
| Seasonally inundated sub-saline herbland | EVC 196 |
| Brackish herbland | EVC 538 |
| Saline aquatic meadow | EVC 842 |
| Sea-grass meadow | EVC 845 |
| Estuarine flats grassland | EVC 914 |
| Brackish grassland | EVC 934 |
| Estuarine reedbed | EVC 952 |
| Estuarine scrub | EVC 953 |
| Mud flats | EVC 990 |
| Littoral rainforest | no number |

* + 1. Valuing Vegetation Condition

AVIRA Metric – Riparian Vegetation Condition

The Streamside Zone Sub-Index of 3ISC was used to measure the degree of riparian vegetation naturalness, with Riparian Vegetation Condition value scored using the following metric:

| Value Score | Descriptor | Data Descriptor |
| --- | --- | --- |
| 5 | Streamside Zone Sub-Index Score: 9 - 10 | 3ISC SZ Score |
| 4 | Streamside Zone Sub-Index Score: 7 - 8 |
| 3 | Streamside Zone Sub-Index Score: 5 - 6 |
| 2 | Streamside Zone Sub-Index Score: 3 - 4 |
| 1 | Streamside Zone Sub-Index Score: 0 - 2 |
| no data | Riparian vegetation condition has not been assessed under 3ISC | -1 |
| Data Source:  3ISC Streamside Zone Sub-Index | | |

AVIRA Metric – Wetland Vegetation Condition

The key ecological component of the IWC Biota Sub-Index is wetland plants. To determine the condition of wetland plants, the IWC Field Assessment Sheet lists the following key steps:

1. Determine the wetland EVCs present at the wetland.
2. Estimate the proportion (e.g.0.1, 0.2 etc.) of the wetland area covered by each EVC.
3. Assess each EVC by undertaking wetland vegetation quality assessments based on:

* critical lifeforms;
* presence of weeds;
* indicators of altered processes; and
* vegetation structure and health.

1. Determine the Biota Sub-Index score.

To maintain consistency with the Riparian Vegetation Condition metric, the Biota Sub-Index was used to measure the condition of wetland plants, with Wetland Vegetation Condition value scored using the following metric:

| Value Score | Descriptor | Data Descriptor |
| --- | --- | --- |
| 5 | IWC Biota Sub-Index Score: 17- 20 | IWC Biota Score |
| 4 | IWC Biota Sub-Index Score: 13 - 16 |
| 3 | IWC Biota Sub-Index Score: 9 - 12 |
| 2 | IWC Biota Sub-Index Score: 5 - 8 |
| 1 | IWC Biota Sub-Index Score: 0 - 4 |
| no data | Wetland plant condition has not been assessed under IWC | -1 |
| Data Source:  IWC Biota Sub-Index | | |

AVIRA Metric – Estuary Vegetation Condition

A metric for estuary vegetation condition has not been determined. A metric for degraded estuarine vegetation was included in AVIRA, which utilised data from the IEC. This data could be used in future assessments to determine a metric for estuary vegetation condition.

1. Landscape Features

This category identifies three additional landscape features of waterways:

* Drought Refuges;
* Important Bird Habitats; and
* Biosphere Reserves.

These values are discussed in the following sections.

* 1. Drought Refuges
     1. Background

The essential components of a refuge are:

* it is a physical place secure from one or more disturbances; and
* it is a source of colonists for the wider landscape after disturbance has ceased (Robson et al 2008).

The need for refuges therefore implies that there is a disturbance, natural or anthropogenic, that threatens aquatic life and also that the disturbance will end so that there are opportunities for recolonisation.

Two types of places are clearly discernible as providing a refuge for a wide range of plants and animals:

* places where the natural water regime is maintained; and
* places where natural water-riparian zone interactions are maintained (Robson et al 2008).
  + 1. Valuing Drought Refuges

DSE recently engaged Monash University to develop predictive models that explain historical freshwater fish species distributions in Victorian rivers, and to apply these models to explore potential distributional changes expected under four different climate scenarios:

* step change (continuation of the last 13 years of drought (1997-2010); and
* low, median and high CSIRO climate-change scenarios for 2030 (Bond et al 2010).

Based on the modelled fish distributions under the step change (drought) scenario, Thompson and Bond (2011) have identified and classified:

* 243 ISC reaches as having a high likelihood of acting as refuge habitat during drought for at least one threatened species[[1]](#footnote-1); and
* 701 ISC reaches as having a high likelihood of acting as refuge habitat during drought for non-threatened species.

Whilst these results can be used to value those rivers providing drought refuge to native fish, no comparable or consistently adopted approach currently exists in Victoria to identify:

* drought refuges within river systems for other native fauna/flora species; or
* drought refuges within wetland or estuarine systems.

It is therefore recommended that for these circumstances, regional organisations nominate an interim set of drought refuge areas using the definitions as described in Section 8.1.1 in combination with local knowledge.

AVIRA Metric – Drought Refuges

Based on the above, Drought Refuge value was scored using the following metric:

| Value Score | Descriptor | Data Descriptor |
| --- | --- | --- |
| 5 | Modelled drought refuge for one or more significant fish species OR Nominated drought refuge for significant fauna and/or significant EVCs | Significant Refuge |
| 3 | Modelled drought refuge for one or more other fish species OR Nominated drought refuge for other fauna and/or EVCs | Other Refuge |
| 1 | Not a modelled drought refuge OR Not considered to be a drought refuge | No Refuge |
| no data | Value of waterway as a drought refuge has not been assessed or considered | No data |
| Data Sources:  *Interpreting Species Distribution Models to Identify Drought Refuges for Native Fish in Victorian Streams* (Thompson and Bond 2011).  CMA Dry Inflow Contingency Plans  Australian Wetlands Database (specifically, wetlands meeting criterion 3) <http://www.environment.gov.au/water/publications/environmental/wetlands/database>  Regional Wetland Strategies  Local knowledge | | |

* 1. Important Bird Habitats
     1. Background

Effective conservation of Australia’s birds requires that we focus our activities at a regional scale, to particular bird species, or to specific sites of interest (Birds Australia ~2009). For AVIRA, the following bird habitats have been determined as important for prioritisation:

* Important Bird Areas;
* Migratory Shorebird Sites; and
* Colonial Nesting Bird Sites.
  + 1. Valuing Important Bird Habitats

Measure 1 - Important Bird Areas

Important Bird Areas (IBAs) are sites of global bird conservation importance and are priority areas for bird conservation. Each IBA meets one of four global criteria used by BirdLife International. The following IBAs are located in Victoria:

* Cheetham & Altona
* Anderson's Inlet
* Werribee & Avalon
* Avoca Plains
* Barmah - Millewa
* Bellarine Wetlands
* Victorian Box-Ironbark
* Carrum Wetlands
* Corner Inlet
* Discovery Bay to Picanninnie Ponds
* Gabo & Tullaberga Island
* Gippsland Lakes
* Lake Buloke
* Lake Corangamite Complex
* Lawrence Rocks
* Little Desert
* Lower Snowy & Brodribb Rivers
* Murray-Sunset, Hattah & Annuello
* Nadgee to Mallacoota Inlet
* Natimuk-Douglas
* North Victorian Wetlands
* Otway Ranges
* Patho Plains
* Phillip Island
* Port Fairy to Warrnambool
* Pukapunyal
* Riverland
* Shallow Inlet
* Swan Bay & Port Phillip Bay Islands
* Terrick Terrick woodlands
* Wandown
* Westernport Bay
* Wilson's Prom Islands
* Wyperfeld, Big Desert & Ngarkat
* Yambuk
* Victorian Alps

| Descriptor | Data Descriptor |
| --- | --- |
| Important bird area | Important |
| Not considered to be an important bird area | Not Important |

Measure 2 - Migratory Shorebird Sites

In addition to the five internationally significant shorebird sites occurring in Victoria (refer to Section 4.2), Birds Australia have listed an additional 12 sites considered important to migratory shorebirds (Birds Australia ~2009), namely:

* Lough Calvert
* Lake Martin
* Lake Murdeduke
* Ocean Grove to Barwon Heads
* Gippsland Lakes
* Port Fairy to Warrnambool coast
* Lake Tutchewop, Kerang
* Lake Buloke
* Edithvale-Seaford Wetlands
* Anderson Inlet
* Hazelwood Cooling Pond
* Lake Hindmarsh

| Descriptor | Data Descriptor |
| --- | --- |
| Important habitat for migratory shorebirds | Important |
| Not considered to be an important habitat for migratory shorebirds | Not Important |

Measure 3 - Colonial Nesting Bird Sites

Colonial nesting waterbirds (e.g.ibis, egrets, herons and spoonbills) are widespread throughout much of Australia, particularly in the south east and along coastal regions. These waterbirds are found in a variety of habitats, including terrestrial wetlands, grasslands and sheltered marine habitats. Breeding occurs in groups in either fresh or brackish water, often in wetlands surrounded with reeds and trees which are used for nest building. Feeding usually occurs in shallow waters, or along the margins of deep water bodies.

| Descriptor | Data Descriptor |
| --- | --- |
| Important breeding habitat for colonial nesting birds | Important |
| Not considered to be an important breeding habitat for colonial nesting birds | Not Important |

AVIRA Metric – Important Bird Habitats

Based on the above, the Important Bird Habitat value was scored using the following metric:

| Value Score | Descriptor |
| --- | --- |
| 5 | Important bird area OR Important habitat for migratory shorebirds OR Important breeding habitat for colonial nesting birds |
| 1 | Not considered to be an important bird habitat |
| Data Source:  Birds Australia (~2009) <http://www.birdsaustralia.com.au> | |

* 1. Biosphere Reserves
     1. Background

A Biosphere Reserve is an international designation made by the United Nations Educational, Scientific and Cultural Organisation (UNESCO) on the basis of nominations submitted by countries participating in the Man and the Biosphere Program (DEWHA ~2008c). However this designation does not alter the legal status of the land and there are no internationally legally binding requirements regarding their management (MDBC 2006c).

Australia has 14 Biosphere Reserves with four occurring in Victoria, namely:

* Croajingolong National Park;
* Hattah-Kulkyne National Park;
* Mornington Peninsula and Western Port; and
* Wilsons Promontory Marine Park & Marine Reserve.

Two of these reserves (Croajingolong National Park and Hattah-Kulkyne National Park) specifically include freshwater ecosystems within their respective management plans.

* + 1. Valuing Biosphere Reserves

Biosphere Reserves have been nominated based on a mosaic of ecological systems. To ensure that only those waterways considered significant in the Biosphere nomination process are recognised, only those waterways listed as key features of the Biosphere Reserves should be considered (i.e.described within a corresponding management plan).

AVIRA Metric –Biosphere Reserves

Based on the above, Biosphere Reserve value was scored using the following metric:

| Value | Descriptor | Data Descriptor |
| --- | --- | --- |
| Listed | Listed as a key feature of a Biosphere Reserve | Listed |
| Not Listed | Not listed as a key feature of a Biosphere Reserve | Not Listed |
| Data Sources:  *Croajingolong National Park Management Plan* (DNRE 1996)  *Hattah-Kulkyne Lakes Ramsar Site Strategic Management Plan* (DSE 2003)  *Wilsons Promontory National Park Management Plan* (Parks Victoria 2002) | | |

Part B Social Values

Social values have been grouped under the following categories:

* Activity;
* Place; and
* People.

These categories are presented in the following sections.

1. Activity

This category considers the recreational use of waterways; specifically:

* recreational fishing;
* non-motor boating;
* motor boating;
* camping;
* swimming;
* beside water activities; and
* game hunting.

The following sections detail approaches to measuring and valuing the recreational uses of waterways.

* 1. Recreational Fishing
     1. Background

Recreational fishing is popular in rivers, lakes and estuaries and can take place:

* from the bank (including fishing platforms);
* in the water (e.g.fly fishing); and
* on the water (from a boat).

Over 500,000 Victorians go fishing each year (DPI 2007a); some for the relaxation, others for the sport. Although some anglers are happy just to catch any fish, the species most freshwater anglers target are trout, redfin, golden perch, and Murray cod (Tunbridge and Rogan ~2008).

* + 1. Valuing Recreational Fishing

Valuing fishing waters can be very subjective. For example, a remote trout fishery may be considered very high value to some keen fly-fishers; just as an easily accessed estuary could be highly valued by the occasional weekend fisher. Therefore, whilst local knowledge is believed to be a key source of information, its use in valuing recreational fishing waters can lead to subjective interpretations of what constitutes a ‘popular’ location.

Therefore, to describe recreational fishing value for Victorian waterways, four data sources were identified:

* Regional Fishery Management Plans;
* *A* *Guide to the Inland Angling Waters of Victoria* (Tunbridge and Rogan ~2008);
* Victorian Social Benchmarking of River Health Project; and
* Improving Inland Recreational Fishing, DEPI: Fisheries Victoria, July 2012.

Regional Fishery Management Plans

The purpose of Regional Fishery Management Plans (RFMPs) is to specify the objectives, strategies and performance measures for managing recreational fishing activities in rivers and impoundments across a specific fishery.

The RFMPs describe:

* key recreational fishing waterways and target species;
* current management arrangements for fishing activities and for other relevant issues that may impact on fisheries resources;
* strategies, goals, objectives, performance indicators and actions for management of fishing activities; and
* a process for addressing other resource management issues that can impact recreational fisheries.

The following RFMPs have been completed in Victoria:

* Bendigo Regional Fishery Management Plan (DNRE 2002d);
* Glenelg Hopkins Fishery Management Plan (DPI 2006a);
* Goulburn-Eildon Fishery Management Plan (DNRE 2002e);
* North East Fishery Management Plan (DPI 2006b);
* West Gippsland Fishery Management Plan (DPI 2008a); and
* Corangamite Fishery Management Plan (draft) (DPI 2008b).

Appendix K provides information on waterways identified as priority, key or popular fisheries within each of the above RFMPs.

Guide to the Angling Waters of Victoria.

*A Guide to the Inland Angling Waters of Victoria* (Tunbridge and Rogan ~2008) is an on-line guide that provides valuable information to recreational fishers including:

* best fishing waters within each basin;
* a list of recreational fishing waters within each basin; and
* fish species known to occur in each water.

Victorian Social Benchmarking of River Health Project

In late 2006, the Victorian River Health Program commissioned the River Health Social Benchmarking project. This project sought to add a social component to the ISC (referred to as the Social Index of Stream Condition - SISC).

The key aims of the SISC are to provide:

* a benchmark of the social condition of communities’ attitudes, values, understanding and behaviours in relation to river health;
* an information resource for developing priorities (both social and environmental) for action for river managers; and
* an assessment of the long-term effectiveness of community education and engagement activities in achieving changes in attitudes, values, understanding and behaviours in relation to river health.

The second dot point is of particular relevance to AVIRA as this information can assist in identifying social values of waterways at a local level (including recreational fishing).

Improving Inland Recreational Fishing, DEPI: Fisheries Victoria, July 2012

Fisheries Victoria surveyed 3,025 Recreational Fishing Licence holders to better understand what lake, river and estuary locations are most important to recreational fishers.

AVIRA Metric – Recreational Fishing

Based on the above, Recreational Fishing value was scored using the following metric:

| Value Score | Descriptor | Data Descriptor |
| --- | --- | --- |
| 5 | More than six recreational fishing licence holders identified this reach as their most preferred fishing location  OR  Listed as a priority/key/popular fishery in a Regional Fishery Management Plan OR Rated as a ‘best fishing water’ in *A Guide to the Inland Angling Waters of Victoria* | Popular Fishery |
| 3 | Some recreational fishing occurs | Some Fishing |
| 1 | Not known to be used for recreational fishing | Not known |
| 0 | Not suitable for recreational fishing | No Fishing |
| Data Sources:  Fisheries Victoria Survey *Improving Inland Recreational Fishing (DEPI:Fisheries Victoria)*  Regional Fishery Management Plans (refer to Appendix K)  *A Guide to the Inland Angling Waters of Victoria* (Tunbridge and Rogan ~2008) <http://www.dpi.vic.gov.au/angling>  Victorian Social Benchmarking of River Health Project  Local knowledge | |  |

* 1. Non-Motor Boating
     1. Background

Waterways are popular locations for a number of non-motor boating activities including:

* canoeing/kayaking;
* white-water rafting;
* rowing; and
* sailing.
  + 1. Valuing Non-Motor Boating

Many peak bodies exist for non-boating activities e.g.Canoeing Victoria, Rowing Victoria. These organisations hold annual events at specific locations and also have considerable knowledge as to which waterways are utilised for specific water-based activities. As such, it was recommended that peak bodies be consulted to identify:

* waterways used for annual events; and
* waterways considered popular for non-motor boating.

AVIRA Metric – Non-Motor Boating

Based on the above, Non-Motor Boating value was scored using the following metric:

|  |  |  |
| --- | --- | --- |
| Value Score | Descriptor | Data Descriptor |
| 5 | Waterway used for annual (or more frequent) non-motor boating event | Annual Events |
| 4 | Waterway is popular for non-motor boating | Popular |
| 3 | Waterway is occasionally used for non-motor boating | Some Boating |
| 1 | Not known to be used for non-motor boating | Not Known |
| 0 | Not suitable for non-motor boating | No Boating |
| Data Sources:  Peak body e.g.Canoeing Victoria, Rowing Victoria (refer to Appendix L)  Victorian Social Benchmarking of River Health Project  Local knowledge | | |

* 1. Motor Boating
     1. Background

Motor boating is a popular activity associated with:

* water skiing;
* recreational fishing;
* sight-seeing; and
* power boat racing.

Motor boating generally occurs in lowland river reaches, estuaries, lakes and impoundments. The key facilities required include access (specifically boat launching ramps) and parking (for car and boat trailer).

* + 1. Valuing Motor Boating

As for non-motor boating, it was recommended that peak bodies and clubs were consulted as the primary source in identifying:

* waterways used for annual events; and
* waterways considered popular for motor boating.

AVIRA Metric – Motor Boating

Based on the above, Motor Boating value was scored using the following metric:

|  |  |  |
| --- | --- | --- |
| Value Score | Descriptor | Data Descriptor |
| 5 | Waterway used for annual (or more frequent) motor boating event | Annual Events |
| 4 | Waterway is popular for motor boating with accessible formal boating facility (i.e.boat ramp and car/trailer parking) | Popular |
| 3 | Waterway is occasionally used for motor boating but has no formal boating facility available | Some Boating |
| 1 | Not known to be used for motor boating | Not Known |
| 0 | Not suitable for motor boating | No Boating |
| Data Sources:  Peak body e.g.Ski Racing Victoria, Victorian Speed Boat Club, Boating Victoria, Club Marine (refer to Appendix M)  Victorian Social Benchmarking of River Health Project  Local knowledge | | |

* 1. Camping
     1. Background

There are many camping opportunities available to Victorians including National Parks, State Parks, State Forests, Scenic Reserves and Foreshore Reserves.

The banks of rivers, lakes and estuaries are popular destinations because of their scenic value and also for opportunities for fishing, swimming, boating or water-skiing, particularly in the summer (LCC 1991).

* + 1. Valuing Camping

To identify and value waterways associated with camping locations, a metric based on the following main types of camping area was developed:

* serviced campgrounds;
* campgrounds with basic facilities; and
* bush camping areas.

Serviced campgrounds generally have flush toilets, tap water, picnic tables, barbecues and hot showers. These areas are managed by either local or private authorities. Some examples include foreshore reserve campgrounds along the Great Ocean Road (e.g. Cumberland River), Wilsons Promontory National Park, and Lake Eildon National Park. To assist with the maintenance of these areas, camping fees usually apply.

Campgrounds with basic facilities are generally less popular than serviced campgrounds but can offer a more natural camping experience. Facilities in these areas generally include fireplaces, picnic tables, a water supply and usually non-flushing toilets.

Bush camping areas are generally more difficult (i.e.rough tracks, by foot or boat) and remote. These areas have no formal facilities and campers must be entirely self-sufficient.

AVIRA Metric – Camping

Based on the above, Camping value was scored using the following metric:

|  |  |  |
| --- | --- | --- |
| Value Score | Descriptor | Data Descriptor |
| 5 | Serviced campground adjacent to waterway\* OR Multiple campsites with basic facilities adjacent to waterway | Serviced or Multiple Basic |
| 4 | Campground with basic facilities adjacent to waterway OR Multiple bush camping areas adjacent to waterway | Basic or Multiple Bush |
| 3 | Bush camping area adjacent to waterway | Bush |
| 1 | Not a known camping area | Not Known |
| 0 | Not suitable for camping | No Camping |
| Data Sources:  Camping guides e.g.*Camping in Victoria* (Lewis and Savage 1998), Parks Notes, etc.  Victorian Social Benchmarking of River Health Project  Local knowledge | | |

\* Does not include caravan parks occupied by permanent residents

* 1. Swimming
     1. Background

Swimming is a popular recreational activity of waterways, particularly in the warmer months. The most popular locations for swimming are:

* estuaries;
* lowland rivers;
* upland rivers (particularly those adjacent to camping areas); and
* lakes.
  + 1. Valuing Swimming

Whilst local knowledge is believed to be the most appropriate source for determining value scores for swimming, it is acknowledged that this approach is open to considerable interpretation e.g.what would constitute a ‘popular’ swimming location.

Therefore, it was recommended that some evidence must be supplied in order to value a waterway as a popular swimming location. One option is to cite the information source e.g.camping guides, park notes etc.

AVIRA Metric – Swimming

Based on the above, swimming value was scored using the following metric:

|  |  |  |
| --- | --- | --- |
| Value Score | Descriptor | Data Descriptor |
| 5 | Popular swimming location | Popular |
| 3 | Some swimming | Some Swimming |
| 1 | Not a known swimming location | Not Known |
| 0 | Not suitable for swimming | No Swimming |
| Data Sources:  Camping guides, Park notes  Victorian Social Benchmarking of River Health Project  Local knowledge | | |

* 1. Beside Water Activities
     1. Background

Many low-impact activities occur along waterways including:

* walking, hiking, cycling;
* sightseeing; and
* picnics and barbecues.
  + 1. Valuing Beside Water Activities

The recent trial of DSE’s River Health Social Benchmarking Project revealed a strong correlation between recreational ‘beside water use’ and good river health behaviour. Therefore, understanding specific beside water uses of waterways was seen as particularly advantageous (both for priority setting and engagement activities).

Based on the above, Beside Water Activities value was scored using three metrics:

* tracks;
* sightseeing; and
* picnics and barbecues.

It is recommended that a buffer of 100m be placed around each waterway to ensure that only those activities strongly linked to waterways are identified.

AVIRA Metric – Beside Water Activities (Tracks)

|  |  |  |
| --- | --- | --- |
| Value Score | Descriptor | Data Descriptor |
| 5 | Sealed or formed tracks follow waterway\* and are mapped or sign-posted | Formal |
| 3 | Unformed tracks follow waterway\* but are not mapped or sign-posted | Informal |
| 0 | No tracks are present | No Tracks |
| Data Sources:  Bushwalking guides e.g.*Walking the Otways* (Rose 2001), camping guides e.g.*Camping in Victoria* (Lewis and Savage (1998), Parks Notes, local government  Victorian Social Benchmarking of River Health Project  Local knowledge | | |

AVIRA Metric – Beside Water Activities (Sightseeing)

|  |  |  |
| --- | --- | --- |
| Value Score | Descriptor | Data Descriptor |
| 5 | Identified waterway feature of interest with high visitor numbers\* | High Numbers |
| 3 | Identified waterway feature of interest with low visitor numbers\* | Low Numbers |
| 1 | No known waterway features of interest. | Not Known |
| Data Sources:  Parks Notes, local government  Local knowledge | | |

\* Definition of high and low visitor numbers to be determined at a regional level.

AVIRA Metric – Beside Water Activities (Picnics and Barbecues)

|  |  |  |
| --- | --- | --- |
| Value Score | Descriptor | Data Descriptor |
| 5 | Designated picnic/barbecue areas present\* | Present |
| 0 | No designated picnic/barbecue areas present\* | Not Present |
| Data Sources:  Parks Notes, local government  Victorian Social Benchmarking of River Health Project  Local knowledge | | |

* 2. Game Hunting
     1. Background

In Victoria, licenses can be obtained for recreation game hunting of the following game species:

* Ducks (Pacific Black Duck, Chestnut Teal, Grey Teal, Hardhead (White-eyed Duck), Australian Shelduck (Mountain Duck), Pink-eared Duck, Maned Duck (Wood Duck) and Blue Wing Shoveler);
* Stubble Quail; and
* Deer (Sambar, Hog, Red and Fallow).
  + 1. Valuing Game Hunting

*Game Hunting in Victoria* (DSE 2005b) lists the following locations as available for hunting:

* **State forest and other unoccupied Crown land**. Game species may be hunted during the open season only. Pest animals may be hunted at any time.
* **State Game Reserves**. Game species may be hunted, but only during the open season. Sixteen State Game Reserves are available for quail hunting and six for Hog Deer hunting. Pest animals may not be hunted at any time, unless specifically authorised by the Department.
* **Sanctuaries.** Game species may not be hunted at any time. Pest animals may be hunted.
* **National Parks, State Parks, Coastal Parks, Wilderness Parks**. Generally, hunting of any type is not permitted at any time; however, there are some exceptions.
* **Leased Crown land**. Game (only during the open season) and pest animals may be hunted, but only with the permission of the lessee.
* **Licensed Crown land**. Generally, game (only during the open season) and pest animals may be hunted at any time, unless the land is licensed under the Land Act 1958.
* **Private land**. Game (only during the open season) and pest animals may be hunted, but only with the permission of the land owner/manager.

AVIRA Metric – Game Hunting

Based on the above, Game Hunting value was scored using the following metric:

|  |  |  |
| --- | --- | --- |
| Value Score | Descriptor | Data Descriptor |
| 5 | Game hunting is permitted | Permitted |
| 0 | Game hunting is not permitted | Not Permitted |
| Data Source:  *Game Hunting in Victoria* (DSE 2005b) | | |

1. Place

This category considers the intrinsic values of waterways; specifically:

* heritage; and
* landscape.

The following sections detail approaches to measuring and valuing heritage and landscape.

* 1. Heritage
     1. Background

Heritage includes places, values, traditions, events and experiences that capture where we've come from, where we are now and gives context to where we are headed as a community.

This section considers only those places listed for their cultural and/or social values. Heritage places listed for their natural values are described and assessed under environmental values (refer to Sections 4.3 and 4.7).

* + 1. Valuing Heritage

Knowing the location of social and cultural heritage values is considered critical in the planning and implementation of protection and rehabilitation works.

However, attempting to score heritage for the purpose of risk assessment within AVIRA is believed to be inappropriate. A more specific, site-based risk assessment approach needs to be adopted to ensure protection of heritage values.

Therefore, no scoring has been recommended for this value; only whether a site is known to exist.

In addition, two measures have been identified to define heritage:

* Pre-European (Indigenous) Heritage; and
* Post-European Heritage.

AVIRA Metric – Pre-European (Indigenous) Heritage

|  |  |  |
| --- | --- | --- |
| Value | Descriptor | Data Descriptor |
| Known | Listed as a key feature of a site in the National Heritage List OR Listed as a key feature of a site in the Victorian Heritage Register OR Listed as an area of Cultural Sensitivity | Listed |
| Unknown | No sites listed | Not Listed |
| Data Sources:  *Heritage Places in Victoria* (DEWHA ~2008a) <http://www.environment.gov.au/heritage/places/vic/index.html>  *Victorian Heritage Database* (Heritage Victoria ~2008) <http://vhd.heritage.vic.gov.au/vhd/heritagevic>  Aboriginal Affairs Victoria – Areas of Cultural Significance database | | |

AVIRA Metric – Post-European Heritage

|  |  |  |
| --- | --- | --- |
| Value | Descriptor | Data Descriptor |
| Known | Listed as a key feature of a site in the National Heritage List OR Listed as a key feature of a site in the Victorian Heritage Register | Listed |
| Unknown | No sites listed | Not Listed |
| Data Sources:  *Heritage Places in Victoria* <http://www.environment.gov.au/heritage/places/vic/index.html>  *Victorian Heritage Database* (Heritage Victoria ~2008) <http://vhd.heritage.vic.gov.au/vhd/heritagevic> | | |

* 1. Landscape
     1. Background

The key sources of information available to determine significant landscapes are Local Government Planning Schemes (particularly Significant Landscape Overlays).

* + 1. Valuing Landscape

The Significant Landscape Overlay provisions are set out at Clause 42.03 within all Victorian Planning Schemes. The purposes of the Significant Landscape Overlay are:

* To implement the State Planning Policy Framework and the Local Planning Policy Framework, including the Municipal Strategic Statement and local planning policies.
* To identify significant landscapes.
* To conserve and enhance the character of significant landscapes.
* A schedule to this overlay must contain:
* A statement of the nature and key elements of the landscape.
* The landscape character objective to be achieved.

AVIRA Metric – Landscape

Based on the above, Landscape value was scored using the following metric:

|  |  |  |
| --- | --- | --- |
| Value Score | Descriptor | Data Descriptor |
| 5 | Covered by a Significant Landscape Overlay | SLO |
| 3 | Listed as scenic landscape in another report e.g.High Scenic Value listing in *Rivers and Streams Special Investigation: Final Recommendations* (LCC 1991) | Other Listing |
| 0 | Waterway not listed as a significant or scenic landscape | Not Listed |
| Data Sources:  Victoria’s Planning Schemes [www.dse.vic.gov.au/PlanningSchemes](http://www.dse.vic.gov.au/PlanningSchemes)  *Rivers and Streams Special Investigation: Final Recommendations* (LCC 1991) - Table 24 and Map 15, pp 156-7  Other reports e.g.Estuaries Coastal Action Plans | | |

1. People

This category considers the associations people have with waterways; specifically:

* community groups; and
* use of flagship species.

These associations are described in the following sections.

* 1. Community Groups
     1. Background

Communities and the individuals that make up communities have a number of roles in river health. Individuals are relied upon to manage their own enterprises in ways that acknowledge their ‘duty of care’ and their role as stewards of natural resources. They may participate in community groups and networks, such as Waterwatch and Landcare, aimed at monitoring river health and/or undertaking restoration projects. Other community groups may take on the role of advocates for protection and/or restoration of waterways (e.g.Friends of Merri Creek). Community members may also participate in regional river health planning, priority setting and the implementation of works programs related to river management and restoration, often at a scale far broader than an individual waterway (DNRE 2002a).

* + 1. Valuing Community Groups

To value community groups in a river health context, two measures were identified:

* presence/absence of community groups (with a river health focus); and
* level of river health advocacy.

AVIRA Metric – Community Groups

Based on the above, Community Group value was scored using the following metric:

|  |  |  |
| --- | --- | --- |
| Value Score | Descriptor | Data Descriptor |
| 5 | Significant and palpable community advocacy for waterway and/or campaign for increased river health works | Active Group Present |
| 3 | Notable presence of community groups engaged in supporting waterway (e.g.Waterwatch, Landcare etc.) | Group Present |
| 2 | Informal community group present with interest in waterway | Informal Group |
| 0 | No community groups present | No Group |
| Data Source:  Local Knowledge | | |

* 1. Use of Flagship Species
     1. Background

Flagship species are species which have public appeal, promotional and publicity value (BIRD ~2008). The concept of a flagship species is that by giving publicity to a few key species, the support given to those species will successfully leverage conservation of entire ecosystems and all species contained therein.

* + 1. Valuing Use of Flagship Species

Flagship species can be chosen for their vulnerability (e.g.trout cod), attractiveness (e.g.Darter) or distinctiveness (e.g.platypus).

For example, local communities may identify a flagship species that currently does not reside in a particular waterway, but may use its status to promote waterway rehabilitation.

Furthermore, as current sustainability is not a mandatory requirement for determining flagship species, there is no need to include qualifiers other than presence/absence. In fact highly threatened species may be considered more relevant as flagships for a local community.

AVIRA Metric – Use of Flagship Species

Based on the above, Flagship Species value was scored using the following metric:

|  |  |  |
| --- | --- | --- |
| Value Score | Descriptor | Data Descriptor |
| 5 | Waterway known to support waterway-dependent flagship species | Flagship Present |
| 3 | Waterway not known to support waterway-dependent flagship species BUT waterway condition/habitat suitable | Possible with Suitable Habitat |
| 1 | Waterway not known to support waterway-dependent flagship species AND waterway condition/habitat currently unsuitable | Possible but Unsuitable |
| 0 | Waterway does not and cannot support waterway-dependent flagship species. | Not Possible |
| no data | Presence and/or condition of waterway for flagship species has not been assessed or considered | No Data |
| Data Source:  Victorian Flora and Fauna Databases  Expert/Local Knowledge | | |

Note: Double-counting with environmental values may occur where threatened species are chosen as flagships.

It was recommended that the designation of flagship species be undertaken by the regional authorities in consultation with local communities. This approach may have resulted in flagship species designated at regional, basin, management unit and/or local scales.

Part C Economic Values

Economic values have been grouped under the following categories:

* Water;
* Power Generation; and
* Other Resources.

These categories are presented in the following sections.

1. Water

This category considers the key beneficial use of waterways; namely water. In particular:

* urban/rural township water sources;
* rural water sources for production;
* water storages;
* water carriers; and
* wastewater discharge.
  1. Urban/Rural Township Water Sources
     1. Background

Formally known as Proclaimed Water Supply Catchments, Special Water Supply Catchments (SWSCs) are the basis for catchment planning and management under the provisions of the *Catchment and* *Land Protection Act 1994*. Special water supply catchments provide water resources to a reservoir or water storage used primarily for domestic water supply purposes. For a complete listing of SWSCs in Victoria, refer to Appendix N.

* + 1. Valuing Urban/Rural Township Water Sources

The condition of a SWSC is largely dependent on its catchment state i.e.whether the catchment is open or closed. Open refers to SWSCs where the land is privately managed over many titles by the rural community. Closed refers to SWSCs where the majority of land is managed by a single land manager.

AVIRA Metric – Urban/Rural Township Water Sources

Based on the above, Urban/Rural Township Water Source value was scored using the following metric:

|  |  |  |
| --- | --- | --- |
| Value Score | Descriptor | Data Descriptor |
| 5 | Waterway forms part of a closed SWSC | Closed SWSC |
| 4 | Waterway forms part of an open SWSC | Open SWSC |
| 3 | Waterway is used to source water for urban/rural township but does not form part of a SWSC | Other Water Source |
| 0 | Waterway is not used to source water for urban/rural township | Not Used |
| Data Sources:  Special Water Supply Catchments [www.dpi.vic.gov.au/dpi/vro/vrosite.nsf/pages/landuse-water-supply-catchments](http://www.dpi.vic.gov.au/dpi/vro/vrosite.nsf/pages/landuse-water-supply-catchments)  Urban Water Authorities | | |

* 1. Rural Water Sources for Production
     1. Background

Irrigation Districts

Irrigation accounts for more than 75% of consumptive water use in Victoria (DSE 2004a).

An Irrigation District is declared under the *Water Act 1989* and supplies water by channels and pipelines mainly for irrigation purposes.

Victoria's irrigation sector underpins the regional economies of many rural Victorian communities and produces $2.7 billion worth of agricultural produce (Australian Bureau of Statistics 2006 in DSE ~2008b).

For a complete listing of Irrigation Districts in Victoria, refer to Appendix O.

Other Purposes

Outside of irrigation districts, water from waterways is utilised either by:

* extraction under licence for irrigation, stock watering or other purposes; or
* direct access by stock for drinking.
  + 1. Valuing Rural Water Sources for Production

Ryan and Marvenek (2004) noted that per megalitre of irrigation water in the Murray Darling Basin, the highest returns are obtained from those land uses that have high to moderate returns and lower water requirements per hectare including cut flowers, vegetables, fruit, grapes and tree nuts. The large water users (dairy, cotton and rice) have moderate returns per megalitre. Beef and sheep pasture, legumes, oilseeds etc. have low returns per megalitre because although they have low water requirements their returns are very low.

AVIRA Metric – Rural Water Sources for Production

Based on the above, Rural Water Source for Production value was scored using the following metric:

|  |  |  |
| --- | --- | --- |
| Value Score | Descriptor | Data Descriptor |
| 5 | Water source is used for horticulture (e.g.cut flowers, vegetables, fruit, grapes, tree nuts) | Horticulture |
| 4 | Water source is used for irrigated modified pastures | Irrigated Pasture |
| 3 | Water source is used for irrigated cropping, legumes, oilseeds, etc. | Crops |
| 2 | Water source is used for dryland stock watering | Stock Watering |
| 0 | Water source is not used for production | Not Used |
| Data Sources:  Rural Water Authorities  Department of Primary Industries  Australian Land Use Mapping <http://adl.brs.gov.au/mapserv/landuse/>  Local knowledge | | |

* 1. Water Storages
     1. Background

The high year-to-year and within-year variability of rivers in most Victorian basins means that large reservoirs are necessary to even out the fluctuations in river flow to provide a continuous and reliable water supply to towns and farms (DSE 2008c).

Surface waters are stored in a number of ways; the most common storages being:

* dams (which can be large (e.g.Lake Eildon), medium or small (e.g.farm dams)); and
* weirs (e.g.Charlton Weir).
  + 1. Valuing Water Storages

In order to value waterways used to store water, the key measure was deemed to be the size of the storage. For a listing of Victorian storages and their capacities, refer to Appendix P.

AVIRA Metric – Water Storages

Based on the above, Water Storage value was scored using the following metric:

|  |  |  |
| --- | --- | --- |
| Value Score | Descriptor | Data Descriptor |
| 5 | Waterway used to store water for rural and/or urban water supply (storage capacity >50,000ML) | Storage Capacity (ML) |
| 4 | Waterway used to store water for rural and/or urban water supply (storage capacity 10,000-50,000ML) |
| 3 | Waterway used to store water for rural and/or urban water supply (storage capacity <10,000ML) |
| 0 | Waterway is not used to store water for rural and/or urban water supply | Not Used |
| Data Source:  *Victorian Water Accounts 2006-2007* (DSE 2008c) - refer to Appendix P  Local knowledge | | |

* 1. Water Carriers
     1. Background

Natural waterways are sometimes used as water carriers to distribute water to irrigation, industrial and urban users.

Irrigation reticulation systems consist of a variety of carriers including, constructed open channels (lined and unlined), natural streams and pipelines. In Victoria, 644km of natural waterways are used as carriers (ANRA 2009).

In addition, a number of rivers are used to transfer water from storages to urban townships (e.g.Moorabool River).

* + 1. Valuing Water Carriers

The value of natural waterways as carriers is significant considering the resources that would be required to replicate their function using channels or pipe networks.

AVIRA Metric – Water Carriers

Based on the above, Water Carrier value was scored using the following metric:

|  |  |  |
| --- | --- | --- |
| Value Score | Descriptor | Data Descriptor |
| 5 | Natural waterway used as a carrier | Used |
| 0 | Natural waterway is not used as a carrier | Not Used |
| Data Sources:  Rural Water Authorities  Urban Water Authorities | | |

* 1. Wastewater Discharges
     1. Background

The impact of wastewater discharges to inland waterways is attracting greater interest, particularly given predictions for a drier climate in the future. Impacts are often exacerbated by drought conditions, with low flows reducing the dilution of discharges. However, in other cases, the flow from some wastewater discharges can be an important contribution to waterway health, if they are of the right environmental quality and managed well (EPA Victoria ~2008c).

* + 1. Valuing Wastewater Discharges

Whilst not ideal, waterways are often used to discharge a number of wastewater products including:

* treatment plant effluents;
* industrial waste; and
* irrigation runoff.

AVIRA Metric – Wastewater Discharges

Based on the above, Wastewater Discharge value was scored using the following metric:

|  |  |  |
| --- | --- | --- |
| Value Score | Descriptor | Data Descriptor |
| 5 | Waterway used to discharge wastewater \* | Used |
| 0 | Waterway is not used for wastewater discharge | Not Used |
| no data | Information on wastewater discharges is not available | No Data |
| Data Sources:  EPA Victoria discharge licenses  Rural Water Authorities – irrigation discharges | | |

\* Stormwater discharges are not included in the above metric.

1. Power Generation
   1. Hydro-Electricity
      1. Background

Hydroelectricity is a well-developed renewable technology that uses the energy of flowing water to spin a turbine connected to a generator that produces electricity. The amount of electricity generated depends on the volume of water and the height of the water above the turbine. Large hydroelectric power stations need dams to store the water needed to produce the electricity. These dams are often built for irrigation or drinking water. Smaller hydro power stations, called mini or micro may not need dams but rely on naturally flowing water such as streams (Clean Energy Council 2007).

* + 1. Valuing Hydro-Electricity

In order to value waterways contributing to the generation of hydro-electricity, the key measure was deemed to be the size of the generation facility i.e.the greater the electricity generated, the more valuable the feeding waterways.

For a listing of the main hydroelectric power stations operating in Victoria, refer to Appendix Q.

AVIRA Metric – Hydro-Electricity

Based on the above, Hydro-Electricity value was scored using the following metric:

|  |  |  |
| --- | --- | --- |
| Value Score | Descriptor | Data Descriptor |
| 5 | Waterway contributes to a large scale hydroelectric power station (>10MW capacity\*) | Capacity (MW) |
| 3 | Waterway contributes to a small scale hydroelectric power station (100kW - 10MW capacity\*) |
| 1 | Waterway contributes to a micro hydro system (<100kW\*) |
| 0 | Waterway not used for hydroelectric power generation | 0 |
| Data Source:  Victorian energy suppliers e.g.AGL Energy, Citipower, Powercor, TRUenergy, Origin Energy | | |

\* Capacity rating distribution derived from Australian Institute of Energy (2003)

1. Other Resources

This category considers other resources made available from waterways; specifically:

* commercial fishing;
* extractive industries; and
* timber harvesting and firewood collection.
  1. Commercial Fishing
     1. Background

Eel Fishery

Victoria's eel industry produces on average 280 tonnes of short finned and long finned eel worth between $1.4 million and $4.7 million a year. There are 18 commercially licensed eel fishers in Victoria (DPI ~2008c). A list of the eel fishery licence locations taken from the *Eel Fishery Management Plan* (DNRE 2002f) is shown in Appendix S.

Other Fisheries

Other fisheries of relevance to AVIRA include:

* Corner Inlet - 18 Fishery Access Licences;
* Gippsland Lakes - 10 Fishery Access Licences, 10 Fishery Access Licences (Bait) and 2 Fishery Access Licences (Mussel Dive);
* Anderson Inlet and/or the lower reaches of the Tarwin River - several Fishery Access Licences (Bait – mainly pumping for sand worm) (DPI 2006c);
* Lake Tyers – 3 Fishery Access Licences (Bait – mainly prawn, shrimp and sandworm) (DPI 2007b); and
* Mallacoota Inlet – several Fishery Access Licences (Bait – mainly prawn and bass yabbies) (DPI 2006d).
  + 1. Valuing Commercial Fishing

As commercial fishing requires the issuing of a licence, it is considered reasonable to assess commercial fishing value based on the licence information contained within the various fishery management plans.

However, commercial fishing activity should be confirmed with the local fisheries management officer (Arundel 2007).

AVIRA Metric – Commercial Fishing

Based on the above, Commercial fishing value was scored using the following metric:

|  |  |  |
| --- | --- | --- |
| Value Score | Descriptor | Data Descriptor |
| 5 | Commercially licensed fishery | Licensed |
| 0 | Not a commercially licensed fishery | Not Licensed |
| Data Sources:  Fisheries Victoria  *Eel Fishery Management Plan* (DNRE 2002f)  *Anderson Inlet Fisheries Reserve Management Plan* (DPI 2006c)  *Mallacoota Inlet Fisheries Reserve Management Plan* (DPI 2006d)  *Lake Tyers Fisheries Reserve Management Plan* (DPI 2007b) | | |

* 1. Extractive Industries
     1. Background

An extractive industry is defined as the removal or extraction of stone from land if the main purpose of that removal is for:

1. The sale or commercial use of the stone; or
2. Use in construction, building, road or manufacturing works.

Stone includes gravel, sand, building stone and clay.

Approval is required from the CMA where the extractive works will interfere with the bed or banks of a waterway, or within the floodplain inundation zone where the CMA has floodplain management functions.

Approvals are also required from Department of Primary Industries (DPI) under the *Extractive Industries Development Act 1995*, except where the depth of extraction is less than two metres below the natural surface and the total area of extraction is less than 2000 m2 (Goulburn Broken CMA 2003).

* + 1. Valuing Extractive Industries

Generally, extractive works within waterways will only be permitted if they are a component of a regional waterway management strategy, or it can be demonstrated to the CMA that there are clear net gains to the environment or stability of the waterway. For example, extraction may be permitted in cases where a build up of sand and gravel has occurred in a section of waterway, causing stream deviation or erosion (Goulburn Broken CMA 2003).

AVIRA Metric – Extractive Industries

Based on the above, Extractive Industry value was scored using the following metric:

|  |  |  |
| --- | --- | --- |
| Value Score | Descriptor | Data Descriptor |
| 5 | Sand, gravel, gypsum, salt or shellgrit extraction operations occur under CMA approval | Permitted |
| 0 | No sand, gravel, gypsum, salt or shellgrit extractions approved | Not Permitted |
| Data Source:  CMA Works on Waterways Permits | | |

* 1. Timber Harvesting and Firewood Collection
     1. Background

State forest is managed to balance a variety of uses and values. These include conserving flora and fauna, protecting water catchments and water supply, providing timber for sustainable forestry, protecting landscape, archaeological and historic values, and providing recreational and educational opportunities (DSE ~2008d).

VicForests is the Victorian government business with responsibility for the sustainable harvest and commercial sale of Victoria's valued forest timber in eastern Victoria. DSE remains responsible for the management and licensing of timber harvesting in State forests in western Victoria, and the sale of domestic firewood and some other minor forest produce throughout the State (DSE ~2008d).

* + 1. Valuing Timber Harvesting and Firewood Collection

Timber harvesting is the harvesting of any tree, or part of any tree for the purpose of sale or processing and sale. This excludes harvesting firewood for personal (domestic) use (DSE ~2008d).

Permits are required for any commercial timber use and harvesting activities in Victoria's State forests. The *Sustainable Forest (Timber Harvesting) Regulations 2006* require anyone engaged in commercial timber harvesting in Victoria’s State forests to hold a Timber Harvesting Operator’s Licence (DSE ~2008d).

Permits are also required for domestic firewood collection.

AVIRA Metric – Timber Harvesting and Firewood Collection

Based on the above, Timber Harvesting and Firewood Collection value was scored using the following metric:

|  |  |  |
| --- | --- | --- |
| Value Score | Descriptor | Data Descriptor |
| 5 | Commercial timber harvesting operations occur under DSE permit OR within areas managed by VicForests | Commercial Harvesting |
| 3 | Firewood collection is permitted | Firewood Collection |
| 0 | No timber harvesting is permitted | No Harvesting |
| Data Source:  DSE Forests - <http://www.dse.vic.gov.au/dse/nrenfor.nsf/Home+Page/DSE+Forestry~Home+Page?open> | | |

Part D Threats

The waterway threats identified for AVIRA have been categorised under the following groupings:

* Altered Water Regimes;
* Altered Physical Form;
* Poor Water Quality;
* Degraded Habitats;
* Invasive Flora and Fauna; and
* Reduced Connectivity.

These groupings are presented in the following sections.

1. Altered Water Regimes

Under this category, the following threats have been identified:

* For river reaches:
  + Altered Flow Regimes.
* For wetlands:
  + Changed Water Regime.
* For estuaries:
  + Altered Flow Regimes; and
  + Altered Marine Exchange.

These threats are described in the following sections.

* 1. River Reaches
     1. Background

The harnessing of rivers to provide secure water supplies for towns and irrigation has had profound effects on the ecology of rivers, floodplains and estuaries. The introduction of dams and other regulating structures, of diversions from streams, of groundwater bores, and of small catchment dams have impacted on the natural flow regime of our rivers. Furthermore, water resource development is not the only activity that can impact on river hydrology. Changes in land use within catchments, such as land clearing and urbanisation, have also modified the water regimes within our rivers (DNRE 2002a).

* + 1. Altered Flow Regimes

To determine the degree of hydrologic stress for Victorian Rivers, SKM (2005) developed a flow stress index that established a relative indication of threat to river health based on the level of water extractions by rural, urban, and industry users.

This index was derived from five (largely independent) indices:

* low flow index (the lowest and second lowest monthly flows in a year);
* high flow index (the highest and second highest monthly flows in a year);
* zero flow index (the proportion of time that the stream is dry (or nearly so));
* variability index (the variability in monthly streamflows); and
* seasonality index (the seasonal timing of when low and high flows occur).

These indices are scored between 0 (stressed) and 10 (pristine).

Analysis of these individual flow stress indicators provides useful information concerning the nature of flow stress to particular asset values. As such, five measures were selected to assess the threat of altered flow regimes as follows:

* Increase in Low Flow Magnitude;
* Reduction in High Flow Magnitude;
* Increase in Proportion of Zero Flow;
* Change in Monthly Streamflow Variability; and
* Altered Streamflow Seasonality.

These measures were then used to develop the following metrics.

AVIRA Metric – Increase in Low Flow Magnitude

Altering the magnitude of low flows changes the availability of instream habitat, which can lead to a long term reduction in the viability of populations of flora and fauna (SKM 2005). The Low Flow Index measures the change in low flow magnitude under current and unimpacted conditions (SKM 2005).

|  |  |  |
| --- | --- | --- |
| Threat Score | Descriptor | Data Descriptor |
| 5 | Low Flow Index Score 0.0 - 2.0 | Low Flow Score |
| 4 | Low Flow Index Score 2.1 - 4.0 |
| 3 | Low Flow Index Score 4.1 - 6.0 |
| 2 | Low Flow Index Score 6.1 - 8.0 |
| 1 | Low Flow Index Score 8.1 – 10.0 |
| No data | Methodology to derive flow stress index has not been applied | -1 |
| Data Source:  3ISC Hydrology Sub-Index | | |

AVIRA Metric – Reduction in High Flow Magnitude

High flows act as a natural disturbance in river systems, removing vegetation and organic matter and resetting successional processes (SKM 2005). The High Flow Index measures the change in high flows under current and unimpacted conditions (SKM 2005).

|  |  |  |
| --- | --- | --- |
| Threat Score | Descriptor | Data Descriptor |
| 5 | High Flow Index Score 0.0 - 2.49 | High Flow Score |
| 4 | High Flow Index Score 2.5 - 4.49 |
| 3 | High Flow Index Score 4.5 - 6.49 |
| 2 | High Flow Index Score 6.5 - 8.49 |
| 1 | High Flow Index Score 8.5 – 10.0 |
| No data | Methodology to derive flow stress index has not been applied | -1 |
| Data Source:  3ISC Hydrology Sub-Index | |  |

AVIRA Metric – Increase in Proportion of Zero Flow

Periods of zero flow are a natural feature of ephemeral rivers and creeks; however increases in the natural duration of cease to flow periods are regarded as harmful to aquatic ecosystems (SKM 2005). The Zero Flow Index simply reflects the differences in the proportion of zero flow occurring under unimpacted and current conditions (SKM 2005).

|  |  |  |
| --- | --- | --- |
| Threat Score | Descriptor | Data Descriptor |
| 5 | Zero Flow Index Score 0.0 - 2.0 | Zero Flow Score |
| 4 | Zero Flow Index Score 2.1 - 4.0 |
| 3 | Zero Flow Index Score 4.1 - 6.0 |
| 2 | Zero Flow Index Score 6.1 - 8.0 |
| 1 | Zero Flow Index Score 8.1 – 10.0 |
| No data | Methodology to derive flow stress index has not been applied | -1 |
| Data Source: 3ISC Hydrology Sub-Index | | |

AVIRA Metric – Change in Monthly Streamflow Variability

The Variability index measures variability across all months between current and unimpacted conditions (SKM 2005).

|  |  |  |
| --- | --- | --- |
| Threat Score | Descriptor | Data Descriptor |
| 5 | Variability Index Score 0.0 - 2.0 | Variability Score |
| 4 | Variability Index Score 2.1 - 4.0 |
| 3 | Variability Index Score 4.1 - 6.0 |
| 2 | Variability Index Score 6.1 - 8.0 |
| 1 | Variability Index Score 8.1 - 10.0 |
| No data | Methodology to derive flow stress index has not been applied | -1 |
| Data Source:  3ISC Hydrology Sub-Index | | |

AVIRA Metric – Altered Streamflow Seasonality

The timing of periods of flooding and low flows has an important influence on how floodplain and riverine ecosystems respond (SKM 2005). The Seasonality Index provides a measure of the shift in the timing of the maximum flow month and the minimum flow month under both unimpacted and current conditions (SKM 2005).

|  |  |  |
| --- | --- | --- |
| Threat Score | Descriptor | Data Descriptor |
| 5 | Seasonality Index Score 0.0 - 2.49 | Seasonality Score |
| 4 | Seasonality Index Score 2.5 - 4.49 |
| 3 | Seasonality Index Score 4.5- 6.49 |
| 2 | Seasonality Index Score 6.5 - 8.49 |
| 1 | Seasonality Index Score 8.5 - 10.0 |
| No data | Methodology to derive flow stress index has not been applied | -1 |
| Data Source:  3ISC Hydrology Sub-Index | | |

* 1. Wetlands
     1. Background

Hydrology is considered a key variable of wetland ecosystems, driving the development of wetland soils and leading to the development of the biotic communities (Mitsch and Gosselink 2000 in DSE 2005c).

Activities with the potential to cause a change in water regime are those that:

* change the flow regime of the water source of the wetland;
* interfere with the natural connectivity of flow to and from the wetland;
* involve disposal of water into the wetland or extraction of water from the wetland; and
* change wetland depth and, therefore, alter the duration of inundation by changing the rate of evaporation (DSE 2005c).
  + 1. Changed Water Regime

To determine the severity of effect of activities that change the water regime of a wetland, the IWC Field Assessment Sheet lists the following key steps (refer to DSE 2008e):

1. Determine the primary water source for the wetland (river or stream, surface runoff, groundwater, artificial channel).
2. Determine activities that change the wetland’s water regime.
3. Determine the severity of the effect of the activities on the water regime components (seasonality, duration, frequency).
4. Estimate the collective severity of effect of the activities.

Whilst this approach is subjective, it does provide useful information to assessing both threat type and source beyond simple evidence of flow stress.

AVIRA Metric – Changed Water Regime

Based on the above, Changed Water Regime threats were scored using the following metric:

|  |  |  |
| --- | --- | --- |
| Threat Score | Descriptor | Data Descriptor |
| 5 | IWC Hydrology Sub-Index Score: 0 | IWC Hydrology Score |
| 3 | IWC Hydrology Sub-Index Score: 5 - 15 |
| 1 | IWC Hydrology Sub-Index Score: 20 |
| no data | IWC methodology to identify changed water regime has not been applied | -1 |
| Data Source:  IWC Hydrology Sub-Index | | |

Additional Information

Whilst the above metric provides an overview of the degree of water regime change for a particular wetland, additional IWC information was available that better defines the specific activities that have changed the wetland water regime. This information can be accessed through the IWC database (website: <http://iwc/iwc/dms/welcome>) and includes the following:

|  |  |  |
| --- | --- | --- |
| Activities that Change the Wetland Water Regime | Present | Not Present |
| River regulation (applicable to wetlands fed by rivers or streams) |  |  |
| Activities that change surface drainage patterns (applicable to wetlands fed by local surface runoff) |  |  |
| Activities that change groundwater levels (applicable to wetlands fed by groundwater) |  |  |
| Regulation not associated with maintaining or restoring reference condition (applicable to wetlands fed by artificial channels) |  |  |
| Obstruction or regulation of natural water inlets |  |  |
| Obstruction or regulation of natural water outlets |  |  |
| Drainage of water from the wetland |  |  |
| Disposal of water into wetland |  |  |
| Extraction of water directly from the wetland |  |  |
| Permanently raised water level |  |  |

* 1. Estuaries
     1. Background

Estuaries are defined as places where fresh and marine waters meet and the salinity regime is a key physical factor that influences estuarine ecology. Changes to the relative amounts and timing of these waters entering an estuary can alter the fundamental nature of an estuary (Arundel et al 2008).

Therefore, changes to either freshwater or marine inputs can alter many aspects of the physical and chemical environment of estuaries e.g.salinity regimes, biological connectivity.

To assess the level of threat posed to estuaries by altered hydrologic processes, two measures were used:

* Altered Flow Regimes; and
* Altered Marine Exchange.
  + 1. Altered Flow Regimes

To describe the threat of altered flow regimes to estuaries, the same five metrics as described for river reaches were used (refer to Section 15.1.2), ie:

* Increase in Low Flow Magnitude;
* Reduction in High Flow Magnitude;
* Increase in Proportion of Zero Flow;
* Change in Monthly Streamflow Variability; and
* Altered Streamflow Seasonality.

It should be noted however, that direct translation of scores from the 3ISC should be used with caution as no specific assessment of their relationship to estuarine condition has been made (Arundel et al 2008). A Victorian method for determining freshwater flow requirements of estuaries is currently under development (the Estuary Environmental Flows Assessment Methodology – EEFAM). When available, results of EEFAM assessments should be used to inform these metrics.

Also, at present, approximately one third of estuaries do not have populated datasets for the 3ISC Hydrology Sub-Index. Therefore, to ensure consistency across all estuaries, it is recommended that the methodology to derive flow stress indices for the 3ISC Hydrology Sub-index be applied to all waterways directly linked to estuaries.

* + 1. Altered Marine Exchange

In Victoria intermittent estuary entrances are often artificially opened to prevent inundation of low-lying land and structures. This can cause major changes to the ecology of a system over both the short and long term.

Based on the recommendations of Arundel et al (2008), two metrics for altered marine exchange were used:

* Altered Marine Exchange (Intermittently Open Estuaries)
* Altered Marine Exchange (Permanently Open Estuaries)

AVIRA Metric – Altered Marine Exchange (Intermittently Open Estuaries)

|  |  |  |
| --- | --- | --- |
| Threat Score | Descriptor | Data Descriptor |
| 5 | >50% of all estuary mouth openings\* are artificial with non-environmental objectives | >50% Artificial Openings |
| 4 | 25% -50% of all estuary mouth openings\* are artificial with non-environmental objectives | 25% -50% Artificial Openings |
| 3 | <25% of all estuary mouth openings\* are artificial with non-environmental objectives | <25% Artificial Openings |
| 0 | No artificial estuary mouth openings\* occur with non-environmental objectives | None OR Permanently Open |
| no data | Type and/or number of estuary mouth openings is unknown | No data |
| Data Sources:  CMA Works on Waterways Licences  Local knowledge. Data requires record of all openings (over entire reporting cycle) and whether natural or artificial. | | |

\* The height at which the mouth is opened is also a key factor. However, further work is required to determine the severity of impact at various elevations for different estuary types. Once this work is completed, the above scores may alter to combine heights in a matrix that weights artificial openings at various elevations.

AVIRA Metric – Altered Marine Exchange (Permanently Open Estuaries)

|  |  |  |
| --- | --- | --- |
| Threat Score | Descriptor | Data Descriptor |
| 5 | Dredging of the estuary mouth occurs OR Training walls have been constructed at the estuary mouth | Altered |
| 0 | Dredging of the estuary mouth does not occur AND No training walls have been constructed at the estuary mouth | Not Altered OR Intermittently Open |
| Data Source:  Local knowledge | | |

1. Altered Physical Form

Under this category, the following threats have been identified:

* For river reaches:
  + Bank Instability; and
  + Bed Instability (Degradation).
* For wetlands:
  + Reduced Wetland Area; and
  + Altered Wetland Form.
* For estuaries:
  + Bank Instability; and
  + Reduced Estuary Extent.

These threats are described in the following sections.

* 1. River Reaches

Most natural streams have developed a grade, shape and planform which balance the variable inputs of water and sediment (Melbourne Water ~2009). However, as a result of European settlement and development, many streams have been destabilised, sometimes resulting in significant channel changes; most notably:

* Bank Instability; and
* Bed Instability (Degradation).
  + 1. Bank Instability

The common causes of bank erosion and failure modes include:

* direction and velocity of stream flow causing bank failure by direct removal of bank material, undermining or by slip circle failure where the toe has been eroded;
* susceptibility of bank material to both surface water and ground water flow;
* reduction of the cohesive strength of bank material (bank slumping);
* rapid drawdown of water levels, such as after high flow conditions, causing bank slumping or slip circle failure depending on soil types;
* instream flow obstructions such as willows, fallen trees, bridge piers or culverts;
* bed deepening usually resulting in toe undermining and subsequent bank collapse;
* over bank flows leaving or re-entering the main waterway causing bank failure by the direct removal of bank material; and
* lack of bank vegetation increasing the risk of bank failure (Melbourne Water ~2009).

The 3ISC Physical Form Sub-Index includes a bank condition indicator to determine bank stability.

AVIRA Metric – Bank Instability

Based on the above, Bank Instability threats were scored using the following metric:

|  |  |  |
| --- | --- | --- |
| Threat Score | Descriptor | Data Descriptor |
| 5 | Greater than 33% of reach is eroding  3ISC Bank Condition Indicator Rating – 1 | 3ISC Bank Condition Score |
| 4 | 19-33% of reach is eroding  3ISC Bank Condition Indicator Rating – 2 |
| 3 | 10-19% of reach is eroding  3ISC Bank Condition Indicator Rating – 3 |
| 2 | 2-10% of reach is eroding  3ISC Bank Condition Indicator Rating – 4 |
| 1 | Less than 2% of reach is eroding  3ISC Bank Condition Indicator Rating – 5 |
| Data Source:  3ISC Bank Condition Indicator | | |

* + 1. Bed Instability (Degradation)

Numerous Victorian streams dramatically deepened and widened following European settlement. New channels (gullies) formed in depressions that did not have defined channels before. Also, many streams catastrophically deepened by several metres (known as valley floor incised streams). Both types of incised stream are a major source of nutrient and sediment.

Many of these incised streams have now stabilised, and are beginning to recover. Recovery is characterised by an absence of knickpoints in the bed, reducing sediment yield and stable banks that are progressively battering-back to a low angle.

AVIRA Metric – Bed Instability (Degradation)

Although streams can incise naturally, they became ubiquitous after European settlement. Stream bed incision (also known as stream bed degradation) is often a response to increases in runoff from changes in land use, or more commonly, concentration of flow by digging drains.

Incised streams are a threat to:

1. higher value upstream reaches, because knickpoints (and degradation) will migrate upstream;
2. higher value downstream reaches because coarse sediment will accumulate downstream, filling pools, and simplifying morphology;
3. higher value downstream reaches where fine grained sediment will affect water quality (e.g.algal blooms); and/or
4. the immediate reach due to widening and damage to adjoining riparian land.

DSE (2007c) cites a number of distinct stages associated with the process of channel incision. These are:

1. **Relatively stable system.** Comprises cut and fill system subject to geological timescale incision and infill processes.
2. **Initiation of instabilities.** Swamp drained, channel excavated.
3. **Degradation.** Channel bed degrades. Sediment stripped from bed and moved downstream.
4. **Degradation and widening.** Channel degradation steepens the banks, and increases their height. Banks begin to fail and collapse, and channel widens. Sediment begins to accumulate in the channel bed.
5. **Aggradation and widening.** Banks continue to fail. Channel widens by basal undercutting.
6. **Recovery.** A sinuous low-flow channel forms within the trench formed by the incision of the channel. Benches form within the trench, producing a new floodplain (grasses begin to stabilise the channel bed; sediment accumulates either side of the sinuous low flow channel). Vegetation stabilisation.

Based on the above, Bed Instability (Degradation) threats were scored using the following metric:

|  |  |  |
| --- | --- | --- |
| Threat Score | Descriptor | Data Descriptor |
| 5 | Bed instability recently initiated. *Typical Features:* recent channel disturbance, raw, vertical banks, presence of minor knickpoints (<1m deep), bed locally cut to clay or rock; incision occurs in minor floods. | Recent Bed Deg |
| 4 | Active bed degradation. *Typical Features:* channel deepening occurring with major knickpoints (>1m deep), no significant channel widening. | Active Bed Deg |
| 3 | Bed degradation and channel widening. *Typical features:* bed continues to deepen (but at a reduced rate – and during larger floods rather than minor floods), channel banks collapsing, channel widening. | Bed Deg  Channel Widening |
| 2 | Bed aggradation and widening. *Typical Features:* sediment beginning to accumulate in the channel bed, no active knickpoints, banks continue to fail. | Bed Agg  Channel Widening |
| 1 | Relatively stable or recovered system. | Stable |
| no data | Bed stability of waterway is unknown | No data |
| Data Sources:\*  Sediment River Network Model (SedNet)\*\*  Fluvial Geomorphological studies  Local knowledge | | |

\* The 3ISC does not include a bed instability measure as it was deemed to be too variable and difficult to determine in the field at a single point in time. Although no state-wide dataset exists, bed stability remains a significant impact. As such it is recommended that the metric is scored in the regions by CMAs, rather than at State level from a data base.

\*\* SedNet identifies sources and sinks of sediment and nutrients in river networks and predicts spatial patterns of erosion and sediment load.

Note: the same sequence and scoring can be used to score potential avulsions on floodplains (these go through similar ‘stages’). An example is Deep Creek on the Ovens River – a major potential source of sediment to the river.

* 1. Wetlands

Wetland area and bathymetry are the principal components of physical form (DSE 2005c). The key threats to physical form are:

* reduction in wetland area (through drainage or infilling); and
* alteration in wetland form – depth, shape, bathymetry (through excavation, landforming or sedimentation).

Such threats can result in changes to the availability of wetland habitats for biota and changes to wetland depth, which affects the duration of inundation (DSE 2005c, DSE 2006b).

The IWC includes two threat measures for physical form:

* the percentage reduction in wetland area; and
* the percentage of the wetland where activities have resulted in a change in bathymetry.
  + 1. Reduced Wetland Area

To determine the reduction in wetland area, the IWC estimates the percentage reduction in area (by comparing original to current boundaries).

AVIRA Metric – Reduced Wetland Area

Based on the above, Reduced Wetland Area threats were scored using the following metric:

|  |  |  |
| --- | --- | --- |
| Threat Score | Descriptor | Data Descriptor |
| 5 | >75% reduction in wetland area | >75% |
| 4 | >50 to 75% reduction in wetland area | >50–75% |
| 3 | >25 to 50% reduction in wetland area | >25-50% |
| 2 | >5 to 25% reduction in wetland area | >5-25% |
| 1 | 0 to 5% reduction in wetland area | 0-5% |
| no data | IWC methodology to identify reduced wetland area has not been applied | no data |
| Data Source:  IWC Physical Form Sub-Index | |  |

* + 1. Altered Wetland Form

Possible measures of ‘altered wetland form’ assessed by DSE (2006a) as part of the IWC included:

* Wetland bathymetry;
* Depth of wetland (maximum water depth); and
* Percentage of wetland where activities (excavation and landforming) have resulted in a change in bathymetry.

The only practical measure of altered wetland form was considered to be the percentage of wetland where activities (excavation and landforming) result in a change in bathymetry. These activities can cause significant changes in depth (e.g.digging of channels or dams) or natural form of the bed (e.g.laser levelling, raised-bed cropping or building of mounds) (DSE 2005c).

To determine the percentage of wetland where activities have resulted in a change in bathymetry, the IWC identifies the presence of activities that change wetland bathymetry and estimates the percentage of the wetland where form has changed by such activities.

AVIRA Metric – Altered Wetland Form

Based on the above, that Altered Wetland Form threats were scored using the following metric:

|  |  |  |
| --- | --- | --- |
| Threat Score | Descriptor | Data Descriptor |
| 5 | >75% of wetland form altered by excavation or land forming activities | >75% |
| 4 | >50–75% of wetland form altered by excavation or land forming activities | >50–75% |
| 3 | >25-50% of wetland form altered by excavation or land forming activities | >25-50% |
| 2 | >5-25% of wetland form altered by excavation or land forming activities | >5-25% |
| 1 | 0-5% of wetland form altered by excavation or land forming activities | 0-5% |
| no data | IWC methodology to identify altered wetland form has not been applied | no data |
| Data Source:  IWC Physical Form Sub-Index | | |

* 1. Estuaries

To assess the level of threat posed to estuaries by altered physical form, two measures were selected:

* Bank Instability; and
* Reduced Estuary Extent.
  + 1. Bank Instability

To describe the threat of bank instability to estuaries, the 2ISC data descriptors were used.

Ultimately, scoring should be interpreted in context of the type of estuary and the influence of other sediment sources in the estuary (e.g.not just a move to a new equilibrium in response to a reduction in sediment supply).

|  |  |  |
| --- | --- | --- |
| Threat Score | Descriptor | Data Descriptor |
| 5 | Extreme erosion. Typical features: unstable toe of bank; no woody vegetation; very recent bank movement (trees may have recently fallen into stream); steep bank surface; numerous exposed roots of woody vegetation; erodible soils.  (2ISC Bank Condition Indicator Rating – 0) | 2ISC Bank Condition Indicator Rating |
| 4 | Extensive erosion. Typical features: mostly unstable toe of the bank; little woody vegetation many exposed roots of woody vegetation.  (2ISC Bank Condition Indicator Rating – 1) |
| 3 | Moderate erosion. Typical features: some bank instabilities that extend to the toe of the bank (which is generally stable); discontinuous woody vegetation; some exposure of roots of woody vegetation.  (2ISC Bank Condition Indicator Rating – 2) |
| 2 | Limited erosion. Typical features: some isolated bank instabilities, though generally not at the toe of the bank; cover of woody vegetation is nearly continuous; few exposed roots of woody vegetation.  (2ISC Rating – 3) |
| 1 | Stable. Typical features: very few local bank instabilities, none of which are at the toe of the bank’ continuous cover of moody vegetation; gently batter; very few exposed roots of woody vegetation; erosion resistant soils.  (2ISC Bank Condition Indicator Rating – 4) |
| No data | The 2ISC methodology to identify the bank condition score has not been applied. | -1 |
| Data Source:  IEC Bank Stability Rating using 2ISC | | |

* + 1. Reduced Estuary Extent

Artificial barriers can reduce the diversity of estuarine habitat by preventing upstream movement of salt water. The threat severity is related to presence/absence of a barrier and the distance of the barrier downstream from the 'natural’ head of the estuary (Arundel et al 2008). As such, the threat of reduced estuary extent was determined from two measures:

* Barrier Characteristics; and
* Barrier Proximity.

Measure 1 – Barrier Characteristics

|  |  |
| --- | --- |
| Descriptor | Data Descriptor |
| Artificial barrier completely blocks the movement of water (in a typical year) | Complete |
| Artificial barrier interferes (intermittently or selectively) with the movement of water (in a typical year) | Partial |
| No artificial barrier occurs within the estuary | None |

Measure 2 – Barrier Proximity

|  |  |
| --- | --- |
| Descriptor | Data Descriptor |
| >50% of the estuary is affected by an artificial barrier | Lower |
| >25-50% of the estuary is affected by an artificial barrier | Mid |
| 1-25% of the estuary is affected by an artificial barrier | Upper |
| No artificial barrier occurs within estuary | None |

Rating Table

|  |  |  |  |
| --- | --- | --- | --- |
| Total Area of Estuary Affected by an Artificial Barrier | Barrier Characteristics | | |
| No artificial barrier exists | Artificial barrier interferes (intermittently or selectively) with the movement of water (in a typical year) | Artificial barrier completely blocks the movement of water (in a typical year) |
| >50% | 0 | 4 | 5 |
| >25-50% | 0 | 3 | 4 |
| 1-25% | 0 | 2 | 4 |

AVIRA Metric – Reduced Estuary Extent

Based on the above, Reduced Estuary Extent was scored using the following metric:

|  |  |
| --- | --- |
| Threat Score | Descriptor |
| 5 | >50% of the estuary is affected by an artificial barrier that completely blocks the movement of water (in a typical year) |
| 4 | 1 to 50% of the estuary is affected by an artificial barrier that completely blocks the movement of water (in a typical year) OR >50% of the estuary is affected by an artificial barrier that interferes (intermittently or selectively) with the movement of water (in a typical year) |
| 3 | >25 to 50% of the estuary is affected by an artificial barrier that interferes (intermittently or selectively) with the movement of water (in a typical year) |
| 2 | 1 to 25% of the estuary is affected by an artificial barrier that interferes (intermittently or selectively) with the movement of water (in a typical year) |
| 0 | No artificial barrier occurs within the estuary |
| Data Source:  IEC Physical Form Sub Index  Local knowledge | |

1. Poor Water Quality

Under this category, the following threats have been identified:

* For river reaches:
  + Degraded Water Quality;
  + Thermal Water Pollution; and
  + Disturbance of Acid Sulfate Soils.
* For wetlands:
  + Changed Water Properties; and
  + Disturbance of Acid Sulfate Soils.
* For estuaries:
  + Degraded Water Quality; and
  + Disturbance of Acid Sulfate Soils.

These threats are described in the following sections.

* 1. River Reaches
     1. Background

Key threats to riverine ecosystems from poor water quality include rising salinity, increasing sediment and nutrient loads, changing pH and temperature levels, and reduced dissolved oxygen (DNRE 2002a). Significant deviation of these parameters from ‘natural’ levels can result in ecosystem degradation and may impact environmental qualities and beneficial uses (EPA Victoria 2003).

To assess the threat posed to river values from poor water quality, three measures were selected:

* Degraded Water Quality;
* Thermal Water Pollution;
* Disturbance of Acid Sulfate Soils.
  + 1. Degraded Water Quality

Six measures were identified to determine the threat severity posed by degraded water quality:

* SIGNAL objectives;
* EPA Victoria water quality objectives at Victorian Water Quality Monitoring Network (VWQMN) sites;
* EPA Victoria water quality objectives using Waterwatch data;
* Algal blooms;
* Fish kills; and
* Excessive instream plant growth.

Measure 1 – SIGNAL Objectives

SIGNAL stands for ‘Stream Invertebrate Grade Number – Average Level.’ It is a simple scoring system for macroinvertebrate samples from Australian rivers.

A SIGNAL score gives an indication of water quality in the river from which the sample was collected. Rivers with high SIGNAL scores are likely to have low levels of salinity, turbidity and nutrients such as nitrogen and phosphorus. They are also likely to be high in dissolved oxygen.

The biotic index SIGNAL has been accepted and used nationally in stream assessments. The output is a single number, between zero and ten, reflecting the degree of water pollution - high quality sites have high SIGNAL scores. While SIGNAL is particularly good for assessing organic pollution, its usefulness for toxic impacts and other types of disturbance is less certain (Metzeling et al 2004).

EPA Victoria has developed objectives for biological indicators of environmental quality (including SIGNAL) within the SEPP WoV. Appendix J provides information on how SIGNAL data was applied to AVIRA.

|  |  |
| --- | --- |
| Descriptor | Data Descriptor |
| Fails to meet SIGNAL objective in SEPP (WoV) | Fails SEPP (WoV) |
| Meets SIGNAL objective in SEPP (WoV) | Meets SEPP (WoV) |
| No SIGNAL data is available for the reach | No data |

Measure 2 – EPA Victoria Water Quality Objectives at VWQMN Sites

The VWQMN was established in 1975 to collect information on the State’s water resources. The VWQMN currently monitors 155 river and stream sites throughout Victoria.

The physical and chemical parameters measured most regularly at each site are discharge, dissolved oxygen, electrical conductivity, pH, total phosphorus, total nitrogen and turbidity. This data is stored on the Victorian Water Resource Data Warehouse and describes long-term water quality trends

Water quality objectives for individual indicators are set by EPA Victoria for defined segments in SEPP (WoV) according to beneficial uses. Appendix K provides information on how VWQMN site data was applied in AVIRA.

|  |  |
| --- | --- |
| Descriptor | Data Descriptor |
| Fails to meet two or more EPA Victoria water quality objectives at VWQMN site | Fails 2 or More |
| Fails to meet one EPA Victoria water quality objective at VWQMN site | Fails 1 |
| Meets all EPA Victoria water quality objectives at VWQMN site | Meets All |
| Reach does not include a VWQMN site | No data |

Measure 3 – EPA Victoria Water Quality Objectives using Waterwatch Data

Waterwatch is a national community-based monitoring network that aims to involve community groups and individuals in the protection and management of waterways. Waterwatch Victoria has the dual objectives of catchment education and water quality monitoring.

The significant spatial coverage of the Waterwatch water quality monitoring value-adds to other monitoring programs such as the VWQMN.

The key water quality parameters monitored by Waterwatch volunteers are turbidity, electrical conductivity, temperature, reactive phosphorus and pH.

Waterwatch Victoria has recently developed a State-wide Data Confidence Framework and Guidelines, identifying minimum data confidence standards for a range of monitoring purposes. The framework and guidelines were developed to ensure that water quality data collected by Waterwatch groups is recognised, valued and utilised to the greatest degree possible.

There are four standards within the framework:

* Standard 1 – Education focus;
* Standard 2 – Education “Indicative” Data;
* Standard 3 – “High Quality” Data Collection Focus, Educational Benefits; and
* Standard 4 –Data Warehouse focus.

Standards 3 and 4 have strong Quality Assurance/Quality Control procedures in place and are considered to provide an accurate indication of water quality trends. Appendix K provides information on how Waterwatch data was applied in AVIRA.

|  |  |
| --- | --- |
| Descriptor | Data Descriptor |
| Fails to meet two or more EPA Victoria water quality objectives using Waterwatch data (standard 3 or 4) | Fails 2 or More |
| Fails to meet one EPA Victoria water quality objective using Waterwatch data (standard 3 or 4) | Fails 1 |
| Meets all EPA Victoria water quality objectives using Waterwatch data (standard 3 or 4) | Meets All |
| No Waterwatch data is available for the reach | No data |

Measure 4 – Algal Blooms

Algae are a common seasonal occurrence in Victoria and a natural component of most aquatic systems, including streams, lakes, estuaries and the sea. However, under certain environmental conditions, numbers can increase rapidly and blooms become easily visible across the water surface. Many factors trigger algal blooms including, but not limited to, nutrient levels, low inflows, low storage volumes and warm weather conditions.

|  |  |
| --- | --- |
| Descriptor | Data Descriptor |
| Algal blooms occur every 1 to 2 years (on average) | 1 to 2 years |
| Algal blooms occur every 3 to 10 years (on average) | 3 to 10 years |
| No algal blooms are known to have occurred in the last 10 years | More than 10 years |
| Algal bloom occurrence in the last 10 years is unknown | No data |

Measure 5 – Fish Deaths

The deaths of large numbers of fish are reported in Victorian waterways from time to time. The cause of the deaths often relates to environmental stresses such as low flow conditions, elevated water temperatures, or on occasions, pollution (EPA Victoria ~2009).

|  |  |
| --- | --- |
| Descriptor | Data Descriptor |
| Fish deaths resulting from anthropogenic degradation of water quality occur every 1 to 2 years (on average) | 1 to 2 years |
| Fish deaths resulting from anthropogenic degradation of water quality occur every 3 to 10 years (on average) | 3 to 10 years |
| No fish deaths resulting from anthropogenic degradation of water quality are known to have occurred in the last 10 years | More than 10 years |
| Fish deaths resulting from anthropogenic degradation of water quality in the last 10 years is unknown | No data |

Measure 6 – Excessive Instream Macrophyte Growth

Excessive emergent and submerged macrophyte growth can result when the light, temperature and nutrient levels of streams are elevated. As such, they can be a useful indicator of poor water quality, in the absence of other data.

|  |  |
| --- | --- |
| Descriptor | Data Descriptor |
| >25% of the reach has excessive instream macrophyte growth | >25% |
| 5-25% of the reach has excessive instream macrophyte growth | 5-25% |
| <5% of the reach has excessive instream macrophyte growth | <5% |
| Extent of excessive instream macrophyte growth is unknown | No data |

AVIRA Metric – Degraded Water Quality

Based on the above, Degraded Water Quality for river reaches was scored using the following metric:

|  |  |
| --- | --- |
| Threat Score | Descriptor |
| 5 | Fails to meet SIGNAL objective in SEPP (WoV)  IF NO SIGNAL DATA THEN Fails to meet two or more EPA Victoria water quality objectives at VWQMN site  IF NO VWQMN SITE THEN Fails to meet two or more EPA Victoria water quality objectives using Waterwatch data (standard 3 or 4)  IF NO WATERWATCH DATA THEN Algal blooms occur every 1 to 2 years (on average) OR Fish deaths resulting from anthropogenic degradation of water quality occur every 1 to 2 years (on average) OR >25% of the reach length has excessive instream macrophyte growth |
| 3 | Fails to meet one EPA Victoria water quality objective at VWQMN site  IF NO VWQMN SITE THEN Fails to meet one EPA Victoria water quality objective using Waterwatch data (standard 3 or 4)  IF NO WATERWATCH DATA THEN Algal blooms occur every 3 to 10 years (on average) OR Fish deaths resulting from anthropogenic degradation of water quality occur every 3 to 10 years (on average) OR 5-25% of the reach length has excessive instream macrophyte growth |

|  |  |
| --- | --- |
| Threat Score | Descriptor |
| 1 | Meets SIGNAL objective in SEPP (WoV)  IF NO SIGNAL DATA THEN Meets all EPA Victoria water quality objectives at VWQMN site  IF NO VWQMN SITE THEN Meets all EPA Victoria water quality objectives using Waterwatch data (standard 3 or 4)  IF NO WATERWATCH DATA THEN No algal blooms are known to have occurred in the last 10 years AND No fish deaths resulting from anthropogenic degradation of water quality are known to have occurred in the last 10 years AND <5% of the reach length has excessive instream macrophyte growth |
| no data | No SIGNAL data is available for the reach AND Reach does not include a VWQMN site AND No Waterwatch data is available for the reach AND Algal bloom occurrence in the last 10 years is unknown AND Fish deaths resulting from anthropogenic degradation of water quality in the last 10 years is unknown AND Extent of excessive instream macrophyte growth is unknown |
| Data Sources:  EPA Victoria databases  Victorian Water Resources Data Warehouse <http://www.vicwaterdata.net/vicwaterdata/home.aspx>  Waterwatch databases  Local knowledge | |

AVIRA Metric – Degraded Water Quality (cont.)

* + 1. Thermal Water Pollution

Water temperature is a vital physical characteristic of rivers and streams.

Thermal water pollution can have a profound adverse impact on native warm water fish communities both directly and indirectly, including slower growth rates, cold water shock, disruption of breeding cycles and increased egg and fingerling mortality (DNRE 2002a).

The main causes of thermal pollution are:

* the release of cold water from dams which have offtakes or outlets set deep in the water; and
* the release of warm water (at higher temperatures than the receiving waters) from industrial cooling processes.

Three measures have been identified to assess thermal water pollution:

Measure 1 – Thermal Impact from Dam Releases (Evidence Based)

|  |  |
| --- | --- |
| Descriptor | Data Descriptor |
| Clear evidence of thermal impact from dam releases (based on monitoring program) | Clear Evidence |
| Inconclusive thermal impact from dam releases (based on monitoring program) | Inconclusive |
| No thermal impact from dam releases (based on monitoring program) | No Impact |

Measure 2 – Thermal Impact from Industrial Coolant

|  |  |
| --- | --- |
| Descriptor | Data Descriptor |
| Clear evidence of thermal impact from industrial coolant water releases (based on monitoring program) | Clear Evidence |
| Industrial coolant water released but thermal impact is unknown | Unknown |
| No industrial coolant water is released into the reach | No Impact |

Measure 3 – Thermal Impact from Dam Releases (Suspected)

|  |  |
| --- | --- |
| Descriptor | Data Descriptor |
| Suspected thermal water pollution from dam release (listed as a high priority for dam release temperature research) but impact is unknown | High Priority |
| Suspected thermal water pollution from dam release (listed as a medium priority for dam release temperature research) but impact is unknown | Medium Priority |
| Suspected thermal water pollution from dam release (listed as a low priority for dam release temperature research) but impact is unknown | Low Priority |
| No dam OR Dam does not discharge to natural streams | No Impact |

AVIRA Metric – Thermal Water Pollution

Based on the above, Thermal Water Pollution threats were scored using the following metric:

|  |  |
| --- | --- |
| Threat Score | Descriptor |
| 5 | Monitoring program undertaken AND clear evidence of thermal impact from dam releases  OR  Clear evidence of thermal impact from industrial coolant water releases (based on monitoring program) |
| 4 | Monitoring program undertaken AND inconclusive thermal impact from dam releases  OR  Suspected thermal water pollution from dam release (listed as a high priority for dam release temperature research) AND thermal impact not assessed  OR  Industrial coolant water released but thermal impact is unknown |
| 3 | Suspected thermal water pollution from dam release (listed as a medium priority for dam release temperature research) AND thermal impact not assessed |
| 2 | Suspected thermal water pollution from dam release (listed as a low priority for dam release temperature research) AND thermal impact not assessed |
| 0 | No dam  OR  Dam does not discharge to natural streams  OR  Monitoring program undertaken AND no thermal impact from dam releases AND No industrial coolant water is released into the reach |
| Data Sources:  *Temperature Monitoring of Dam Releases in Victorian Rivers 2002-2007* (SKM 2008)  *Status of Cold Water Releases from Victorian Dams* (Ryan et al 2001)  EPA Victoria databases | |

* + 1. Disturbance of Acid Sulfate Soils

Acid sulfate soils occur naturally in both coastal and inland settings. Left undisturbed these soils are harmless, however when sulfidic material in acid sulfate soils is disturbed and exposed to air, an oxidation process occurs and sulfuric acid is produced (Department of Sustainability and Environment 2009a).

Sulfuric acid has the potential to mobilise heavy metals such as arsenic and aluminium which may be dissolved in the soil. The combination of sulfuric acid and heavy metals can have severely detrimental effects on land and water, including:

* Acidification of waterways, wetlands, and estuaries which leads to massive fish kills. In turn, deoxygenation of the water can lead to toxic algal blooms.
* Degradation of the ecology of wetlands, shallow freshwater and brackish aquifer systems through loss of water quality, degradation of habitat and decline in dependent ecosystems.
* Adverse impacts on commercial and recreational fisheries and rural productivity.
* Corrosion of concrete and steel infrastructure, such as foundations and footings, culverts, pipes (including drinking water conduits), bridges and floodgates, reducing their functional life span.
* Immediate detrimental human health effects such as skin and eye irritations and burns.
* Loss of high recreational and environmental value.
* Irreversible change to landforms and soils (Department of Sustainability and Environment 2009a).

Identifying Risk Areas

Two reports are readily available that can assist in the identification of risk areas for acid sulphate soils:

* the Victorian Coastal Acid Sulfate Soils Strategy (Department of Sustainability and Environment 2009a): and
* the Acid Sulfate Soils in the Murray–Darling Basin report (Murray-Darling Basin Authority 2009).

The *Victorian Coastal Acid Sulfate Soils Strategy* has identified and mapped land that potentially contains coastal acid sulphate soils. Coastal acid sulphate soils are generally found in low lying areas within coastal plains and along the edges of water bodies. This includes flood plains and lower slopes, abandoned river meanders and oxbow lakes, swamps (including backswamps, peat swamps and reclaimed swamps), morasses, beaches, coastal dunes and swales and tidal flats (Department of Sustainability and Environment 2009a).

The purpose of the *Acid Sulfate Soils in the Murray–Darling Basin report* was to determine the spatial occurrence of, and risk posed by, acid sulfate soils at priority wetlands in the River Murray system, wetlands listed under the Ramsar Convention on Wetlands of International Importance (excluding the Coorong and Lower Lakes) and other key environmental sites in the Murray–Darling Basin. In Victoria, waterways found to contain acid sulfate soils at levels of concern were located in appear localised around Mildura and in some areas impacted by dryland salinity. Of the Ramsar-listed wetlands, acid sulfate soils were found at levels that present a medium to high acidification, deoxygenation and/or metal release hazard at some lakes in the Kerang Wetlands (Murray-Darling Basin Authority 2009).

AVIRA Metric – Disturbance of Acid Sulfate Soils

Based on the above, Disturbance of Acid Sulfate Soils was scored using the following metric:

|  |  |  |
| --- | --- | --- |
| Threat Score | Descriptor | Data Descriptor |
| 5 | Adjacent land has the potential to contain Coastal Acid Sulfate Soils OR Inland waterway is at high risk from acid sulfate soils | ASS |
| 0 | Adjacent land does not contain Coastal Acid Sulfate Soils OR Inland waterway is not at high risk from acid sulfate soils | No ASS |
| no data | Waterway occurs in an area where no acid sulfate soil assessments have been completed | No data |
| Data Sources:  Areas mapped in the Victorian Coastal Acid Sulfate Soils Strategy (Department of Sustainability and Environment 2009a)  *Acid Sulfate Soils in the Murray–Darling Basin* report (Murray-Darling Basin Authority 2009) | | |

* 1. Wetlands
     1. Changed Water Properties

Poor water quality can be attributed to a range of land use activities in the wetland (e.g.livestock grazing, feral animals, aquaculture) and its catchment (e.g.clearing of vegetation, land uses such as agriculture or urbanisation, fire, poor irrigation practices, point source discharges) and may be manifested by changes in several physical and chemical water properties. Nutrient enrichment, salinisation and turbidity are of particular concern in Victoria’s wetlands (DSE 2005c).

The IWC includes a Water Properties Sub-Index that considers threat measures for nutrients and electrical conductivity, in particular:

* activities leading to an input of nutrients to a wetland; and
* factors likely to lead to secondary salinisation of a wetland, in particular:
  + saline water inputs to a wetland; and/or
  + a wetland occurring in a salinity risk area.

AVIRA Metric – Changed Water Properties

Based on the above, Changed Water Regime threats were scored using the following metric:

|  |  |  |
| --- | --- | --- |
| Threat Score | Descriptor | Data Descriptor |
| 5 | IWC Water Properties Sub-Index Score: 0 - 4 (Very Poor) | IWC Water Properties Score |
| 4 | IWC Water Properties Sub-Index Score: 5 - 8 (Poor) |
| 3 | IWC Water Properties Sub-Index Score: 9 - 12 (Moderate) |
| 2 | IWC Water Properties Sub-Index Score: 13 - 16 (Good) |
| 1 | IWC Water Properties Sub-Index Score: 17 - 20 (Excellent) |
| no data | IWC methodology to identify changed water properties has not been applied | -1 |
| Data Source:  IWC Water Properties Sub-Index | | |

Additional Information

Whilst the above metric provides an overview of the degree of change in water properties for a particular wetland, additional IWC information is available that better defines the specific activities that have changed the wetland water properties. This information can be accessed through the IWC database (website: <http://iwc/iwc/dms/welcome>) and includes the following:

|  |  |  |
| --- | --- | --- |
| Activities or Evidence that Change the Wetland Water Properties | Present | Not Present |
| Discharge of nutrient-rich water to the wetland |  |  |
| Drainage of water into the wetland from an urban area |  |  |
| Grazing by livestock and feral animals |  |  |
| Aquaculture |  |  |
| Wetland within 250 m of a salinity discharge site |  |  |
| Saline water delivered to the wetland OR freshwater delivered to the saline wetland |  |  |

* + 1. Disturbance of Acid Sulfate Soils

To describe the threat of acid sulphate soils to wetlands, the same metric as described for river reaches was used (refer to Section 17.1.4).

* 1. Estuaries
     1. Degraded Water Quality

Measure 1 – EPA Victoria Water Quality Guideline Values for Estuaries

EPA Victoria has sampled 31 estuaries between 2000-2005, with varying frequency of data collection. Water quality and catchment condition information from this sampling program, and additional work carried out by Dr Jan Barton (Deakin University), have been used to determine which estuaries could be considered in reference or near reference (best available) condition. Water quality data from these reference estuaries have then been used to develop preliminary water quality guidelines in both surface and bottom waters for:

* dissolved oxygen;
* total phosphorus;
* total nitrogen;
* turbidity;
* pH; and
* chlorophyll *a.*

Summary statistics have been used to determine an annual median and a maximum and minimum level (where both are required) for individual measurements. For some parameters (dissolved oxygen, total nitrogen, total phosphorus and turbidity) statistical models and control charting were used to set limits for each individual measurement.

In 2011, EPA Victoria published the *Environmental Water Quality Guidelines for Victorian Riverine Estuaries*. These guidelines provide a framework and tools for assessing the environmental condition of riverine estuaries and document guideline values that describe the condition of reference-quality estuaries which can be used as an indicator for assessment of other estuaries.

|  |  |
| --- | --- |
| Descriptor | Data Descriptor |
| Fails to meet two or more EPA Victoria water quality guideline values for estuaries | Fails 2 or More |
| Fails to meet one EPA Victoria water quality guideline values for estuaries | Fails 1 |
| Meets all EPA Victoria water quality guideline values for estuaries | Meets All |
| No EPA water quality data is available for the estuary | No data |

Measure 2 – Algal Blooms

Refer to Section 17.1.2 for background information.

|  |  |
| --- | --- |
| Descriptor | Data Descriptor |
| Algal blooms occur every 1 to 2 years (on average) | 1 to 2 years |
| Algal blooms occur every 3 to 10 years (on average) | 3 to 10 years |
| No algal blooms are known to have occurred in the last 10 years | More than 10 years |
| Algal bloom occurrence in the last 10 years is unknown | No data |

Measure 3– Fish Deaths

Refer to Section 17.1.2 for background information.

|  |  |
| --- | --- |
| Descriptor | Data Descriptor |
| Fish deaths resulting from anthropogenic degradation of water quality occur every 1 to 2 years (on average) | 1 to 2 years |
| Fish deaths resulting from anthropogenic degradation of water quality occur every 3 to 10 years (on average) | 3 to 10 years |
| No fish deaths resulting from anthropogenic degradation of water quality are known to have occurred in the last 10 years | More than 10 years |
| Fish deaths resulting from anthropogenic degradation of water quality in the last 10 years is unknown | No data |

Measure 4 – Excessive Instream Macrophyte Growth

Refer to Section 17.1.2 for background information.

|  |  |
| --- | --- |
| Descriptor | Data Descriptor |
| >25% of the reach has excessive instream macrophyte growth | >25% |
| 5-25% of the reach has excessive instream macrophyte growth | 5-25% |
| <5% of the reach has excessive instream macrophyte growth | <5% |
| Extent of excessive instream macrophyte growth is unknown | No data |

* + 1. Disturbance of Acid Sulfate Soils

To describe the threat of acid sulphate soils to estuaries, the same metric as described for river reaches was used (refer to Section 17.1.4).

AVIRA Metric – Degraded Water Quality

Based on the above, and including some of the measures identified for river reaches (refer to Section 17.1.2), Degraded Water Quality for estuaries was scored using the following metric:

|  |  |
| --- | --- |
| Threat Score | Descriptor |
| 5 | Fails to meet two or more EPA Victoria water quality guideline values for estuaries  IF NO MONITORING SITE THEN Algal blooms occur every 1 to 2 years (on average) OR Fish deaths resulting from anthropogenic degradation of water quality occur every 1 to 2 years (on average) OR >25% of the estuary length has excessive instream macrophyte growth |
| 3 | Fails to meet one EPA Victoria water quality guideline values for estuaries  IF NO MONITORING SITE THEN Algal blooms occur every 3 to 10 years (on average) OR Fish deaths resulting from anthropogenic degradation of water quality occur every 3 to 10 years (on average) OR 5-25% of the estuary length has excessive instream macrophyte growth |
| 1 | Meets all EPA Victoria water quality guideline values for estuaries  IF NO MONITORING SITE THEN No algal blooms are known to have occurred in the estuary in the last 10 years AND No fish deaths resulting from anthropogenic degradation of water quality are known to have occurred in the last 10 years AND <5% of the estuary length has excessive instream macrophyte growth |
| no data | No EPA water quality data is available for the estuary  AND Algal bloom occurrence in the last 10 years is unknown AND Fish deaths resulting from anthropogenic degradation of water quality in the last 10 years is unknown AND Extent of excessive instream macrophyte growth is unknown |
| Data Sources:  *Environmental Water Quality Guidelines for Victorian Riverine Estuaries (EPA Victoria, 2011)*  EPA Victoria databases  Deakin Great Ocean Road water quality data  Index of Estuary Condition water quality data  Estuarywatch databases and local knowledge | |

1. Degraded Habitats

Under this category, the following threats have been identified:

* For river reaches:
  + Degraded Riparian Vegetation
  + Loss of Instream Habitat
  + Livestock Access
* For wetlands:
  + Soil Disturbance
* For estuaries:
  + Degraded Estuarine Vegetation
  + Livestock Access
  + Altered Extent of Aquatic Macrophytes
  + Sedimentation

These threats are described in the following sections.

* 1. River Reaches
     1. Background

Two key ecosystems exist for river reaches: land-based and water-based. Riparian lands and their vegetation provide vital habitat for land-based plants and animals (LWRRDC 1996). Whereas the river itself provides habitat for both aquatic and terrestrial species (deep pools, logs, etc.).

To determine the threat posed to river values from degraded habitats, three measures were identified:

* Degraded Riparian Vegetation;
* Loss of Instream Habitat; and
* Livestock Access.
  + 1. Degraded Riparian Vegetation

The 3ISC streamside zone assessment is based on a comparison between the current condition of a site compared with its EVC benchmark. It assesses seven indicators:

* width;
* fragmentation;
* overhang i.e.the percentage of streambank toe with overhanging vegetation;
* structure (2 measures);
* large trees[[2]](#footnote-2); and
* weeds (trees).

One of these indicators was identified for use as a measure of threat to riparian habitats, namely large trees.

AVIRA Metric – Degraded Riparian Vegetation (Large Trees)

Large trees can be a dominant feature of remnant native vegetation and are often old, making them a difficult habitat feature to replace once lost. They provide nesting and food resources (Parkes et al 2003).

|  |  |  |
| --- | --- | --- |
| Threat Score | Descriptor | Data Descriptor |
| 5 | 3ISC Large Trees Value Score: 1 | 3ISC Large Tree Score |
| 4 | 3ISC Large Trees Value Score: 2 |
| 3 | 3ISC Large Trees Value Score: 3 |
| 2 | 3ISC Large Trees Value Score: 4 |
| 1 | 3ISC Large Trees Value Score: 5 |
| no data | The 3ISC methodology to identify the large tree score has not been applied, no reference available | -1 |
| Data Source:  3ISC Large Trees Indicator | | |

* + 1. Loss of Instream Habitat

Two measures were identified to assess threats to instream habitats:

* Loss of Instream Habitat (Large Wood); and
* Loss of Instream Habitat (Sedimentation).

AVIRA Metric – Loss of Instream Habitat (Large Wood)

Woody debris (snags) consists of the logs, stems and branches of trees and shrubs that fall into the stream from the side of the river (DNRE 2001a). Woody debris provides valuable habitat for fish, birds, reptiles, mammals, amphibians and insects, for example:

* fish use woody debris as sites to spawn and rear juveniles (e.g.blackfish);
* water birds use emergent woody debris as sites for roosting, preening and nesting; and
* reptiles use woody debris as vantage points to catch aquatic prey.
* The 3ISC Physical Form Sub-Index includes a Large Wood Indicator that measures large wood by assessing:
* the density of instream large wood;
* the location of large wood (e.g.stream edges, mid-stream, etc.); and
* the origin of the large wood (indigenous or exotic).

This indicator was used as a measure of instream habitat condition.

Based on the above, Loss of Instream Habitat (Large Wood) was scored using the following metric:

|  |  |  |
| --- | --- | --- |
| Threat Score | Descriptor | Data Descriptor |
| 5 | Very Poor Habitat. *Typical features*: No instream wood visible. (3ISC Large Wood Value Score = 1) | 3ISC Large Wood Score |
| 4 | Poor Habitat. *Typical features*: Few visible pieces of instream wood in channel (either from indigenous or exotic species). (3ISC Large Wood Value Score = 2) |
| 3 | Marginal Habitat. *Typical features*: Moderate visible pieces of instream wood from indigenous species in channel. Abundant pieces of exotic instream wood in channel. Moderate impact of desnagging. Streamside vegetation clearing evident. (3ISC Large Wood Value Score = 3) |
| 2 | Good Habitat. *Typical features*: Numerous pieces of instream wood from indigenous species. Perhaps limited instream wood from exotic species present also. Limited impact of desnagging or streamside vegetation clearing. (3ISC Large Wood Value Score = 4) |
| 1 | Excellent Habitat. *Typical features*: Abundant instream wood from indigenous woody vegetation taxa. Site probably never desnagged. Streamside vegetation probably never cleared. (3ISC Large Wood Value Score = 5) |
| no data | The 3ISC methodology to identify the large wood score has no been applied, no reference available | -1 |
| Data Source:  3ISC Large Wood Indicator | | |

AVIRA Metric – Loss of Instream Habitat (Sedimentation)

Stream beds aggrade when more sediment is delivered to a reach than can be transported through the reach. Increased sediment is delivered to streams from erosion of the bed and banks (as described in Section 15.1.2), and from sources within the catchment (erosion following fires, logging, clearing, mining). Deposited sediment is typically sand, as silts and clays are transported right through the system. Once in a stream, coarse sediment will either settle out, or be transported gradually downstream or onto floodplains. As this occurs, habitat structure is simplified as major habitat features such as pools and riffles become covered and disappear (DNRE, 2002a). Aggradation can also lead to decreased hydraulic capacity (more frequent floods).

A number of observations can be made to determine the degree of sedimentation of the streambed, particularly:

* location and distribution of sediment (from collection points at instream obstructions (e.g.large woody debris) and channel bends (e.g.point bars) to complete channel widths);
* channel shape (e.g.deep and narrow v shallow and wide); and
* substrate variability (e.g.riffles and pools v flat, uniform streambed).

Based on the above, Loss of Instream Habitat (Sedimentation) was scored using the following metric:

|  |  |  |
| --- | --- | --- |
| Threat Score | Descriptor | Data Descriptor |
| 5 | Extensive deposition of sediments throughout reach with no observable instream habitat features OR Floodplain/valley inundation (i.e.loss of channel) OR Reach classified as aggradational in SedNet (usually greater than 1m of net deposition) | Extensive |
| 4 | Deposition of sediments throughout reach AND Channel bed beginning to become uniform (i.e.some observable instream habitat features) OR More than half of the reach classified as aggradational in SedNet | Significant |
| 3 | Deposition of sediments above natural levels mainly at bends and/or instream obstructions | Some |
| 1 | No obvious deposition of sediments above natural levels | Negligible |
| no data | Bed stability of waterway is unknown | No data |
| Data Sources:\*  SedNet \*\*  Fluvial Geomorphological studies  Local knowledge | | |

\* The 3ISC does not include a bed instability measure as it was deemed to be too variable and difficult to determine in the field at a single point in time. Although no state-wide dataset exists, bed stability remains a significant impact. As such it is recommended that the metric is scored in the regions by CMAs, rather than at State level from a data base.

\*\* SedNet provides an estimate of aggradation based on the hydraulic capacity of the reach.

* + 1. Livestock Access

The 2ISC included an assessment of livestock access, under the following measures:

* damage to vegetation;
* damage to banks;
* pugging;
* manure; and
* tracks.

This information was not collected under 3ISC. Therefore, livestock access was determined from information and on-ground knowledge of regional agencies.

AVIRA Metric – Livestock Access

Based on the above, Livestock Access threats were scored using the following metric:

|  |  |  |
| --- | --- | --- |
| Threat Score | Descriptor | Data Descriptor |
| 5 | >75% of waterway is affected by livestock access | >75% |
| 3 | 25-75% of waterway is affected by livestock access | 25-75% |
| 1 | <25% of waterway is affected by livestock access | <25% |
| no data | Livestock access to waterway is unknown | No data |
| Data Source:  Local knowledge | | |

* 1. Wetlands
     1. Background

To determine the threat posed to wetland values from degraded habitats, three measures derived from the IWC were identified - Soil Disturbance, Degraded Buffer and Livestock Access.

* + 1. Soil Disturbance

Wetland soils provide a physical substrate for aquatic plants including macrophytes and algae and habitat for benthic invertebrates and micro-organisms. Threats to the physical properties of wetland soils are activities such as pugging by livestock and feral animals, human trampling, driving of vehicles in the wetland and carp mumbling. These activities cause soil disturbance which can reduce water storage capacity of soil, can have negative impacts on some invertebrates and increase turbidity during filling (DSE 2008e).

The IWC includes a measure of soil disturbance relating to the physical disturbance of the soil structure and profile.

Activities with the potential to cause soil disturbance include:

* pugging by livestock and/or feral animals;
* cultivation;
* carp mumbling;
* human trampling; and
* driving of vehicles in the wetland.

To determine the severity of effect of these activities, the IWC Field Assessment Sheet lists the following key steps (refer to DSE 2008e):

1. Identify the presence of activities that cause soil disturbance.
2. Estimate the percentage of wetland soil affected by these activities.
3. Estimate the collective severity of effect of the activities on wetland soils.

AVIRA Metric – Soil Disturbance

Based on the above, Soil Disturbance threats were scored using the following metric:

|  |  |  |
| --- | --- | --- |
| Threat Score | Descriptor | Data Descriptor |
| 5 | IWC Soils Sub-Index Score: 0 - 4 (Very Poor) | IWC Soils Score |
| 4 | IWC Soils Sub-Index Score: 5 - 8 (Poor) |
| 3 | IWC Soils Sub-Index Score: 9 - 12 (Moderate) |
| 2 | IWC Soils Sub-Index Score: 13 - 16 (Good) |
| 1 | IWC Soils Sub-Index Score: 17 - 20 (Excellent) |
| no data | IWC methodology to identify degree of soil disturbance has not been applied | -1 |
| Data Source:  IWC Soils Sub-Index | | |

Additional Information

Whilst the above metric provides the severity of soil disturbance for a particular wetland, additional IWC information is available that better defines the specific activities that have caused the disturbance. This information can be accessed through the IWC database (website: <http://iwc/iwc/dms/welcome>) and includes the following:

|  |  |  |
| --- | --- | --- |
| Soil Disturbance | Not Present | Present |
| Pugging by livestock and/or feral animals |  |  |
| Cultivation |  |  |
| Carp mumbling |  |  |
| Human trampling |  |  |
| Driving of vehicles in the wetland |  |  |

* + 1. Degraded Buffer Vegetation

Wetland buffer condition is collected as part of the IWC. It assesses data including the average width and percentage of perimeter of wetland with buffer. The buffer must contain >25% of native vegetation ground cover to be included as a buffer. This data is used to indicate the level of degradation to the buffer.

|  |  |  |
| --- | --- | --- |
| Threat Score | Descriptor | Data Descriptor |
| 5 | IWC Wetland Buffer Assessment Score: 0 - 5 | IWC Wetland Buffer Assessment |
| 4 | IWC Wetland Buffer Assessment Score: >5 - 9 |
| 3 | IWC Wetland Buffer Assessment Score: >9 - 13 |
| 2 | IWC Wetland Buffer Assessment Score: >13 - 17 |
| 1 | IWC Wetland Buffer Assessment Score: >17 - 20 |
| no data | IWC assessment has not been undertaken | -1 |
| Data Source:  IWC Wetland Buffer Assessment Score | | |

* + 1. Livestock Access

To describe the threat of livestock access to wetlands, the same metric as described for river reaches was used (refer to Section 18.1.4)

|  |  |  |
| --- | --- | --- |
| Threat Score | Descriptor | Data Descriptor |
| 5 | >75% of waterway is affected by livestock access | >75% |
| 3 | 25 to 75% of waterway is affected by livestock access | 25-75% |
| 1 | <25% of waterway is affected by livestock access | <25% |
| no data | Livestock access to waterway is unknown | No Data |
| Data Source:  Local knowledge | |  |

* 1. Estuaries
     1. Background

To assess the threat posed to estuary values from degraded habitats, four measures were identified:

* Degraded Estuarine Vegetation;
* Livestock Access;
* Altered Extent of Aquatic Macrophytes; and
* Sedimentation.
  + 1. Degraded Estuarine Vegetation

This metric refers to the condition of fringing estuarine vegetation. The IEC method for assessing fringing, estuary-associated macrophytes has not yet been developed. However, detailed mapping of fringing vegetation was undertaken at 1:50,000 scale for the following:

* seven estuaries in the Glenelg Hopkins CMA (Sinclair & Sutter 2008),
* eight estuaries in the Corangamite CMA (Osler et al. 2010) and
* state-wide for saltmarsh and mangroves (Boon et al. 2010).

These projects (Sinclair and Sutter 2008, Osler et al. 2010 and Boon et al. 2010) each made an assessment of vegetation condition. This data can be used to assess vegetation at each of the estuaries in AVIRA to assign a threat class (Highly disturbed, Modified, Near natural or No data – see below for definitions). Scoring is based on the change from historical (pre-European) condition.

|  |  |  |
| --- | --- | --- |
| Threat Score | Descriptor | Data descriptor |
| 5 | Highly disturbed: no remaining fringing macrophytes | Highly disturbed |
| 3 | Modified: fringing macrophytes present, some EVCs absent or modified from benchmark | Modified |
| 1 | Near natural: no change in extent or condition of EVCs | Near natural |
| no data | Estuary has not been assessed for degraded vegetation condition | No data |
| Data Source:  Boon, Allen, Brook, Carr, Frood, Hoye, Harty, McMahon, Mathews, Rosengren, Sinclair, White and Yugovic (2010). *Victorian Saltmarsh Study: Mangroves and Costal Saltmarsh of Victoria: distribution, condition, threats and management*. Institute for Sustainability and Innovation, Victoria University, Melbourne.  Osler, Cook, Sinclair and White (2010). *Ecological Vegetation Class Mapping – Corangamite Estuaries*, Australian Ecosystems Pty Ltd, Patterson Lakes, Victoria.  Sinclair and Sutter (2008). *Estuarine wetland vegetation mapping, Glenelg Hopkins CMA*, Technical Report Series No. 178 Arthur Rylah Institute, DSE, Heidelberg, Victoria.  Local knowledge | | |

* + 1. Livestock Access

To describe the threat of livestock access to estuaries, the same metric as described for river reaches and wetlands was used (refer to Section 18.1.4).

1. Invasive Flora and Fauna

Invasive animals, plants, and ecological diseases or pathogens[[3]](#footnote-3) are major threats to biodiversity because of their ability to change and destroy habitats and ecosystems. They are the number one cause of native animal extinctions in Australia, the second biggest threat to river and stream areas and nationally important wetlands, and the third biggest threat to threatened ecosystems (DSE ~2009b).

The impact that invasive flora and fauna have on natural ecosystems is very serious; weeds such as blackberry and bridal creeper and pest animals such as foxes, rabbits, and common carp have the potential to destroy the biodiversity values of highly-prized ecosystems. Internationally, invasive species are now recognised as the second-greatest threat to natural ecosystems (DNRE 2002g).

Under this category, the following threats have been identified:

* For river reaches:
  + Invasive Flora (Riparian);
  + Invasive Flora (Aquatic);
  + Invasive Fauna (Terrestrial); and
  + Invasive Fauna (Aquatic).
* For wetlands:
  + Invasive Flora (Wetland);
  + Invasive Fauna (Terrestrial); and
  + Invasive Fauna (Aquatic).
* For estuaries:
  + Invasive Flora (Riparian);
  + Invasive Flora (Aquatic);
  + Invasive Fauna (Terrestrial); and
  + Invasive Fauna (Aquatic).

These threats are described in the following sections.

* 1. River Reaches
     1. Invasive Flora (Riparian)

Invasive plants, or weeds, can pose a serious threat to biodiversity and to primary production. They contribute to land and water degradation, losses in productivity, and they can significantly impact native flora and fauna populations (DSE ~2009c).

To determine the threat posed by invasive flora (riparian), two measures were identified:

* the total cover of invasive flora; and
* the presence of high threat weeds.

Measure 1 – Total Cover of Invasive Flora

|  |  |
| --- | --- |
| Descriptor | Data Descriptor |
| >60% cover of invasive riparian flora | >60% |
| 41-60% cover of invasive riparian flora | 41-60% |
| 11-40% cover of invasive riparian flora | 11-40% |
| <11% cover of invasive riparian flora | <11% |
| Cover of invasive riparian flora is unknown | no data |

The cover of invasive riparian vegetation was determined as follows:

* Tree Layer. Use the 3ISC Cover of Exotic Vegetation Indicator (Tree Layer).
* Shrub and Ground Layers. Use local knowledge together with invasive flora data collected as part of the 2ISC Streamside Zone Sub-Index.

Measure 2 – Presence of High Threat Weeds

|  |  |
| --- | --- |
| Descriptor | Data Descriptor |
| High threat weeds present | Present |
| No high threat weeds present | Not Present |
| Presence of high threat weeds is unknown | no data |

Determining whether particular invasive species are high threat was the responsibility of each CMA.

Rating Table

|  |  |  |  |
| --- | --- | --- | --- |
| Total Cover of Invasive Flora | Presence of High Threat Weeds | | |
| Not Present | Present | No Data |
| >60% | 4 | 5 | 5 |
| 41-60% | 3 | 4 | 4 |
| 11-40% | 2 | 3 | 3 |
| <11% | 1 | 2 | 2 |

The cover of invasive riparian vegetation (as collected in 2ISC) divides vegetation into three layers (tree, shrub, and ground). This division can be advantageous in determining threats to specific values.

Based on the above, three metrics were used to score Invasive Flora (Riparian) as follows:

* Invasive Flora (Riparian) – Trees;
* Invasive Flora (Riparian) – Shrub Layer; and
* Invasive Flora (Riparian) – Ground Layer.

AVIRA Metric –Invasive Flora (Riparian) – Tree Layer

This metric was only assessed for willows and hawthorn (no other high threat or other types of weeds).

|  |  |
| --- | --- |
| Threat Score | Descriptor |
| 5 | >60% cover of willows or hawthorn |
| 4 | 41-60% cover of willows or hawthorn |
| 3 | 11-40% cover of willows or hawthorn |
| 2 | <11% cover of willows or hawthorn |
| 1 | <11% cover of invasive riparian flora (tree layer) with no willow or hawthorn detected |
| no data | Cover of invasive riparian flora (tree layer) is unknown |
| Data Sources:  3ISC Cover of Exotic Vegetation Indicator (Tree Layer)  Local knowledge | |

AVIRA Metric –Invasive Flora (Riparian) – Shrub Layer

This metric covers invasive woody vegetation less than 5m high.

|  |  |
| --- | --- |
| Threat Score | Descriptor |
| 5 | >60% cover of invasive riparian flora (shrub layer) with high threat weeds present OR >60% cover of invasive riparian flora (shrub layer) with presence of high threat weeds unknown |
| 4 | 41-60% cover of invasive riparian flora (shrub layer) with high threat weeds present OR 41-60% cover of invasive riparian flora (shrub layer) with presence of high threat weeds unknown OR >60% cover of invasive riparian flora (shrub layer) with no high threat weeds present |
| 3 | 11-40% cover of invasive riparian flora (shrub layer) with high threat weeds present OR 11-40% cover of invasive riparian flora (shrub layer) with presence of high threat weeds unknown OR 41-60% cover of invasive riparian flora (shrub layer) with no high threat weeds present |
| 2 | <11% cover of invasive riparian flora (shrub layer) with high threat weeds present OR <11% cover of invasive riparian flora (shrub layer) with presence of high threat weeds unknown OR 11-40% cover of invasive riparian flora (shrub layer) with no high threat weeds present |
| 1 | <11% cover of invasive riparian flora (shrub layer) with no high threat weeds present |
| no data | Cover of invasive riparian flora (shrub layer) is unknown |
| Data Sources:  2ISC Cover of Exotic Vegetation Indicator (Shrub Layer)  Local knowledge | |

AVIRA Metric –Invasive Flora (Riparian) – Ground Layer

This metric covers all invasive non-woody vegetation.

|  |  |
| --- | --- |
| Threat Score | Descriptor |
| 5 | >60% cover of invasive riparian flora (ground layer) with high threat weeds present OR >60% cover of invasive riparian flora (ground layer) with presence of high threat weeds unknown |
| 4 | 41-60% cover of invasive riparian flora (ground layer) with high threat weeds present OR 41-60% cover of invasive riparian flora (ground layer) with presence of high threat weeds unknown OR >60% cover of invasive riparian flora (ground layer) with no high threat weeds present |
| 3 | 11-40% cover of invasive riparian flora (ground layer) with high threat weeds present OR 11-40% cover of invasive riparian flora (ground layer) with presence of high threat weeds unknown OR 41-60% cover of invasive riparian flora (ground layer) with no high threat weeds present |
| 2 | <11% cover of invasive riparian flora (ground layer) with high threat weeds present OR <11% cover of invasive riparian flora (ground layer) with presence of high threat weeds unknown OR 11-40% cover of invasive riparian flora (ground layer) with no high threat weeds present |
| 1 | <11% cover of invasive riparian flora (ground layer) with no high threat weeds present |
| no data | Cover of invasive riparian flora (ground layer) is unknown |
| Data Sources:  2ISC Cover of Exotic Vegetation Indicator (Ground Layer)  Local knowledge | |

Additional Information

Whilst the above three metrics provide the presence and severity of impact of invasive flora for a particular river reach, additional information regarding specific high threat species should be included for transparency and management purposes. This can be achieved by including the species name in the rationale column of the data file (see Appendix D).

* + 1. Invasive Flora (Aquatic)

In addition to invasive riparian flora, the presence and extent of invasive aquatic flora (including diatoms and algae) is also significant to the health of rivers.

A listing of significant invasive flora (aquatic) is provided below (refer to DPI ~2009):

* Alligator Weed (Declared noxious weed)
* Arrowhead
* Cabomba
* Cunjevoi
* Delta Arrowhead
* Dense Waterweed
* Dwarf Arrowhead
* *Egeria densa*
* Giant Water Lily
* *Lagarosiphon major* (Declared noxious weed)
* Parrots Feather
* Reed Sweet Grass
* *Salvinia molesta* (Declared noxious weed)
* Senegal Tea Plant
* Water Hyacinth (Declared noxious weed)

Regionally significant invasive aquatic flora can be incorporated into this list by CMAs, as appropriate.

As there is no consistent mapping of these aquatic weeds, threat severity was based on a broad assessment of percentage cover.

AVIRA Metric – Invasive Flora (Aquatic)

Based on the above, Invasive Flora (Aquatic) was scored using the following metric:

|  |  |  |
| --- | --- | --- |
| Threat Score | Descriptor | Data Descriptor |
| 5 | >50% of the waterway perimeter has invasive aquatic flora present | >50% |
| 4 | >25-50% of the waterway perimeter has invasive aquatic flora present | 25-50% |
| 3 | 5-25% of the waterway perimeter has invasive aquatic flora present | 5-25% |
| 1 | <5% of the waterway perimeter has invasive aquatic flora present OR No invasive aquatic flora are known to occur | <5% |
| no data | Presence and extent of invasive aquatic flora is unknown | No data |
| Data Sources:  Local knowledge  Waterwatch data | | |

* + 1. Invasive Fauna (Terrestrial)

Invasive fauna can pose a serious threat to biodiversity and primary production. They contribute to the loss of native animals and can significantly disturb native vegetation.

To determine the threat posed by invasive fauna (terrestrial), two measures were identified:

* the presence of invasive species; and
* the type of impact.

Measure 1 – Presence of Invasive Species

|  |  |
| --- | --- |
| Descriptor | Data Descriptor |
| Invasive species present | Present |
| No invasive species are known to occur | Not present |
| Presence of invasive species is unknown | No data |

Measure 2 – Type of Impact

|  |  |
| --- | --- |
| Descriptor | Data Descriptor |
| Invasive terrestrial species directly prey on native species and/or damage native species habitat | Prey or Damage Habitat |
| Invasive terrestrial species compete for food and/or habitat with native species | Compete |
| Invasive terrestrial species have no significant impact | Minor |
| Impact of invasive terrestrial species is unknown | No data |

Rating Table

|  |  |  |
| --- | --- | --- |
|  | **Presence of Invasive Species** | |
| **Type of Impact** | No Invasive Species are Known to Occur | Present |
| **Directly prey on native species or damage habitat** | 1 | 5 |
| **Compete for food or habitat with native species** | 1 | 4 |
| **No significant impact** | 1 | 2 |

AVIRA Metric – Invasive Fauna (Terrestrial)

Based on the above, Invasive Fauna (Terrestrial) was scored using the following metric:

|  |  |
| --- | --- |
| Threat Score | Descriptor |
| 5 | Invasive fauna species (terrestrial) are present and directly prey on native species or damage habitat |
| 4 | Invasive fauna species (terrestrial) are present and compete for food or habitat with native species |
| 2 | Invasive fauna species (terrestrial) are present with no significant impacts |
| 1 | No invasive species (terrestrial) are known to occur |
| no data | Presence and/or impact of invasive fauna species (terrestrial) is unknown |
| Data Sources:  Victorian Fauna Database  Local knowledge | |

Additional Information

Whilst the above metric provides the presence and severity of impact of invasive terrestrial fauna for a particular river reach, additional information regarding specific species should be included for transparency and management purposes. This can be achieved by including the species name in the rationale column of the data file (see Appendix D).

* + 1. Invasive Fauna (Aquatic)

The introduction of live fish outside their natural range has significantly affected many of Victoria’s native fish species. Invasive fish introduced from other countries can threaten the survival of native species through competition for food and habitat, direct predation and the spread of disease (DNRE 2001c).

As for terrestrial invasive fauna, two measures were identified to determine the threat posed by invasive aquatic fauna:

* the presence of invasive species; and
* the type of impact.

Measure 1 – Presence of Invasive Species

|  |  |
| --- | --- |
| Descriptor | Data Descriptor |
| Invasive species present | Present |
| No invasive species are known to occur | Not present |
| Presence of invasive species is unknown | No data |

Measure 2 – Type of Impact

|  |  |
| --- | --- |
| Descriptor | Data Descriptor |
| Invasive aquatic species directly prey on native species and/or damage native species habitat | Prey or Damage Habitat |
| Invasive aquatic species compete for food and/or habitat with native species | Compete |
| Invasive aquatic species have no significant impact | Minor |
| Impact of invasive aquatic species is unknown | No data |

Rating Table

|  |  |  |
| --- | --- | --- |
|  | **Presence of Invasive Species** | |
| **Type of Impact** | No Invasive Species are Known to Occur | Present |
| **Directly prey on native species or damage habitat** | 1 | 5 |
| **Compete for food or habitat with native species** | 1 | 4 |
| **No significant impact** | 1 | 2 |

AVIRA Metric – Invasive Fauna (Aquatic)

Based on the above, Invasive Fauna (Aquatic) were scored using the following metric:

|  |  |
| --- | --- |
| Threat Score | Descriptor |
| 5 | Invasive fauna species (aquatic) are present and directly prey on native species or damage habitat |
| 4 | Invasive fauna species (aquatic) are present and compete for food or habitat with native species |
| 2 | Invasive fauna species (aquatic) are present with no significant impacts |
| 1 | No invasive species (aquatic) are known to occur |
| no data | Presence and/or impact of invasive fauna species (aquatic) is unknown |
| Data Sources:  Victorian Fauna Database  Local knowledge | |

Additional Information

Whilst the above metric provides the severity of impact of invasive aquatic fauna for a particular river reach, additional information regarding specific species present should be included for transparency and management purposes. This can be achieved by including the species name in the rationale column of the data file (see Appendix D).

* 1. Wetlands
     1. Invasive Flora (Wetland)

As part of the IWC, wetland vegetation quality assessments are based on:

* critical lifeforms;
* presence of weeds;
* indicators of altered processes; and
* vegetation structure and health.

The IWC measure ‘presence of weeds’ was used as the measure of threat of invasive flora (wetland). This measure considers the extent of impact of invasion by introduced plant species, with consideration of the ecological competitiveness of the relevant species within the respective wetland EVC (refer to Table 2). The scoring is based on assessing the proportional cover of weeds, and whether the relevant species are assessed as being of high or low threat (DSE 2006c).

Table 2 - IWC Scoring for Precense of Weeds (adapted from DSE 2006b)

|  |  |  |  |
| --- | --- | --- | --- |
| Total Cover of Weeds in EVC | % of Weed Cover made up of High Threat Weeds | | |
| nil | <50% | ≥50% |
| >50% | 7 | 3 | 0 |
| >25-50% | 12 | 10 | 7 |
| 5-25% | 18 | 15 | 12 |
| <5% | 25 | 22 | 18 |

AVIRA Metric –Invasive Flora (Wetland)

Based on the above, Invasive Flora (Wetland) was scored using the following metric:

|  |  |  |
| --- | --- | --- |
| Threat Score | Descriptor | Data Descriptor |
| 5 | >50% cover of weeds with high threat weeds present (i.e.>0%) (IWC Presence of Weeds Score: 0-3) | IWC Presence of Weeds Score |
| 4 | >25-50% cover of weeds with high threat weeds present (i.e.>0%) OR >50% cover of weeds with no high threat weeds present (IWC Presence of Weeds Score: 7-10) |
| 3 | 5-25% cover of weeds with high threat weeds present (i.e.>0%) OR 25-50% cover of weeds with no high threat weeds present (IWC Presence of Weeds Score: 12-15) |
| 2 | <5% cover of weeds with ≥50% of weed cover made up of high threat weeds OR 5-25% cover of weeds with no high threat weeds present (IWC Presence of Weeds Score: 18) |
| 1 | <5% cover of weeds with <50% of weed cover made up of high threat weeds  OR No weeds are known to occur (IWC Presence of Weeds Score: 22-25) |
| no data | IWC methodology to identify invasive flora has not been applied | -1 |
| Data Sources:  IWC Presence of Weeds  Local knowledge | | |

Additional Information

Whilst the above metric provides the severity of impact of invasive flora for a particular wetland, additional information regarding specific species present should be included for transparency and management purposes. This can be achieved by including the species name in the rationale column of the data file (see Appendix D).

* + 1. Invasive Fauna (Terrestrial)

To describe the threat of invasive fauna (terrestrial) to wetlands, the same metric as described for river reaches was used (refer to Section 19.1.3).

* + 1. Invasive Fauna (Aquatic)

To describe the threat of invasive fauna (aquatic) to wetlands, the same metric as described for river reaches was used (refer to Section 19.1.4).

* 1. Estuaries
     1. Invasive Flora (Riparian)

To describe the threat of invasive flora (riparian) to estuaries, the same three metrics as described for river reaches were used (refer to Section 19.1.1):

* Invasive Flora (Riparian) – Trees;
* Invasive Flora (Riparian) – Shrub Layer; and
* Invasive Flora (Riparian) – Ground Layer.
  + 1. Invasive Flora (Aquatic)

To describe the threat of invasive flora (aquatic) to estuaries, the same metric as described for river reaches was used (refer to Section 19.1.2).

* + 1. Invasive Fauna (Terrestrial)

To describe the threat of invasive fauna (terrestrial) to estuaries, the same metric as described for river reaches was used (refer to Section 19.1.3).

* + 1. Invasive Fauna (Aquatic)

To describe the threat of invasive fauna (aquatic) to estuaries, a similar metric as described for river reaches was used (refer to Section 19.1.4). However, as the relative ecological importance of predation, habitat modification or competition is not likely to be known or consistent between species in an estuarine context, the ‘type of impact’ measure has been excluded.

Measure 1 – Presence of Invasive Species

|  |  |
| --- | --- |
| Descriptor | Data Descriptor |
| Invasive species present | Present |
| No invasive species are known to occur | Not Present |
| Presence of invasive species is unknown | No data |

Measure 2 – Type of Impact

|  |  |
| --- | --- |
| Descriptor | Data Descriptor |
| Invasive aquatic species directly prey on native species, damage native species habitat and/or compete for food and/or habitat with native species | Major |
| Invasive aquatic species have no significant impact | Minor |
| Impact of invasive aquatic species is unknown | No data |

Rating Table

|  |  |  |
| --- | --- | --- |
|  | **Presence of Invasive Species** | |
| **Type of Impact** | No Invasive Species are Known to Occur | Invasive Species are Present |
| **Directly prey on native species, damage habitat and/or compete for food or habitat with native species** | 1 | 5 |
| **No significant impact** | 1 | 2 |

AVIRA Metric –Invasive Fauna (Aquatic)

Based on the above, Invasive Fauna (Aquatic) was scored using the following metric:

|  |  |
| --- | --- |
| Threat Score | Descriptor |
| 5 | Invasive fauna species (aquatic) are present and directly prey on native species, damage habitat or compete for food or habitat with native species |
| 2 | Invasive fauna species (aquatic) are present with no significant impacts |
| 1 | No invasive species are known to occur |
| no data | Presence and/or impact of invasive fauna species (aquatic) is unknown |
| Data Sources:  Victorian Fauna Database  Local knowledge | |

Additional Information

Whilst the above metric provides the severity of impact of invasive aquatic fauna for a particular estuary, additional information regarding specific species present should be included for transparency and management purposes. This can be achieved by including the species name in the rationale column of the data file (see Appendix D).

1. Reduced Connectivity

Connectivity is the ability of ecosystems to 'connect' and form networks. For rivers, wetlands and estuaries there are three key connectivity types: lateral; longitudinal; and vertical. These connectivity types cover the movement of water, materials, food and organisms from place to place.

Under the category ‘Reduced Connectivity’, the following threats have been identified:

* For river reaches:
  + Barriers to Fish Migration
  + Reduced Riparian Connectivity; and
  + Reduced Floodplain Connectivity.
* For wetlands:
  + Reduced Wetland Connectivity
* For estuaries:
  + Barriers to Estuarine Biota; and
  + Reduced Floodplain and Wetland Connectivity.

These threats are described in the following sections.

* 1. River Reaches
     1. Background

Rivers form a network of linked habitat through the catchment, such as linkages from forested headwaters to lowland plains and local networks through agricultural land.

In addition, riparian lands often contain a high diversity of living organisms and play an essential role as corridors for the movement of plants and animals (LWRRDC 1996).

To assess the threat posed to river values from reduced connectivity, three measures were identified:

* Barriers to Fish Migration;
* Reduced Riparian Connectivity; and
* Reduced Floodplain Connectivity.
  + 1. Barriers to Fish Migration

Most Victorian river systems have been changed in some way, either to control water, improve drainage or reduce erosion and flooding. Structures have been built for water storage (dams, reservoirs and weirs); for crossings (bridges and culverts); and for erosion control. There are now thousands of these structures in Victorian rivers and streams which act as barriers to fish movement; impacting the migration and recolonisation of aquatic species (DNRE 2001c).

A barrier near the mouth of a river can exclude fish from the entire river system. Barriers located further up the stream may prevent fish from accessing areas necessary for spawning (DNRE 2001c).

The State Fishway Program (McGuckin and Bennett 1999) used the following key criteria to establish priorities for fish passage across Victoria:

* native fish species likely to benefit (high conservation status or migratory species will be highest priority);
* length of river and area of habitat made accessible to fish;
* quality of habitat made accessible to fish;
* proximity to the sea or River Murray (the number and diversity of native fish that would benefit is highest at the lower end of catchments);
* complementary restoration programs being undertaken within the basin;
* an assessment of adverse impacts such as spread of noxious/predatory species; and
* a feasibility analysis that accounts for issues such as total cost of works, drown-out weir frequency, etc.

For AVIRA, the proximity of a barrier to the sea or River Murray was used as the key measure of threat to the migration of native fish.

The remaining criteria are either considered elsewhere in AVIRA (e.g.threatened species, habitat quality) or should be included as part of action plan development (e.g.complementary programs, adverse impacts, feasibility).

AVIRA Metric – Barriers to Fish Migration

Based on the above, Barriers to Fish Migration were scored using the following metric:

|  |  |  |
| --- | --- | --- |
| Threat Score | Descriptor | Data Descriptor |
| 5 | Artificial barrier exists in the estuary OR Artificial barrier exists in the floodplain reach | Estuary or Floodplain Reach |
| 4 | Artificial barrier exists in the valley reach | Valley Reach |
| 3 | Artificial barrier exists in the mountain reach | Mountain Reach |
| 0 | No artificial barrier exists | No Barrier |
| Data Sources:  Statewide Fish Barrier database  Regional fish barrier databases (including location of fishways)  3ISC – location of barriers  Local knowledge | | |

* + 1. Reduced Riparian Connectivity

To determine the threat posed to river values from reduced riparian connectivity, two measures were identified:

* Reduced Longitudinal Continuity; and
* Reduced Vegetation Width.

AVIRA Metric – Reduced Longitudinal Continuity

The 3ISC has two indicators that can be used as measures to assess threats to longitudinal continuity of riparian areas:

* fragmentation of woody vegetation; and
* vegetation overhang.

Measure 1 – Fragmentation of Woody Vegetation

|  |  |
| --- | --- |
| Descriptor | Data Descriptor |
| Gaps in woody vegetation cover 80-100% of riparian area (3ISC score = 1) | 3ISC Fragmentation Score |
| Gaps in woody vegetation cover 60-79 of riparian area (3ISC score = 2) |
| Gaps in woody vegetation cover 40-59% of riparian area (3ISC score = 3) |
| Gaps in woody vegetation cover 20-39% of riparian area (3ISC score = 4) |
| Gaps in woody vegetation cover 0-19% of riparian area (3ISC score = 5) |

Measure 2 – Vegetation Overhang

|  |  |
| --- | --- |
| Descriptor | Data Descriptor |
| 0 – 19% of streambank length has overhanging vegetation, Score = 1 or 2 (Very Poor) | 3ISC Overhang Score |
| 20 – 39% of streambank length has overhanging vegetation, Score = 3 (Poor) |
| 40 – 59% of streambank length has overhanging vegetation, Score = 4 (Moderate) |
| 60 – 79% of streambank length has overhanging vegetation, Score = 5 (Good) |
| 80 – 100% of streambank length has overhanging vegetation, Score = 6 (Excellent) |

Rating Table

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Length of Streambank with Overhanging Vegetation | Gaps in Woody Vegetation Cover | | | | | |
| 0-19% | 20-39% | 40-59% | 60-79 | 80-100% | no data |
| 0 – 19% | 1 | 2 | 3 | 4 | 5 | 5 |
| 20 – 39% | 1 | 1 | 2 | 3 | 4 | 4 |
| 40 – 59% | 1 | 1 | 1 | 2 | 3 | 3 |
| 60 – 79% | 1 | 1 | 1 | 1 | 2 | 2 |
| 80 – 100% | 1 | 1 | 1 | 1 | 1 | 1 |
| no data | 1 | 2 | 3 | 4 | 5 | no data |

Based on the above, Reduced Longitudinal Continuity was scored using the following metric:

|  |  |
| --- | --- |
| Threat Score | Descriptor |
| 5 | 0-39% of streambank has overhanging vegetation with 80-100% of vegetated area being gaps |
| 4 | 0-39% of streambank has overhanging vegetation with 60-79% of vegetated area being gaps OR 40-64% of streambank has overhanging vegetation with 80-100% of vegetated area being gaps |
| 3 | 0-39% of streambank has overhanging vegetation with 40-59% of vegetated area being gaps OR 40-64% of streambank has overhanging vegetation with 60-79% of vegetated area being gaps OR 65-79% of streambank has overhanging vegetation with 80-100% of vegetated area being gaps |
| 2 | 0-39% of streambank has overhanging vegetation with 20-39% of vegetated area being gaps OR 40-64% of streambank has overhanging vegetation with 40-59% of vegetated area being gaps OR 65-79% of streambank has overhanging vegetation with 60-79% of vegetated area being gaps OR 80-94% of streambank has overhanging vegetation with 80-100% of vegetated area being gaps |
| 1 | 0-39% of streambank has overhanging vegetation with 0-19% of vegetated area being gaps OR 40-64% of streambank has overhanging vegetation with 0-39% of vegetated area being gaps OR 65-79% of streambank has overhanging vegetation with 0-59% of vegetated area being gaps OR 80-94% of streambank has overhanging vegetation with 0-79% of vegetated area being gaps OR 95-100% of streambank has overhanging vegetation |
| Data Source:  3ISC Fragmentation of Woody Vegetation  3ISC Vegetation Overhang  Local knowledge | |

AVIRA Metric – Reduced Vegetation Width

Good riparian widths act as habitat corridors, providing a full range of plant communities needed for a range of species and to link effectively with adjacent terrestrial ecosystems. The 3ISC assesses the width of vegetation by measuring both the riparian width (i.e.river dependent vegetation) and adjacent vegetation width.

Based on the above, Reduced Vegetation Width was scored using the following metric:

|  |  |  |  |
| --- | --- | --- | --- |
| Threat Score | Descriptor | | Data Descriptor |
| Small Streams (bankfull width ≤ 15m wide) | Large Streams (bankfull width ≥ 15m wide) |
| 5 | < 5m | < 0.25 x baseflow width | 1 |
| 4 | 5 - 10m | (0.25 x baseflow width) - (< 0.5 x baseflow width) | 2 |
| 3 | > 10 - 30m | (0.5 x baseflow width) - (< 1.5 x baseflow width) | 3 |
| 2 | > 30 - 40m | (1.5 x baseflow width)- (< 3 x baseflow width) | 4 |
| 1 | > 40m | > 3 x baseflow width | 5 |
| Data Source:  3ISC Width of Vegetation Indicator | | | |

* + 1. Reduced Floodplain Connectivity

Reduced linkages between rivers and floodplains are an outcome of:

* water regulation and extraction which reduce flooding;
* actions taken to protect property from flooding, mostly by building levees; and
* laser-levelling on private land which infills floodways (DNRE 2002a).

As the issue of water regulation and extraction is covered under the threat category ‘Altered Water Regimes’, only the location and function of levees and other infrastructure has been considered further under this threat.

AVIRA Metric – Reduced Floodplain Connectivity

Based on the above, Reduced Floodplain Connectivity was scored using the following metric:

|  |  |  |
| --- | --- | --- |
| Threat Score | Descriptor | Data Descriptor |
| 5 | Levees and/or other infrastructure exist that completely disconnect\* the waterway from the floodplain | Completely Disconnected |
| 3 | Levees and/or other infrastructure exist that partially disconnect the waterway from the floodplain | Partially Disconnected |
| 0 | Floodplain is fully connected\*\* to the waterway OR No floodplain naturally exists | Fully Connected |
| Data Source: Regional Floodplain Strategies | | |

\* Completely Disconnected Floodplain - Flood events ≥10% Annual Exceedence Probability (AEP) cannot enter the floodplain

\*\* Fully Connected Floodplain - Floodwaters from all AEP events can naturally enter the floodplain.

* 1. Wetlands
     1. Background

Wetland connectivity is most likely to occur where there are a series of habitat areas arranged like ‘stepping stones’.

DEWHA and DAFF (2008) define connectivity as ‘the location and spatial distribution of natural areas in the landscape to provide species and populations with access to resources (food, breeding sites and shelter), increase habitat availability and facilitate population processes (dispersal, migration, expansion and contraction) and enable ecological processes (evolution, water, fire and nutrients)’.

* + 1. Reduced Wetland Connectivity

At this stage there is insufficient information available to determine optimum proximities between wetlands, or what type or area of wetland is required to provide adequate connectivity. DELWP is currently undertaking a project to model wetland connectivity across the landscape. Part of this project is to develop guidelines for how to use the model results to inform wetland management and prioritisation.

Therefore, the metric for Reduced Wetland Connectivity has been left blank until this work is completed.

* 1. Estuaries
     1. Background

To assess the threat posed to estuary values from reduced connectivity, two measures were identified:

* Barriers to Estuarine Biota; and
* Reduced Floodplain and Wetland Connectivity.
  + 1. Barriers to Estuarine Biota

Artificial barriers within estuaries can impact a number of estuarine fish species, including:

* estuarine dependent (freshwater derived);
* estuarine residents;
* estuarine dependent (marine derived); and
* estuarine opportunists (marine derived).

To describe the threat to estuarine values from barriers, the same metric as ‘Reduced Estuary Extent’ (refer to Section 16.3.2) was used with some minor changes to descriptors.

AVIRA Metric – Barriers to Estuarine Biota

Based on the above, Barriers to Estuarine Biota was scored using the following metric:

|  |  |  |
| --- | --- | --- |
| Threat Score | Descriptor | Data Descriptor |
| 5 | >50% of the estuary length is affected by an artificial barrier that completely blocks the movement of biota (in a typical year) | Very Significant |
| 4 | 1-50% of the estuary length is affected by an artificial barrier that completely blocks the movement of biota (in a typical year) OR >50% of the estuary length is affected by an artificial barrier that interferes (intermittently or selectively) with the movement of biota (in a typical year) | Significant |
| 3 | >25-50% of the estuary length is affected by an artificial barrier that interferes (intermittently or selectively) with the movement of biota (in a typical year) | Moderate |
| 2 | 1-25% of the estuary length is affected by an artificial barrier that interferes (intermittently or selectively) with the movement of biota (in a typical year) | Minor |
| 0 | No artificial barrier occurs within the estuary | No Barrier |
| Data Sources:  IEC Physical Form Sub Index  Statewide Fish Barrier database  Regional fish barrier databases  Local knowledge | | |

* + 1. Reduced Floodplain and Wetland Connectivity

Lateral connectivity is about linkages across the estuarine shoreline, including floodplain and wetland systems and the natural movement of materials and biota between those habitats and the central water body.

The key measures for this threat are:

* the presence of artificial structures (e.g.seawalls, levee banks, jetties, bridges, platforms); and
* degree of connectivity to adjoining floodplains or wetlands.

Measure 1 – Presence of Artificial Structures

|  |  |
| --- | --- |
| Descriptor | Data Descriptor |
| >15% of the estuary perimeter has artificial structures | Major |
| 1-15% of the estuary perimeter has artificial structures | Minor |
| Estuary has no artificial structures | None |

Measure 2 – Degree of Connectivity

|  |  |
| --- | --- |
| Descriptor | Data Descriptor |
| Wetlands are no longer connected to the estuary | Completely Disconnected |
| Wetlands are connected to the estuary but less than natural | Partially Disconnected |
| Wetlands fully connected to the estuary OR No estuarine wetlands exist naturally | Fully Connected |
| Degree of estuary-wetland connectivity is unknown | No data |

AVIRA Metric – Reduced Floodplain and Wetland Connectivity

Based on the above, Reduced Floodplain and Wetland Connectivity were scored using the following metric:

|  |  |
| --- | --- |
| Threat Score | Descriptor |
| 5 | >15% of the estuary perimeter has artificial structures OR Wetlands are no longer connected to the estuary |
| 3 | 1-15% of the estuary perimeter has artificial structures OR Wetlands are connected to the estuary but less than natural |
| 0 | Estuary has no artificial structures AND Wetlands fully connected to the estuary OR No estuarine wetlands exist naturally |
| no data | Degree of estuarine-wetland connectivity is unknown |
| Data Source:  Local knowledge | |

Part E Summary of Values and Threats

The following sections provide a summary of waterway values and threats for AVIRA.

1. Summary of AVIRA Values
   1. Environmental Values

|  |  |  |
| --- | --- | --- |
| **AVIRA ENVIRONMENTAL VALUES** | | |
| **River Reaches** | **Wetlands** | **Estuaries** |
| FORMALLY RECOGNISED SIGNIFICANCE   * National Significance   + Living Murray Icon Sites   + National Heritage Sites * State Significance   + Heritage Rivers   + Icon Rivers   + Essentially Natural Catchments   + Victorian Parks and Reserves   + Victorian Heritage Sites | FORMALLY RECOGNISED SIGNIFICANCE   * International Significance   + Ramsar Sites   + East Asian-Australasian Flyway Sites * National Significance   + Nationally Important Wetlands   + Living Murray Icon Sites   + National Heritage Sites * State Significance   + Heritage Rivers   + Essentially Natural Catchments   + Victorian Parks and Reserves   + Victorian Heritage Sites | FORMALLY RECOGNISED SIGNIFICANCE   * International Significance   + Ramsar Sites   + East Asian-Australasian Flyway Sites * National Significance   + Nationally Important Wetlands   + National Heritage Sites * State Significance   + Heritage Rivers   + Icon Rivers   + Essentially Natural Catchments   + Victorian Parks and Reserves   + Victorian Heritage Sites |
| REPRESENTATIVENESS   * Representative Rivers | REPRESENTATIVENESS | REPRESENTATIVENESS |
| RARE OR THREATENED SPECIES & COMMUNITIES   * Significant Invertebrates – Aquatic * Significant Invertebrates – Terrestrial * Significant Fish – Migratory * Significant Fish – Non-migratory * Significant Birds – Riparian * Significant Birds – Waterway * Significant Amphibians * Significant Reptiles – Aquatic * Significant Reptiles – Riparian * Significant Mammals * Significant Flora – Aquatic * Significant Flora – Terrestrial * Significant Riparian EVCs | RARE OR THREATENED SPECIES & COMMUNITIES   * Significant Invertebrates * Significant Fish * Significant Birds * Significant Amphibians * Significant Reptiles – Aquatic * Significant Reptiles – Riparian * Significant Mammals * Significant Flora * Significant Wetland EVCs | RARE OR THREATENED SPECIES & COMMUNITIES   * Significant Fish – Resident * Significant Fish – Dependent * Significant Birds * Significant Reptiles * Significant Flora * Significant Estuarine EVCs |

**Environmental Values (cont.)**

|  |  |  |
| --- | --- | --- |
| **AVIRA ENVIRONMENTAL VALUES** | | |
| **River Reaches** | **Wetlands** | **Estuaries** |
| NATURALNESS   * Aquatic Invertebrate Community Condition * Native Fish * Riparian Vegetation Condition | NATURALNESS   * Wetland Vegetation Condition | NATURALNESS |
| LANDSCAPE FEATURES   * Drought Refuges * Important Bird Habitats * Biosphere Reserves | LANDSCAPE FEATURES   * Drought Refuges * Important Bird Habitats (Important Bird Areas, Migratory Shorebird Sites, Colonial Nesting Bird Sites) * Biosphere Reserves | LANDSCAPE FEATURES   * Drought Refuges * Important Bird Habitats * Biosphere Reserves |

* 1. Social Values

|  |  |  |
| --- | --- | --- |
| **AVIRA SOCIAL VALUES** | | |
| **River Reaches** | **Wetlands** | **Estuaries** |
| ACTIVITY   * Recreational Fishing * Non-Motor Boating * Motor Boating * Camping * Swimming * Beside Water Activities   + Walking, Hiking, Cycling   + Sightseeing   + Picnics/Barbecues * Game Hunting | ACTIVITY   * Recreational Fishing * Non-Motor Boating * Motor Boating * Camping * Swimming * Beside Water Activities   + Walking, Hiking, Cycling   + Sightseeing   + Picnics/Barbecues * Game Hunting | ACTIVITY   * Recreational Fishing * Non-Motor Boating * Motor Boating * Camping * Swimming * Beside Water Activities   + Walking, Hiking, Cycling   + Sightseeing   + Picnics/Barbecues * Game Hunting |
| PLACE   * Heritage   + Pre-European (Indigenous) Heritage   + Post-European Heritage * Landscape | PLACE   * Heritage   + Pre-European (Indigenous) Heritage   + Post-European Heritage * Landscape | PLACE   * Heritage   + Pre-European (Indigenous) Heritage   + Post-European Heritage * Landscape |
| PEOPLE   * Community Groups * Use of Flagship Species | PEOPLE   * Community Groups * Use of Flagship Species | PEOPLE   * Community Groups * Use of Flagship Species |

* 1. Economic Values

|  |  |  |
| --- | --- | --- |
| **AVIRA ECONOMIC VALUES** | | |
| **River Reaches** | **Wetlands** | **Estuaries** |
| WATER   * Urban/Rural Township Water Sources * Rural Water Sources for Production * Water Storages * Water Carriers * Wastewater Discharges | WATER   * Urban/Rural Township Water Sources * Rural Water Sources for Production * Water Storages * Water Carriers * Wastewater Discharges | WATER   * Urban/Rural Township Water Sources * Rural Water Sources for Production * Wastewater Discharges |
| POWER GENERATION   * Hydro-Electricity | POWER GENERATION   * Hydro-Electricity |  |
| OTHER RESOURCES   * Commercial Fishing * Extractive Industries * Timber Harvesting and Firewood Collection | OTHER RESOURCES   * Commercial Fishing * Extractive Industries * Timber Harvesting and Firewood Collection | OTHER RESOURCES   * Commercial Fishing * Extractive Industries * Timber Harvesting and Firewood Collection |

1. Summary of AVIRA Threats

|  |  |  |
| --- | --- | --- |
| **AVIRA THREATS** | | |
| **River Reaches** | **Wetlands** | **Estuaries** |
| ALTERED WATER REGIMES   * Altered Flow Regimes   + Increase in Low Flow Magnitude   + Reduction in High Flow Magnitude   + Increase in Proportion of Zero Flow   + Change in Monthly Streamflow Variability   + Altered Streamflow Seasonality | ALTERED WATER REGIMES   * Changed Water Regime | ALTERED WATER REGIMES   * Altered Flow Regimes   + Increase in Low Flow Magnitude   + Reduction in High Flow Magnitude   + Increase in Proportion of Zero Flow   + Change in Monthly Streamflow Variability * Altered Streamflow Seasonality * Altered Marine Exchange   + Intermittently Open Estuaries   + Permanently Open Estuaries |
| ALTERED PHYSICAL FORM   * Bank Instability * Bed Instability (Degradation) | ALTERED PHYSICAL FORM   * Reduced Wetland Area * Altered Wetland Form | ALTERED PHYSICAL FORM   * Bank Instability * Reduced Estuary Extent |
| POOR WATER QUALITY   * Degraded Water Quality * EC, turbidity, pH, P * SIGNAL * Algal blooms, fish deaths * Thermal Water Pollution * Disturbance of Acid Sulfate Soils | POOR WATER QUALITY   * Changed Water Properties * Salinity * Nutrients * Disturbance of Acid Sulfate Soils | POOR WATER QUALITY   * Degraded Water Quality * DO, turbidity, pH, Chlorophyll a * Excessive instream macrophyte growth * Algal blooms, fish deaths * Disturbance of Acid Sulfate Soils |

Summary of Threats (cont.)

|  |  |  |
| --- | --- | --- |
| **AVIRA THREATS** | | |
| **River Reaches** | **Wetlands** | **Estuaries** |
| DEGRADED HABITATS   * Degraded Riparian Vegetation   + Large Trees * Loss of Instream Habitat   + Large Wood   + Sedimentation * Livestock Access | DEGRADED HABITATS   * Soil Disturbance * Degraded buffer vegetation * Livestock Access | DEGRADED HABITATS   * Degraded Estuarine Vegetation * Livestock Access |
| INVASIVE FLORA AND FAUNA   * Invasive Flora (Riparian)   + Trees   + Shrub Layer   + Ground Layer * Invasive Flora (Aquatic) * Invasive Fauna (Terrestrial) * Invasive Fauna (Aquatic) | INVASIVE FLORA AND FAUNA   * Invasive Flora (Wetland) * Invasive Fauna (Terrestrial) * Invasive Fauna (Aquatic) | INVASIVE FLORA AND FAUNA   * Invasive Flora (Riparian)   + Trees   + Shrub Layer   + Ground Layer * Invasive Flora (Aquatic) * Invasive Fauna (Terrestrial) * Invasive Fauna (Aquatic) |
| REDUCED CONNECTIVITY   * Barriers to Fish Migration * Reduced Riparian Connectivity   + Longitudinal Continuity   + Vegetation width * Reduced Floodplain Connectivity | REDUCED CONNECTIVITY | REDUCED CONNECTIVITY   * Barriers to Estuarine Biota * Reduced Floodplain and Wetland Connectivity |

Part F Summary of the Risk Assessment Process

This appendix provides a summary of the risk assessment process used within AVIRA. The process is described in full in Peters G, Doeg T and Herron S, 2009, *Aquatic Value Identification and Risk Assessment (AVIRA) – Risk Assessment Process*, Report Prepared for the Department of Sustainability and Environment.

1. Risk Assessment Process for AVIRA
   1. Risk Management Process

The Victorian River Health Strategy (DNRE 2002) and the Victorian Waterway Management Strategy (2013) stated that RRHSs and RWSs will set priorities for protection and restoration using a risk-based approach.

Establishing a risk-based approach within AVIRA will provide guidance that enables CMAs, Melbourne Water and DSE to achieve:

* a more confident and rigorous basis for decision-making and planning;
* better identification of opportunities and threats;
* pro-active rather than re-active management;
* more effective allocation and use of resources; and
* improved stakeholder confidence and trust.

Risk management is the term applied to the culture, processes and structures that are directed towards realizing potential opportunities whilst managing adverse effects (SA/SNZ 2004 p4).

The risk management process is defined by AS/NZS 4360:2004: Risk Management, and is shown in **Figure 5**.

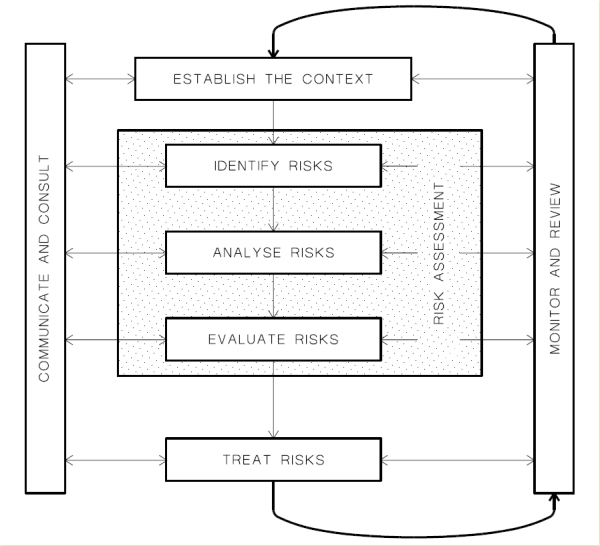


Figure 5 - Risk Management Process from AS/NZS 4360:2004: Risk Management

The risk assessment process for AVIRA is shown in **Figure 6**.

IDENTIFYING RISKS

Key tasks:

Identify Values (environmental, social, economic)

Identify Threats (Altered Water Regimes; Altered Physical Form; Poor Water Quality; Degraded Habitats; Exotic Flora and Fauna; and Reduced Connectivity)

Identify Causes (Direct and Indirect) – not included in AVIRA

ANALYSING RISKS

Key Tasks:

Define Associations (between values and threats)

Determine Consequences (based on value, threat severity and degree of association)

Determine Likelihood (based on existing threats and potential threats)

Calculate Risk Levels (existing and potential)

EVALUATING RISKS

Key Tasks:

Determine appropriate management responses

Evaluate risk types (intolerable, tolerable, acceptable)

Figure 6 - Risk Assessment Process for AVIRA

* 1. Establishing the Context
     1. Objectives

Risk is the chance of something happening that will impact on the objectives. Therefore to ensure that all significant risks are captured, it is necessary to identify the objectives. The AVIRA risk assessment process is broadly aligned to the objectives of the Victorian Waterway Management Strategy, 2013.

* + 1. Management Responses

To achieve the objectives broad management responses need to be identified. Broad management responses have been identified for the AVIRA risk assessment process, and are outlined in Section 23.5.

* + 1. Identifying Risks

To identify the risk, we need to identify the values, threats and causes of these threats. The grouping of values identified for AVIRA which were included in the risk assessment process were:

Environmental

* rare or threatened species/communities
* naturalness
* special features

Social

* activity
* place
* people

Economic

* water
* power generation
* other resources

The threats groupings identified for AVIRA and used in the risk assessment process were:

* Altered Water Regimes;
* Altered Physical Form;
* Poor Water Quality;
* Degraded Habitats;
* Exotic Flora and Fauna; and
* Reduced Connectivity.

Under each grouping individual values and threats have been identified.

* 1. Analysing Risks

To identify risk, the following variables must be defined:

* the impact of the risk if it occurred (the consequence); and
* the probability or frequency of the risk occurring (the likelihood).

A consequence is an outcome or impact of an event. For AVIRA, it is proposed that consequence be evaluated as the severity of the impact that a threat has on a value. Therefore, to measure consequence, we need to determine:

* the value score (e.g.migratory fish);
* the threat score (e.g.the type of fish barrier); and
* the association between the value and the threat (e.g.strong evidence of an association between fish barriers and migratory fish).

An association can be seen as a measure of how much influence a particular threat (e.g.fish barriers) can have on a particular value (e.g.native fish). Each individual threat-value combination has a particular association score. The association rating table for AVIRA and example of possible associations are shown in Table 3 and Table 4**.**

Table 3 - Association Rating Table for AVIRA

|  |  |
| --- | --- |
| Association Ratings | Clarifier |
| High | Threat always or often impacts the value |
| Medium | Threat may impact the value |
| Low | Threat does not impact the value, but it is remotely possible. |
| None | Threat does not impact the value |

Table 4 - Example of Possible Associations

|  |  |  |  |
| --- | --- | --- | --- |
|  |  | Value Category - Naturalness | |
| Threat Category | Threat | Aquatic macroinvertebrates | Native Fish |
| Reduced Connectivity | Barriers | Low | High\* |
| Altered Longitudinal Continuity | Medium | Medium |
| Altered Water Regimes | Changed Variability | Low | Medium |
| Reduced High Flow | Low | Medium |

To further refine the association ratings, a level of confidence should be applied to the source of the information. The confidence ratings are shown in Table 5.

Table 5 - Confidence Ratings for Associations in AVIRA

|  |  |  |
| --- | --- | --- |
| Confidence Ratings | | Clarifier |
| High | Repeated scientific evidence supports association rating | |
| Medium | Single studies or observations suggests association rating | |
| Low | Expert/professional opinion based on logical/plausible connection rather than direct evidence | |

Three consequence ratings were developed based on level of association (high, medium or low). If no association existed, there is no risk. These are shown in **Figure 7**, **Figure 8** and **Figure 9**.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | **Value Score** | | | | | | |
|  |  | **0** | **1** | **2** | **3** | **4** | **5** | **No Data** |
| **Threat Score** | **No Data** | NC | VL | L | M | H | **VH** | **VH** |
| **5** | NC | VL | L | M | H | **VH** | **VH** |
| **4** | NC | NC | VL | L | M | H | H |
| **3** | NC | NC | NC | VL | L | M | M |
| **2** | NC | NC | NC | NC | VL | L | L |
| **1** | NC | NC | NC | NC | NC | VL | VL |
| **0** | NC | NC | NC | NC | NC | NC | NC |

Figure 7 - Consequence Rating Table for High Value-Threat Associations

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | **Value Score** | | | | | | |
|  |  | **0** | **1** | **2** | **3** | **4** | **5** | **No Data** |
| **Threat Score** | **No Data** | NC | NC | VL | L | M | H | H |
| **5** | NC | NC | VL | L | M | H | H |
| **4** | NC | NC | NC | VL | L | M | M |
| **3** | NC | NC | NC | NC | VL | L | L |
| **2** | NC | NC | NC | NC | NC | VL | VL |
| **1** | NC | NC | NC | NC | NC | NC | NC |
| **0** | NC | NC | NC | NC | NC | NC | NC |

Figure 8 - Consequence Rating Table for Medium Value-Threat Associations

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | **Value Score** | | | | | | |
|  |  | **0** | **1** | **2** | **3** | **4** | **5** | **No Data** |
| **Threat Score** | **No Data** | NC | NC | NC | VL | L | M | M |
| **5** | NC | NC | NC | VL | L | M | M |
| **4** | NC | NC | NC | NC | VL | L | L |
| **3** | NC | NC | NC | NC | NC | VL | VL |
| **2** | NC | NC | NC | NC | NC | NC | NC |
| **1** | NC | NC | NC | NC | NC | NC | NC |
| **0** | NC | NC | NC | NC | NC | NC | NC |

Figure 9 - Consequence Rating Table for Low Value-Threat Assocations

Likelihood is a general description of probability or frequency where: probability is a measure of the chance of occurrence; and frequency is a measure of the number of occurrences per unit of time. Likelihood can be measured or estimated in terms of general descriptors (such as rare, unlikely, likely, almost certain), frequencies or (mathematical) probabilities. The likelihood rating table for AVIRA is shown in Table 6.

Table 6 - Likelihood Rating Table for AVIRA

|  |  |  |
| --- | --- | --- |
| Descriptor | Description | Existing Threat Score |
| Certain | Existing Threats Threat already occurring AND is not expected to increase or decrease in the next six years | 0, 1, 2, 3, 4 or 5 |
| Probable | Modified Threats Threat already occurring AND there is clear pressure to increase or decrease the extent or the intensity of the cause of the threat in the next six years | 2, 3, 4 or 5 |
| New Threats Threat currently not present or negligible BUT there is clear pressure to increase the extent or the intensity of the cause of the threat in the next six years | 0,1 |

* 1. Risk Level

The level of risk is determined by combining consequence and likelihood using suitable scales and methods. The level of risk for existing threats (i.e.those that have already occurred and are unlikely to increase or decrease in the foreseeable future) is determined by consequence alone. Therefore, the risk level tables for existing threats are the same as the consequence tables shown in **Figure 7**, **Figure 8** and **Figure 9**, as shown in **Figure 10**.

Determining risk levels for potential threats, requires the modification or ‘gaming’ of existing threats based on existing threat trajectory and an understanding of probable future threatening processes. The approach for assessing risk levels for potential threats involves an assessment process that occurs outside of the AVIRA software application.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | **Value Score** | | | | | | |
|  |  | **0** | **1** | **2** | **3** | **4** | **5** | **No Data** |
| **Threat Score** | **No Data** | NR | VL | L | M | H | **VH** | **VH** |
| **5** | NR | VL | L | M | H | **VH** | **VH** |
| **4** | NR | NR | VL | L | M | H | H |
| **3** | NR | NR | NR | VL | L | M | M |
| **2** | NR | NR | NR | NR | VL | L | L |
| **1** | NR | NR | NR | NR | NR | VL | VL |
| **0** | NR | NR | NR | NR | NR | NR | NR |

Figure 10 - Risk Level (High Association)

* 1. Management Response

For AVIRA, available management responses for identified risks include:

* changing the likelihood;
* changing the consequence; or
* retaining the risk.

For existing threats, a set of generic management responses have been recommended, namely:

* Fill data gap (either threat , value or both);
* Reduce threat level (the priority would be to manage or alter the cause of the threat where possible);
* Investigate whether the threat is the cause of the low value score and act accordingly (e.g.no action, reduce threat);
* Protect (prevent an increase in the threat level); and
* No priority action.

These generic responses were applied to the risk tables, to form a set of management response tables for existing threats shown in **Figure 11**, **Figure 12** and **Figure 13**. For potential threats, prevention is the key primary response.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | **Value Score** | | | | | | |
|  |  | **0** | **1** | **2** | **3** | **4** | **5** | **No Data** |
| **Threat Score** | **No Data** | NR No Priority Action | VL No Priority Action | L Fill Data Gap | M Fill Data Gap | H Fill Data Gap | **VH Fill Data Gap** | **VH Fill Data Gap** |
| **5** | NR No Priority Action | VL No Priority Action | L Investigate | M Investigate | H Reduce Threat | **VH Reduce Threat** | **VH Fill Data Gap** |
| **4** | NR No Priority Action | NR No Priority Action | VL Investigate | L Investigate | MReduce Threat | H Reduce Threat | H Fill Data Gap |
| **3** | NR No Priority Action | NR No Priority Action | NR No Priority Action | VL Investigate | LReduce Threat | MReduce Threat | M Fill Data Gap |
| **2** | NR No Priority Action | NR No Priority Action | NR No Priority Action | NR No Priority Action | VL Protect | L  Protect | L Fill Data Gap |
| **1** | NR No Priority Action | NR No Priority Action | NR No Priority Action | NR No Priority Action | NR No Priority Action | VL  Protect | VL No Priority Action |
| **0** | NR No Priority Action | NR No Priority Action | NR No Priority Action | NR No Priority Action | NR No Priority Action | NR No Priority Action | NR No Priority Action |

Figure 11 - Risk Level and Management Response for Existing Threats (High Association)

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | **Value Score** | | | | | | |
|  |  | **0** | **1** | **2** | **3** | **4** | **5** | **No Data** |
| **Threat Score** | **No Data** | NR No Priority Action | NR No Priority Action | VL Fill Data Gap | L Fill Data Gap | M Fill Data Gap | H Fill Data Gap | H Fill Data Gap |
| **5** | NR No Priority Action | NR No Priority Action | VL Investigate | L Investigate | M Reduce Threat | H Reduce Threat | H Fill Data Gap |
| **4** | NR No Priority Action | NR No Priority Action | NR No Priority Action | VL Investigate | L Reduce Threat | M Reduce Threat | M Fill Data Gap |
| **3** | NR No Priority Action | NR No Priority Action | NR No Priority Action | NR No Priority Action | VL Reduce Threat | L Reduce Threat | L Fill Data Gap |
| **2** | NR No Priority Action | NR No Priority Action | NR No Priority Action | NR No Priority Action | NR No Priority Action | VL Protect | VL Fill Data Gap |
| **1** | NR No Priority Action | NR No Priority Action | NR No Priority Action | NR No Priority Action | NR No Priority Action | NR No Priority Action | NR No Priority Action |
| **0** | NR No Priority Action | NR No Priority Action | NR No Priority Action | NR No Priority Action | NR No Priority Action | NR No Priority Action | NR No Priority Action |

Figure 12 - Risk Level and Management Response for Existing Threats (Moderate Association)

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | **Value Score** | | | | | | |
|  |  | **0** | **1** | **2** | **3** | **4** | **5** | **No Data** |
| **Threat Score** | **No Data** | NR No Priority Action | NR No Priority Action | NR No Priority Action | VL Fill Data Gap | L Fill Data Gap | M Fill Data Gap | M Fill Data Gap |
| **5** | NR No Priority Action | NR No Priority Action | NR No Priority Action | VL Investigate | L Reduce Threat | M Reduce Threat | M Fill Data Gap |
| **4** | NR No Priority Action | NR No Priority Action | NR No Priority Action | NR No Priority Action | VL Reduce Threat | L Reduce Threat | L Fill Data Gap |
| **3** | NR No Priority Action | NR No Priority Action | NR No Priority Action | NR No Priority Action | NR No Priority Action | VL Reduce Threat | VL Fill Data Gap |
| **2** | NR No Priority Action | NR No Priority Action | NR No Priority Action | NR No Priority Action | NR No Priority Action | NR No Priority Action | NR No Priority Action |
| **1** | NR No Priority Action | NR No Priority Action | NR No Priority Action | NR No Priority Action | NR No Priority Action | NR No Priority Action | NR No Priority Action |
| **0** | NR No Priority Action | NR No Priority Action | NR No Priority Action | NR No Priority Action | NR No Priority Action | NR No Priority Action | NR No Priority Action |

Figure 13 - Risk Level and Management Response for Existing Threats (Low Association)

References

AGL (~2008). <http://www.agl.com.au/about/EnergySources/Pages/Hydroelectric.aspx>

Annett, S. and Adamson, K. (2008). *Land Asset-Based Approach Framework.* Department of Sustainability and Environment, Melbourne.

Arundel, H.P. (2006). EEMSS Background Report and Users Manual

Arundel, H.P. (2007). *An Asset Based Framework for Victoria’s Estuaries: Identification of Assets.* Report for Department of Sustainability and Environment, Melbourne

Arundel, H., Pope, A., and Quinn, G. (2008). Victorian Index of Estuary Condition - Recommended Themes and Measures. Draft Report

Australian Institute of Energy (2003). Fact Sheet 6: Hydro Electricity

Australian Natural Resources Atlas (2009). *Irrigation – Victoria*. <http://www.anra.gov.au/topics/irrigation/infrastructure/vic.html>

Barton, J. (2003). Estuarine Health Monitoring & Assessment Review

Barton, J. (2006). Indicators of Estuarine Health in South East Australian Estuaries

Biodiversity Information Resources and Data (~2008). <http://bird.net.au/>

Birds Australia (~2009). <http://www.birdsaustralia.com.au>

Bond, N.R., Reich, P., Thomson, J., Giling, D. and Stein, J. (2010). *Modeling Drought Impacts on Freshwater Biota at Regional Scales to Inform NRM Investment Strategies.* Report to DSE. Prepared by Monash University.

Canoeing Victoria (~2008). <http://www.vic.canoe.org.au/>

Clean Energy Council (2007). Clean Energy Fact Sheets: All about Hydroelectricity

Commonwealth Scientific and Industrial Research Organisation (~2008). *Biodiversity and Ecology Overview.* <http://www.csiro.au/org/ps2w.html#3>

Department of the Environment, Water, Heritage and the Arts (~2008a). *Heritage Places in Victoria.* <http://www.environment.gov.au/heritage/places/vic/index.html>

Department of the Environment, Water, Heritage and the Arts (~2008b). *Environment Protection and Biodiversity Conservation Act.* http://www.environment.gov.au/epbc/index.html

Department of the Environment, Water, Heritage and the Arts (~2008c). *Australia’s Biosphere Reserves.* http://www.environment.gov.au/parks/biosphere/index.html

Department of the Environment, Water, Heritage and the Arts and the Department of Agriculture, Fisheries and Forestry (2008). *Caring For Our Country – Business Plan 2009-10.* Australian Government

Department of Natural Resources and Environment (1996). *Croajingolong National Park Management Plan*

Department of Natural Resources and Environment (2001a). *Removal of Woody Debris.* Freshwater Ecosystems Biodiversity Management Issues No. 7. Parks Flora and Fauna Division.

Department of Natural Resources and Environment (2001b). *Introducing Fish outside their Natural Range.* Freshwater Ecosystems Biodiversity Management Issues No. 10. Parks Flora and Fauna Division.

Department of Natural Resources and Environment (2001c). *Instream Barriers.* Freshwater Ecosystems Biodiversity Management Issues No. 9. Parks Flora and Fauna Division.

Department of Natural Resources and Environment (2002a). *Healthy Rivers, Healthy Communities and Regional Growth – Victorian River Health Strategy.* State Government of Victoria, Melbourne.

Department of Natural Resources and Environment (2002b). Corner Inlet Ramsar Site – Strategic Management Plan

Department of Natural Resources and Environment (2002c). *Victoria’s Native Vegetation Management. A framework for Action.* Department of Natural Resources and Environment. East Melbourne.

Department of Natural Resources and Environment (2002d). *Bendigo Regional Fisheries Management Plan*

Department of Natural Resources and Environment (2002e). *Goulburn-Eildon Fisheries Management Plan*

Department of Natural Resources and Environment (2002f). *Victorian Eel Fishery Management Plan*

Department of Natural Resources and Environment (2002g). *Victorian Pest Management – A Framework for Action*

Department of Natural Resources and Environment (2002h). Western District Lakes Ramsar Site Strategic Management Plan

Department of Primary Industries (2006a). *Glenelg Hopkins Fishery Management Plan*

Department of Primary Industries (2006b). *North East Fishery Management Plan*

Department of Primary Industries (2006c). *Anderson Inlet Fisheries Reserve Management Plan 2006.*  Fisheries Victoria Management Report Series No. 28

Department of Primary Industries (2006d). -*Mallacoota Inlet Fisheries Reserve Management Plan 2006.* Fisheries Victoria Management Report Series No. 36

Department of Primary Industries (2007a). Victorian *Recreational Fishing Guide 2007/2008*

Department of Primary Industries (2007b). *Lake Tyers Fisheries Reserve Management Plan 2007*. Fisheries Victoria Management Report Series No. 43

Department of Primary Industries (2008a). West Gippsland Fishery Management Plan

Department of Primary Industries (2008b). Corangamite Fishery Management Plan (draft)

Department of Primary Industries (~2008c). <http://www.dpi.vic.gov.au/DPI/nrenfaq.nsf/LinkView/BA3626FD9D1A39044A25676300234309F5F3C3DA915AFBE4CA256C6F0016CA60>

Department of Primary Industries (~2009). *Invasive Plants.* <http://www.dpi.vic.gov.au/dpi/vro/vrosite.nsf/pages/lwm_pest_plants>

Department of Sustainability and Environment (2003a). *Western Port Ramsar Site – Strategic Management Plan*

Department of Sustainability and Environment (2003b). Port Phillip Bay (Western Shoreline) and Bellarine Peninsula Ramsar Site – Strategic Management Plan

Department of Sustainability and Environment (2003c). Hattah-Kulkyne Lakes Ramsar Site Strategic Management Plan

Department of Sustainability and Environment (2003d). *Barmah Forest Ramsar Site Strategic Management Plan*

Department of Sustainability and Environment (2003e). *Gippsland Lakes Ramsar Site Strategic Management Plan*

Department of Sustainability and Environment (2003f). *Gunbower Forest Ramsar Site Strategic Management Plan*

Department of Sustainability and Environment (2003g). *Lake Albacutya Ramsar Site Strategic Management Plan*

Department of Sustainability and Environment (2004a). *Securing Our Water Future Together.* Victorian Government White Paper.State Government of Victoria, Melbourne.

Department of Sustainability and Environment (2004b). *Kerang Wetlands Ramsar Site Strategic Management Plan*

Department of Sustainability and Environment (2005a). *Advisory List of Rare or Threatened Plants in Victoria*

Department of Sustainability and Environment (2005b). *Game Hunting in Victoria – Where can I hunt?* Series No 9

Department of Sustainability and Environment (2005c). *Index of Wetland Condition Conceptual Framework and Selection of Measures.*  Department of Sustainability and Environment, East Melbourne, Victoria

Department of Sustainability and Environment (2006a). *2ISC Index of Stream Condition –User’s Manual (2nd Edition).*  Department of Sustainability and Environment, East Melbourne, Victoria

Department of Sustainability and Environment (2006b unpublished). *Index of Wetland Condition -Methods Manual, Version2.*  Department of Sustainability and Environment, East Melbourne, Victoria

Department of Sustainability and Environment (2006c). *Index of Wetland Condition - Assessment of Wetland Vegetation, Update – March 2006.*  Department of Sustainability and Environment, East Melbourne, Victoria

Department of Sustainability and Environment (2007a). *Actions for Biodiversity Conservation – Fact Sheet.*

Department of Sustainability and Environment (2007b). Advisory List of Threatened Vertebrate Fauna in Victoria

Department of Sustainability and Environment (2007c). *Technical Guidelines for Waterway Management.* Department of Sustainability and Environment, Victoria.

Department of Sustainability and Environment (2008a). *Draft Advisory List of Threatened Invertebrate Fauna in Victoria*. Department of Sustainability and Environment, East Melbourne, Victoria.

Department of Sustainability and Environment (~2008b). <http://www.ourwater.vic.gov.au/saving/farms/irrigation>

Department of Sustainability and Environment (~2008c). *Victorian Water Accounts 2006-2007. A statement of Victorian water resources.* Department of Sustainability and Environment, East Melbourne, Victoria.

Department of Sustainability and Environment (~2008d). <http://www.dse.vic.gov.au/dse/nrenfor.nsf/Home+Page/DSE+Forestry~Home+Page?open>

Department of Sustainability and Environment (2008e). *Index of Wetland Condition Methods Manual, Version 5.*  Department of Sustainability and Environment, East Melbourne, Victoria

Department of Sustainability and Environment (2009a). *Victorian Coastal Acid Sulfate Soils Strategy.* Victorian Government. Department of Sustainability and Environment.

Department of Sustainability and Environment (~2009b). *Pest Plants and Animals.* <http://www.dse.vic.gov.au/DSE/nrenpa.nsf/childdocs/-91C7739B92F03CAF4A2567D600824A70?open>

Department of Sustainability and Environment (~2009c). *Pest Plants.* [*http://www.dse.vic.gov.au/DSE/nrenpa.nsf/LinkView/23689205CCAA3159CA256E75000C6653E7605815704C32394A2568E30029E3FA*](http://www.dse.vic.gov.au/DSE/nrenpa.nsf/LinkView/23689205CCAA3159CA256E75000C6653E7605815704C32394A2568E30029E3FA)

Doeg, T. (2001). Representative rivers of Victoria: Selection of regions – A Discussion Paper

Dunn, H. (2000). Identifying and Protecting Rivers of High Ecological Value

Dunn, H. (2007). Guidelines for Applying the Criteria for the Proposed HCVAE Assessment Process – Draft

Edgar, G.J., Barrett, N.S. and Graddon, D.J. (1999). A Classification of Tasmanian Estuaries and Assessment of their Conservation Significance using Ecological and Physical Attributes, Population and Land Use. Tasmanian Aquaculture and Fisheries Institute Technical Series Report 2.

Environment Australia (2001). *A Directory of Important Wetlands in Australia, Third Edition*. Environment Australia, Canberra.

Environment Protection Authority Victoria (2003). *Water Quality Objectives for Rivers and Streams – Ecosystem Protection.* Information Bulletin.

Environment Protection Authority Victoria (~2008a). How EPA Protects and Monitors Freshwater Environments. <http://www.epa.vic.gov.au/water/rivers/rivers.asp#Lakes>

Environment Protection Authority Victoria (~2008b). Estuaries. <http://www.epa.vic.gov.au/water/estuaries/default.asp>

Environment Protection Authority Victoria (~2008c). <http://www.epa.vic.gov.au/water/wastewater/draft-guidelines-wastewater-discharges.asp>

Environment Protection Authority Victoria (~2009). *Response to Fish Deaths in Victorian Waterways.* <http://www.epa.vic.gov.au/water/fish_deaths.asp>

Environment Protection Authority Victoria (2011). Environmental Water Quality Guidelines for Victorian Riverine Estuaries. Publication 1347.1

GHD (2007). *Report for Review of Regional River Health Strategies*. Prepared for the Department of Sustainability and Environment, Victoria.

Goulburn Broken Catchment Management Authority (2003). Works on Waterways Notes No. 4 - Sand and Gravel Extractions

Goulburn Murray Water (~2008). <http://www.g-mwater.com.au/water-resources/surface-water/irrigationareas>

Hardie, D. and Davies, P. (2007). Conserving Freshwater Ecosystem Values in Tasmania, Australia: Identification and Application of Freshwater Conservation Management Priority Areas

Heritage Victoria (~2008). *Victorian Heritage Database*. <http://vhd.heritage.vic.gov.au/vhd/heritagevic>

Land Conservation Council (1991). Rivers and Streams Special Investigation: Final Recommendations

Land and Water Resources Research and Development Corporation (1996). *Land-Based Ecosystems.* Riparian Management Fact Sheet 5.

Lewis, C. and Savage, C. (1998). *Camping in Victoria*

McGuckin, J. and Bennett, P. (1999). An Inventory of Fishways and Potential Barriers to Fish Movement and Migration in Victoria. Department of Natural Resources and Environment

Melbourne Water (~2009). *Land Development Manual*. <http://ldm.melbournewater.com.au/>

Metzeling L., Wells F., Newall P., Tiller D. and Reed J. (2004). *Biological Objectives for Rivers and Streams – Ecosystem Protection*. EPA Victoria

Mornington Peninsula Shire Council (2002). Mornington Peninsula and Western Port Biosphere Reserve Stage 1

Murray-Darling Basin Commission (2006a). *Our Unique Icon Sites.* Fact Sheet.

Murray-Darling Basin Commission (2006b). The Barmah-Millewa Forest Icon Site Environmental Management Plan 2006-2007. MDBC Publication No. 30/06

Murray-Darling Basin Commission (2006c). *The Hattah Lakes Icon Site Environmental Management Plan 2006–2007.* MDBC Publication No. 31/06

Murray-Darling Basin Commission (2006d). The Gunbower-Koondrook-Perricoota Forest Icon Site Environmental Management Plan 2006–2007. MDBC Publication No. 32/06

Murray-Darling Basin Commission (2006e). The River Murray Channel Icon Site Environmental Management Plan 2006–2007. MDBC Publication No. 35/06

Murray-Darling Basin Authority (2009). Acid Sulfate Soils in the Murray–Darling Basin.

National Land and Water Resources Audit (2002). Australian Catchment, River and Estuary Assessment 2002, Volume 1

National Trust of Australia, (~2008). <http://www.nationaltrust.org.au/NationalHeritageSystem.htm>

Pacific Hydro (~2008). [www.pacifichydro.com.au](http://www.pacifichydro.com.au)

Parkes, D., Newell, G. and Cheal, D. (2003). *Assessing the Quality of Native Vegetation: the ‘Habitat Hectares’ Approach.* Ecological Management and Restoration, Vol 4

Parks Victoria (2004). Discovery Bay Parks Management Plan

Parks Victoria (~2008). *Shallow Inlet Marine and Coastal Park – Park Notes*. (<http://www.parkweb.vic.gov.au/resources05/05_0418.pdf>)

Peters, G. (2008). Determining the Purpose of RiVERS (II)

Peters, G. (2009). AVIRA Risk Assessment Process

Robson, B.J., Chester, E.T., Mitchell, B.D. and Matthews, T.G. (2008). *Identification and Management of Refuges for Aquatic Organisms.* Waterlines Report, National Water Commission, Canberra.

Rose, C. (2001). *Walking the Otways*. Track notes compiled by the Geelong Bushwalking Club.

Ryan, B. and Marvenek, S. (2004). Quantifying and valuing land use change for Integrated Catchment Management evaluation in the Murray-Darling Basin 1996/97 – 2000/01. Stage 2 Report to the Murray-Darling Basin Commission.

Ryan T., Webb A., Lennie R. and Lyon J. (2001). *Status of Cold Water Releases from Victorian Dams*

Simpson, K. and Day, N. (1999). *Field Guide to the Birds of Australia.* Sixth Edition

SKM (2005). Development and Application of a Flow Stressed Ranking Procedure

SKM (2007). High Conservation Value Aquatic Ecosystems Project – Identifying, Categorising and Managing HCVAE

SKM (2008). Temperature Monitoring of Dam Releases in Victorian Rivers 2002-2007

Southern Rural Water (~2008). <http://www.srw.com.au/irrigation>

Thompson, J. and Bond, N. (2011). Interpreting Species Distribution Models to Identify Drought Refuges for Native Fish in Victorian Streams.

Tunbridge B.R. and Rogan P.L. (~2008). *A Guide to the Inland Angling Waters of Victoria 5th Edition,* <http://www.dpi.vic.gov.au/angling>

United Nations Educational, Scientific and Cultural Organisation (~2009). World Heritage List. <http://whc.unesco.org/en/list>

Victorian CMAs Wetland Network (2007). Victorian Wetland Prioritisation Framework Discussion Paper

Ward, T., Butler, E. and Hill, B. (1998). *Environmental indicators for National State of the Environment Reporting – Estuaries and the Sea*. Australia: State of the Environment (Environmental Indicator Reports). Department of the Environment, Canberra.

Appendix A - Workshop Participants

**Workshop 1 - Environmental Values of River Reaches (7th July 2008)**

Jane Doolan (DSE, SWE&ID)

Sarina Loo (DSE, SWE&ID)

Paul Wilson (DSE, SWE&ID)

Ian Rutherfurd (DSE, SWE&ID)

Kirsty Hopkins (DSE, SWE&ID)

Janet Holmes (DSE, BES)

Adrian Moorrees (DSE, BES)

Chris Schweizer (Australian Government)

Nick Bond (Monash University, eWater)

Sam Lake (Monash University)

Rhys Coleman (Melbourne Water)

Wayne Tennant (Goulburn Broken CMA)

Greg Peters (Riverness)

Shelley Heron (KBR)

Tim Doeg (Consultant)

Leon Metzeling (EPA Victoria)

Stephen Saddlier (DSE, ARI)

Pat Feehan (Goulburn Broken CMA)

Phil Slessar (North Central CMA)

Patrick Lea (University of Melbourne, eWater)

**Workshop 2 - Threats to River Reaches (8th July 2008)**

Jane Doolan (DSE, SWE&ID)

Sarina Loo (DSE, SWE&ID)

Paul Wilson (DSE, SWE&ID)

Ian Rutherfurd (DSE, SWE&ID)

Kirsty Hopkins (DSE, SWE&ID)

Janet Holmes (DSE, BES)

Chris Schweizer (Australian Government)

Nick Bond (Monash University, eWater)

Rhys Coleman (Melbourne Water)

Wayne Tennant (Goulburn Broken CMA)

Greg Peters (Riverness)

Shelley Heron (KBR)

Tim Doeg (Consultant)

Leon Metzeling (EPA Victoria)

Stephen Saddlier (DSE, ARI)

Pat Feehan (Goulburn Broken CMA)

Phil Slessar (North Central CMA)

Patrick Lea (University of Melbourne, eWater)

**Workshop 3 - Risk Assessment Process (1st August 2008)**

Sarina Loo (DSE, SWE&ID)

Janet Holmes (DSE, BES)

Belinda Wong (DSE, Organisational Risk)

Nick Bond (Monash University, eWater)

Greg Peters (Riverness)

Shelley Heron (KBR)

Tim Doeg (Consultant)

Anne-Maree Westbury (EPA Victoria)

Patrick Lea (University of Melbourne, eWater)

**Workshop 4 - Environmental Values and Threats for Wetlands (4th September 2008)**

Ian Rutherfurd (DSE, SWE&ID)

Sarina Loo (DSE, SWE&ID)

Janet Holmes (DSE, BES)

Andrea Joyce (DSE, North West)

Phil Papas (DSE, ARI)

Michael Smith (DSE, ARI)

Yvette Baker (DSE, BES)

Greg Peters (Riverness)

Shelley Heron (KBR)

Michelle Dickson (West Gippsland CMA)

Donna Smithyman (Corangamite CMA)

Simon Casanelia (Goulburn Broken CMA)

Will Steele (Melbourne Water)

Emer Campbell (North Central CMA)

Rhonda Butcher (Water’s Edge)

Paul Boon (Victoria University)

**Workshop 5 - Social Values (30th September 2008)**

Ian Rutherfurd (DSE, SWE&ID)

Sarina Loo (DSE, SWE&ID)

Michelle Dickson (West Gippsland CMA)

Victoria Penko (DSE, SWE&ID)

Greg Bain (Melbourne Water)

John Cary (Victoria University)

Jane Ryan (DSE, SWE&ID)

Casey Damen (Goulburn Broken CMA)

Greg Peters (Riverness)

**Workshop 6 - Economic Values (1st October 2008)**

Ian Rutherfurd (DSE, SWE&ID)

Sarina Loo (DSE, SWE&ID)

Janet Holmes (DSE, BES)

Claire Edwards (DSE, EEU)

Ingrid Burford (DSE, EEU)

Deb Brown (DSE, WES)

Helen Campbell (Melbourne Water)

Greg Peters (Riverness)

**Workshop 7 - Environmental Values and Threats for Estuaries (13th November 2008)**

Sarina Loo (DSE, SWE&ID)

Janet Holmes (DSE, BES)

Paul Wilson (DSE, SWE&ID)

Jeremy Hindell (DSE, ARI)

Adam Pope (Deakin University)

David Tiller (Karoo Consulting)

Simone Wilkie (Corangamite CMA)

Michelle Dickson (West Gippsland CMA)

Anne Casey (Melbourne Water)

Chris Barry (Gippsland Coastal Board)

Nina Bate (EPA Victoria)

Greg Peters (Riverness)

Appendix B - List of Estuaries in AVIRA

Estuary systems included in AVIRA. Note that for those estuaries that are not part of the IEC program many of the AVIRA threat metrics will not be populated.

|  |  |  |  |
| --- | --- | --- | --- |
| CMA | AVIRA ID | System Name | IEC |
| Glenelg Hopkins | 36~201 | Hopkins River | Yes |
| Glenelg Hopkins | 36~238 | Merri River | Yes |
| Glenelg Hopkins | 37~201 | Wattle Hill Creek | No |
| Glenelg Hopkins | 37~203 | Surrey River | No |
| Glenelg Hopkins | 37~206 | Fitzroy River | Yes |
| Glenelg Hopkins | 37~211 | Lake Yambuk (Eumeralla Rv) | Yes |
| Glenelg Hopkins | 37~216 | Moyne River | No |
| Glenelg Hopkins | 38~201 | Glenelg River | Yes |
| Corangamite | 32~215 | Limeburners Lagoon (Hovell) | No |
| Corangamite | 33~201 | Barwon River | No |
| Corangamite | 35~201 | Curdies Inlet | Yes |
| Corangamite | 35~202 | Sherbrook River | No |
| Corangamite | 35~203 | Johanna River | No |
| Corangamite | 35~211 | Campbell Creek | Yes |
| Corangamite | 36~212 | Gellibrand River | Yes |
| Corangamite | 35~227 | Aire River | Yes |
| Corangamite | 35~230 | Barham River | Yes |
| Corangamite | 35~233 | Erskine River | Yes |
| Corangamite | 35~234 | Anglesea River | Yes |
| Corangamite | 35~235 | Spring Creek | Yes |
| Corangamite | 36~236 | Thompson Creek | Yes |
| Corangamite | 35~242 | Painkalac Creek | Yes |
| Corangamite | 35~244 | St George River | No |
| Corangamite | 35~246 | Wye River | Yes |
| Corangamite | 35~247 | Kennett River | Yes |

|  |  |  |  |
| --- | --- | --- | --- |
| CMA | AVIRA ID | System Name | IEC |
| West Gippsland | 25~219 | Avon River | No |
| West Gippsland | 26~201 | LaTrobe River | No |
| West Gippsland | 27~203 | Bourne Creek | Yes |
| West Gippsland | 27~204 | Wreck Creek | Yes |
| West Gippsland | 27~205 | Powlett River | Yes |
| West Gippsland | 27~206 | Shallow Inlet | No |
| West Gippsland | 27~207 | Old Hat Creek | No |
| West Gippsland | 27~208 | Stockyard Creek | No |
| West Gippsland | 27~210 | Anderson Inlet | Yes |
| West Gippsland | 27~211 | Darby River | No |
| West Gippsland | 27~213 | Sealers Creek | No |
| West Gippsland | 27~214 | Miranda Creek | Yes |
| West Gippsland | 27~218 | Jack Smith Lake | Yes |
| West Gippsland | 27~220 | Bennison Creek | No |
| West Gippsland | 27~221 | Franklin River | No |
| West Gippsland | 27~223 | Tidal River | Yes |
| West Gippsland | 27~225 | Agnes River | No |
| West Gippsland | 27~227 | Nine Mile Creek | No |
| West Gippsland | 27~228 | Albert River | No |
| West Gippsland | 27~233 | Tarra River | Yes |
| West Gippsland | 27~236 | Bruthen Creek | No |
| West Gippsland | 27~239 | Merriman Creek | No |
| East Gippsland | 21~201 | Yeerung River | Yes |
| East Gippsland | 21~202 | Sydenham Inlet | Yes |
| East Gippsland | 21~203 | Mueller River | Yes |
| East Gippsland | 21~208 | Shipwreck Creek | Yes |
| East Gippsland | 21~212 | Tamboon Inlet | Yes |
| East Gippsland | 21~224 | Thurra River | Yes |
| East Gippsland | 21~226 | Wingan Inlet | Yes |
| East Gippsland | 21~230 | Mallacoota Inlet | Yes |

|  |  |  |  |
| --- | --- | --- | --- |
| CMA | AVIRA ID | System Name | IEC |
| East Gippsland | 22~203 | Snowy River | Yes |
| East Gippsland | 23~204 | Tambo River | No |
| East Gippsland | 23~205 | Mississippi Creek | No |
| East Gippsland | 23~206 | Bunga Creek | Yes |
| East Gippsland | 23~221 | Lake Tyers | Yes |
| East Gippsland | 24~201 | Tom Creek | No |
| East Gippsland | 24~203 | Newlands Arm | No |
| East Gippsland | 24~204 | Mitchell/Nicholson | Yes |

Appendix C - AVIRA User Manual – Version 2, November 2012

**Contents**

1. Log into AVIRA
2. Approve Data: DSE Administrator only
3. Load AVIRA layers
4. View Assets
   1. Select Assets
   2. Detailed View for Individual Asset
   3. Import Measure Data
   4. Import Threat Scores
   5. Spatial Layer View
5. Query Assets
6. Symbolise Assets
7. Risk Assessment Mapping Tool
8. Export Assets
9. Upload New Wetland

AVIRA User Manual

1. **Log in to AVIRA**

AVIRA is a desktop application accessible from a Citrix environment using a web browser. It is developed as a plug-in to the Open Source GIS product, MapWindow.

You need to connect to the Citrix environment from a web browser using the following URL:

<https://citrix.dosae.integr8it.com.au/Citrix/XenApp/auth/login.aspx>

Access to the application requires authentication on two levels: to the Citrix server and to the application itself. Users authenticate in the Citrix environment. This gives access to the Axapta Desktop.

**Step 1: Log in to Citrix**



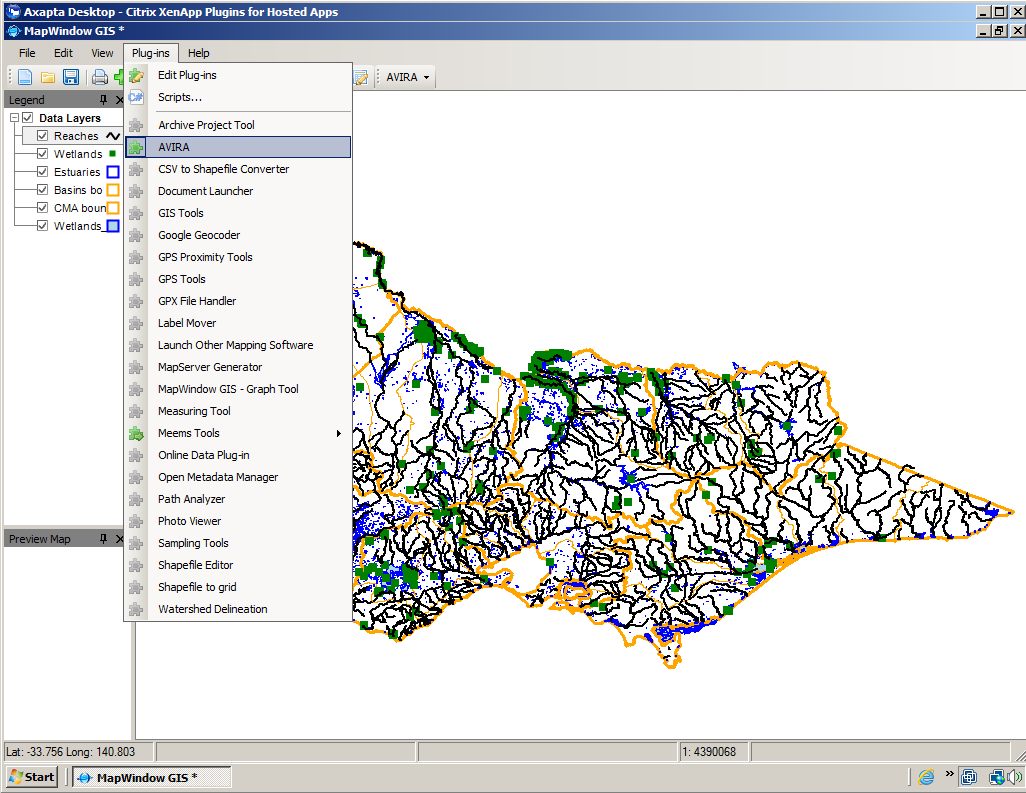
**Step 2: Click on Axapta Desktop**



**Step 3: Double click on MapWindow**

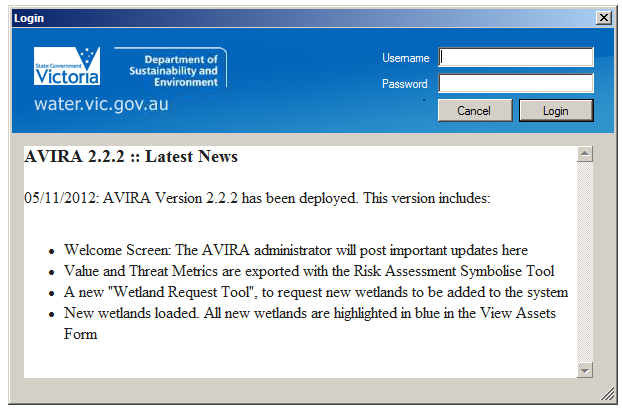


**Step 4: Activate the AVIRA plugin** (Plug-ins drop-down menu). User will be prompted to download the plug-in the first time the site is accessed.

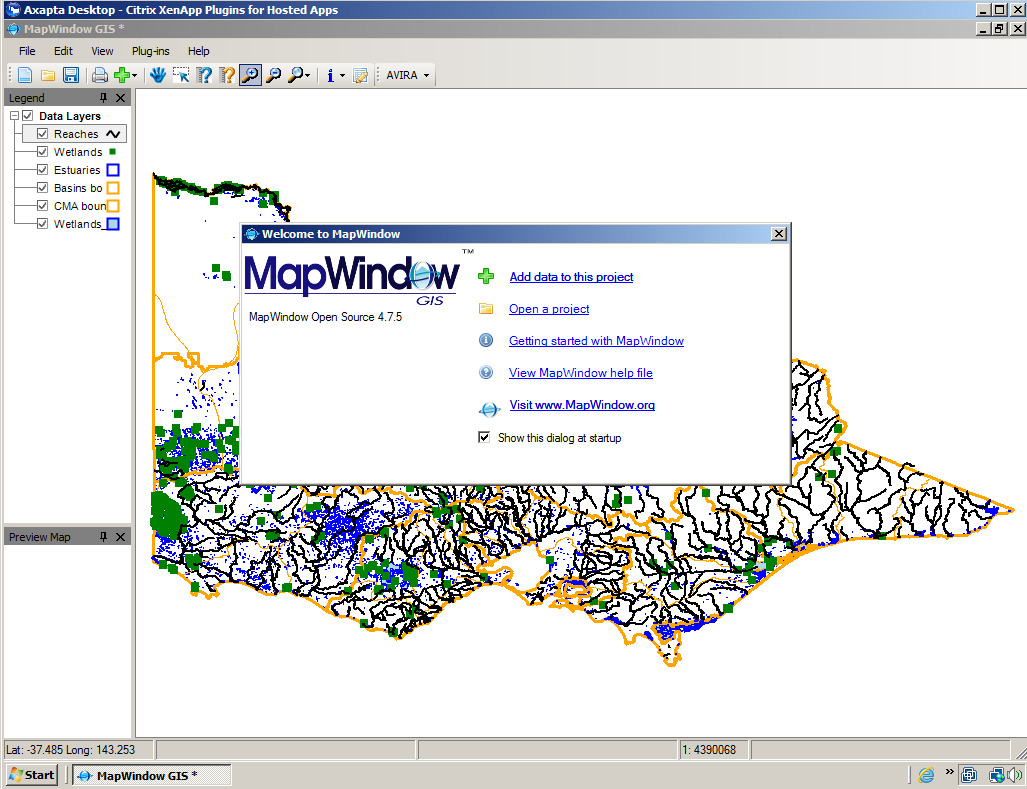


**Step 5: Log in to AVIRA**

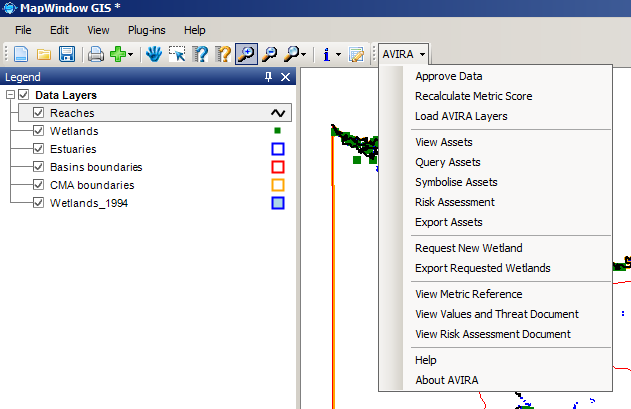
The log in screen includes a “Welcome Screen” where updates are posted.



**Step 6**: You will be prompted to ‘Add Data’ / ‘Open a Project’ etc. – simply close this window.



The **AVIRA** menu should be immediately available.



**Map Window User Manual**

A MapWindow User Manual can be accessed using the following link:

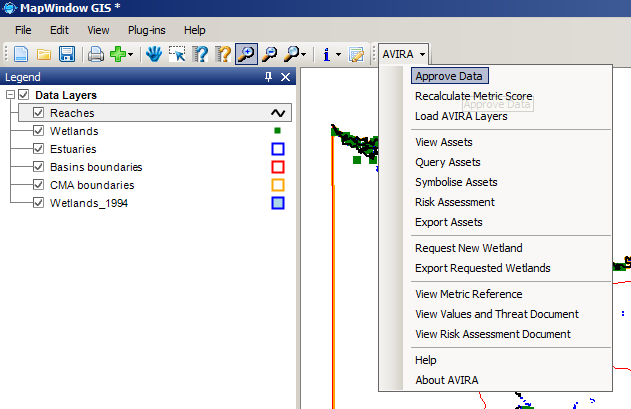
<http://www.mapwindow.org/apps/wiki/doku.php?id=mapwindow_4_users_manual>

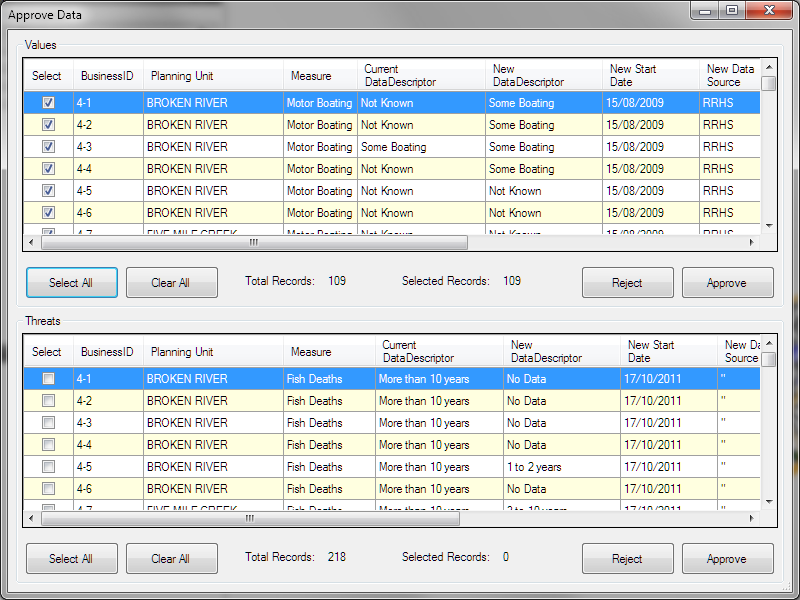
The manual is very helpful if you are not familiar with MapWindow. Particularly useful sections are the *Main User Interface*, *Working with the Legend* and *Creating Print Layouts*. The print layout can be used to create a Map Layout through the File>Print option. This invokes a Print layout from which you can arrange the map and other elements (e.g. north arrow) and either print the layout or export to PNG, BMP, GIF or TIF for insertion into a report. Exporting is possible through the Select>Convert to Bitmap menu option in the Print Layout form.

1. **Approve Data: DSE Administrator only**

**Purpose:** Enables DSE administrator to approve or reject all imported measure values.

The **Approve Data** form is only availabe to the **DSE user with administrator permission**. It will allow the administrator to approve or reject all imported measure values. After logging in, the Approve Data form will be automatically opened on startup. The Approve Data Form can also be accessed from **AVIRA > Approve Data.**





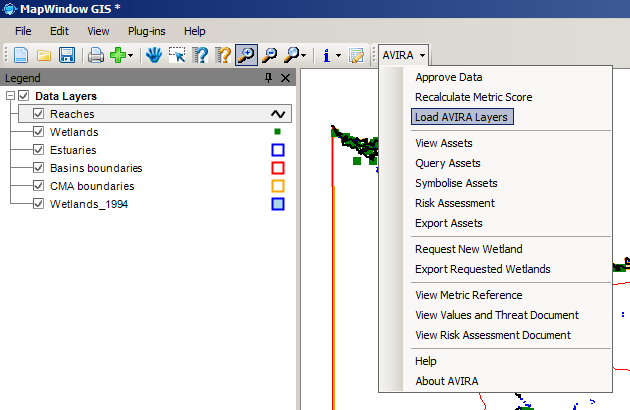
When a general user imports data, only those measures that do not have a value already inserted in the table for a given asset will be added, others will be inserted in the Temporary Import table for Approval (only availabe to the **DSE user with administrator permission**). The approver will compare ‘current’ (original) and new data and assess if original data is to be overriden, using the information contained in the rationale.

* **Reject** – Reject checked measure value.
* **Approve** – Approve checked measure value.

2. **Load AVIRA Layers**

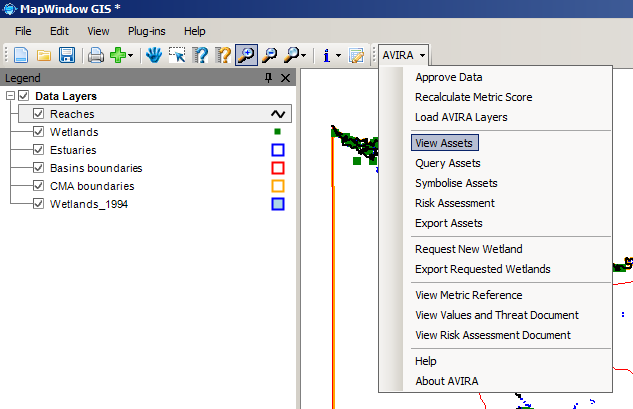
**Purpose:** Use the load layers command to add the default startup layers into the map view, if for some reason they do not appear.

The Load AVIRA Layers command is accessed from AVIRA > Load AVIRA Layers.



1. **View Assets**

To open the **Assets** form, click **AVIRA > View Assets**.



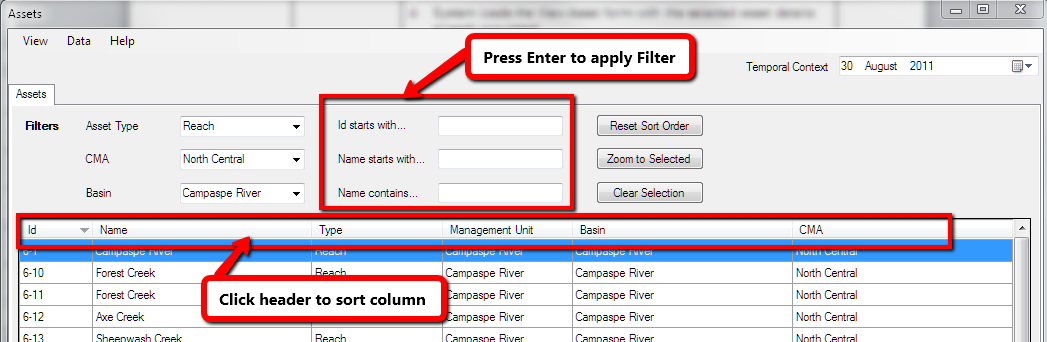
From the **Assets** Form, the user can:

* 4.1 Select Assets
* Access a Detailed View for Individual **Assets**
* 4.3 Import Measure Data (for Values and Threats)

**4.1 Select Assets**

**Purpose:** The **Assets** **View** displays general information for any assets selected in the mapping view.

The **Assets** tab is the default view, it will display general information for any assets selected in the mapping view (selected using the ‘Select’ Tool in MapWindow). If no assets are selected in the mapping view, then no assets will be shown. Click the Show All Assets button to show all available assets.



* **Filters -** You can use the filters to query and limit the number of listed assets – this will speed up processing significantly and is highly recommended (i.e. work on a subset of assets rather than the whole list, e.g. a single basin).
* The drop down filters (Asset Type, CMA and Basin) will be automatically applied when changed. For the textbox filters (Id starts with, Name begins with, and Name contains) user will need to **press Enter** to apply the filter. Please note, the text filters are case sensitive (e.g. to filter for all lakes use ‘Lakes’ as the filter).
* **Sort** - Click on the table header to sort the column alphabetically.
* **Reset Sort Order –** Reset default sort order using the ID column (the default sort order is alphabetical, i.e. 1-1 is followed by 1-2 not 1-10).
* **Zoom to Listed** – Zoom to all assets listed in the table. This will change the extent of the area shown in the map window. E.g. select the Barwon River Basin and the mapped area in the map window will show just this basin, with the assets highlighted.
* **Show All Assets** – Remove all filters, and show all available assets in the table.

**4.2 Detailed View for Individual Asset**

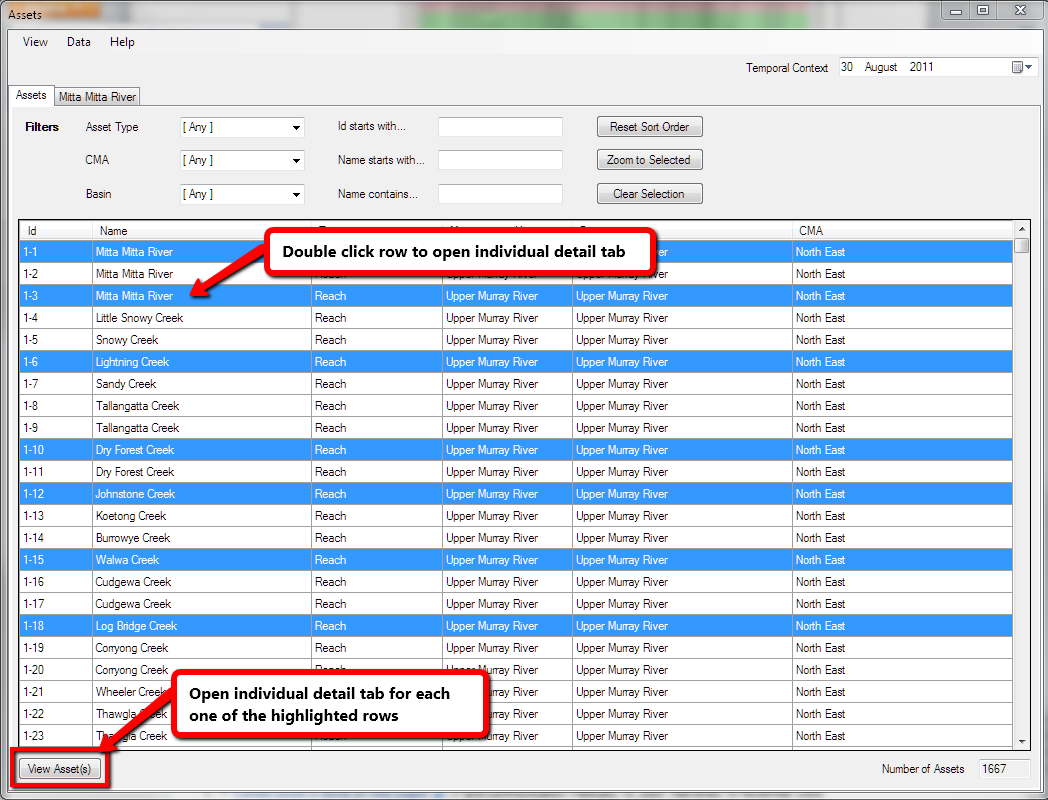
**Purpose:** The **Detailed View** allows the user to view metrics, risk assessments and base data for individual assets.

From the **Assets** tab, user can access the **detailed view** for individual assets via two ways:

**Double click** on the table row to open up the detailed view for a single asset, or

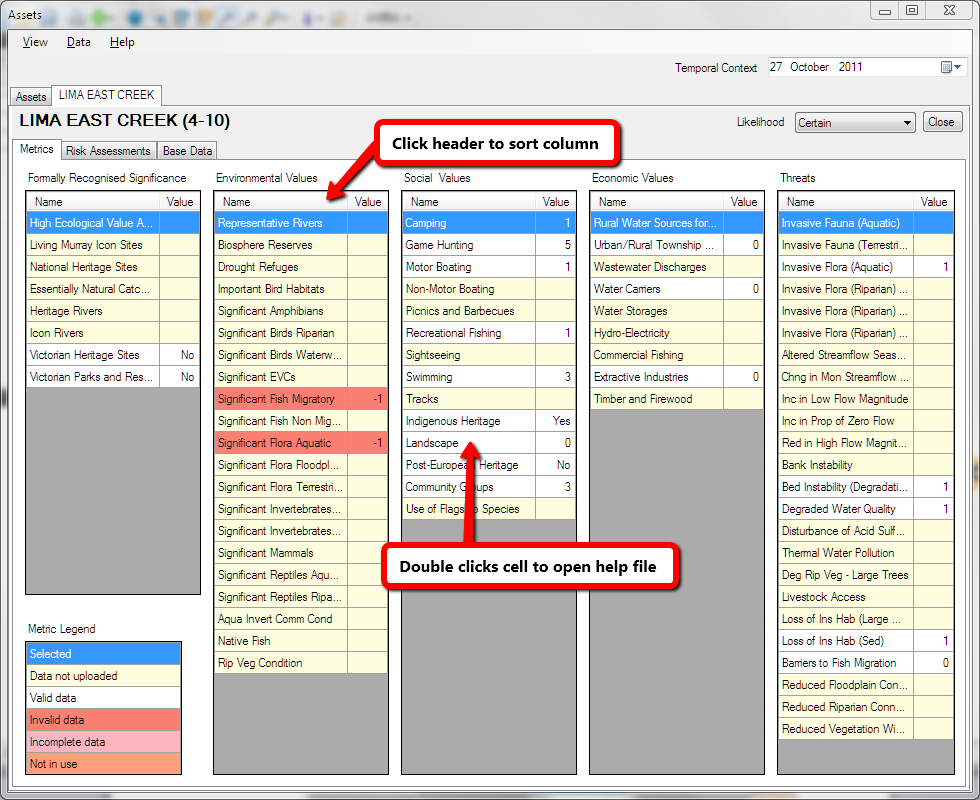
Highlight multiple assets by holding the down the Shift Key and then click the **View Asset(s)** button (bottom left-hand corner).

See diagram below.

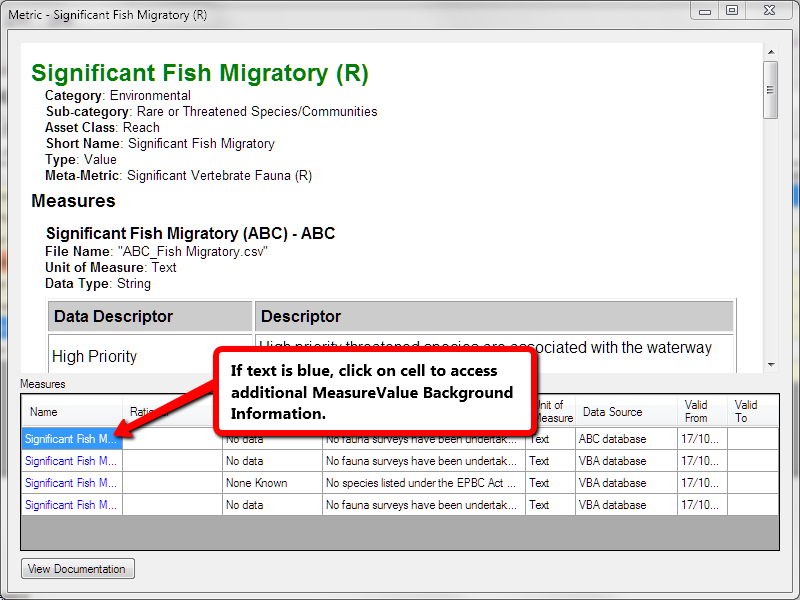


The **detailed view** for individual asset have three tabs:

**Metric**s – Display metric value grouped by category (see below)



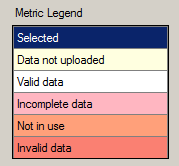
* **Sort** - Click on the table header to sort the column alphabetically, click on the score column to sort according to score value.
* **Display Full Name –** Hover your mouse cursor over a **Value Name** or **Threat Name** cell to display its full name
* **Help File -** You can double click on each of the metric **Name** cells to open up the metric help file. This displays the metric and measure information.



If the text in the Name cell is blue (see previous figure) addditional background information is available by clicking on the cell (additional information may be available for the following metrics: Significant Flora, Fauna, EVCs and Water Quality).

More detail on the metric and measure information can be viewed by clicking on the **View Documentation** button. This will launch the AVIRA Threats and Values Report and take you to the relevant section.

**Metric Legend**



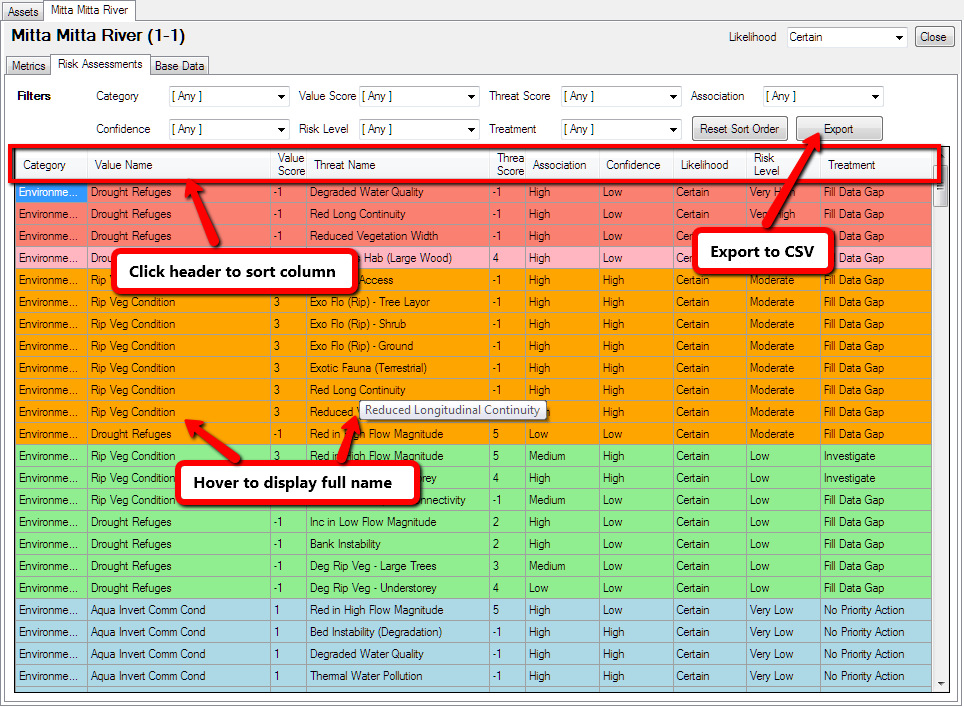
The metric tab has a legend that is colour-coded as follows

* Blue: metric has been selected
* Yellow: data has not been uploaded for this metric
* White: valid data has been uploaded for this metric
* Pink: data has been uploaded for some but not all measures for this metric
* Orange: This metric is not currently in use (to be developed)
* Red: data uploaded for this asset is invalid (double click on metric to access further information – see notes on page 16)

In addition, the value/threat scores for *No Data*, *Incomplete data*, *Not in use* and *Invalid Data* are as follows:

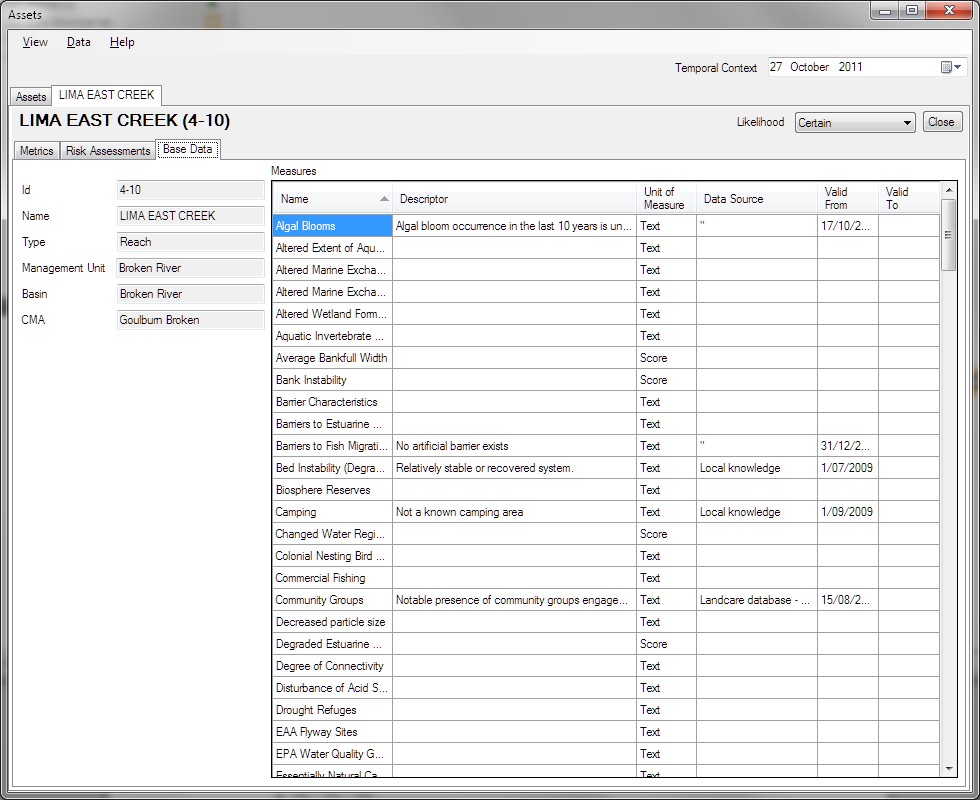
* -1 = No data
* -2 = Incomplete data
* -3 = Metric not in use
* -4 = Invalid Data

**Risk Assessments** – Display risk assessments in a colour coded table



* **Filters -** You can use the filters to query and limit the number risk assessments displayed. The drop-down filters will be automatically applied on change.
* **Sort** - Click on the table header to sort the column alphabetically.
* **Display Full Name –** Hover your mouse cursor over a **Value Name** or **Threat Name** cell to display its full name
* **Reset Sort Order –** Reset default display order (set by Category, then Risk Level, then Value Name).
* **Export –** Export all listed risk assessments as a CSV file. The output file is saved to the V Drive (**V:\**). If multiple files are exported with the same date (i.e. on the same day) for a single asset they will be labelled sequentially.

**Base Data** – Display measure value



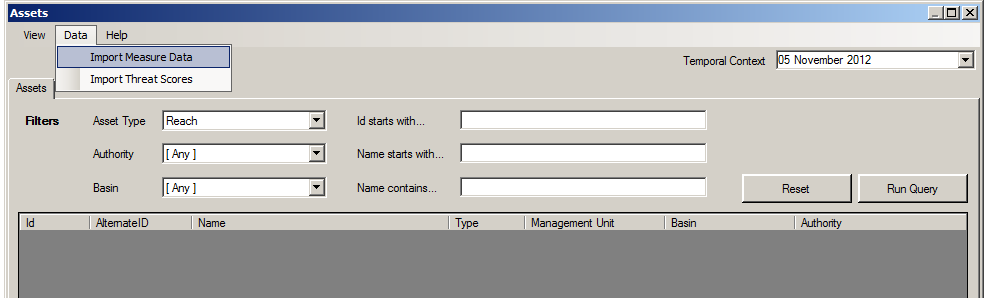
* **Sort** - Click on the table header to sort the column alphabetically.

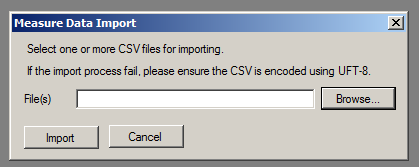
**4.3 Import Measure Data**

**Purpose:** Use the **Measure Data Import** tool to import data for both **threats** and **values**.

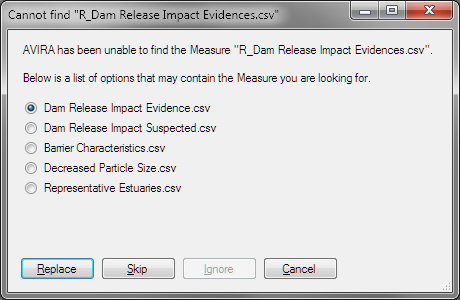
**Note:** Users can only import data from their own authority. Only DSE users with Administrator permission can import data from any authorities.

To open the **Import Measure Data** dialog box, click **Data > Import Measure Data** from the main toolbar on the **Assets** form (see below)

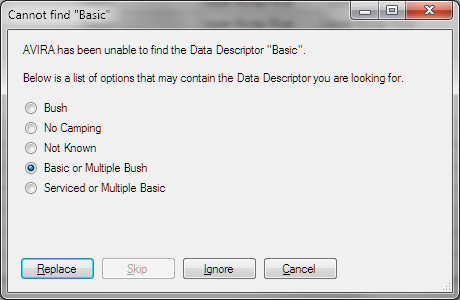


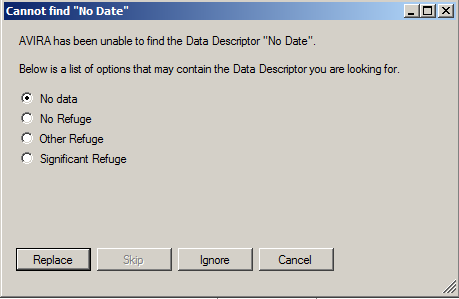


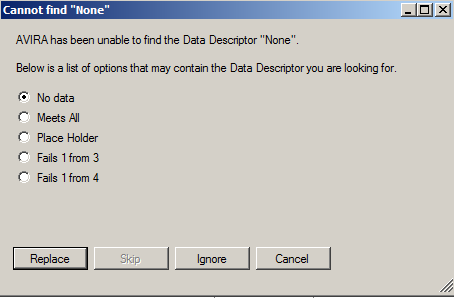
* **Browse -** You can select one **or more** CSV file to import. If you import files in a batch you may wish to set the process and leave it to run overnight.
* **Import -** Click the Import button to process the selected CSV files.
* **File naming error**: If there is a mismatch between the name of the CSV file and the software, user will be prompted to pick the best match.



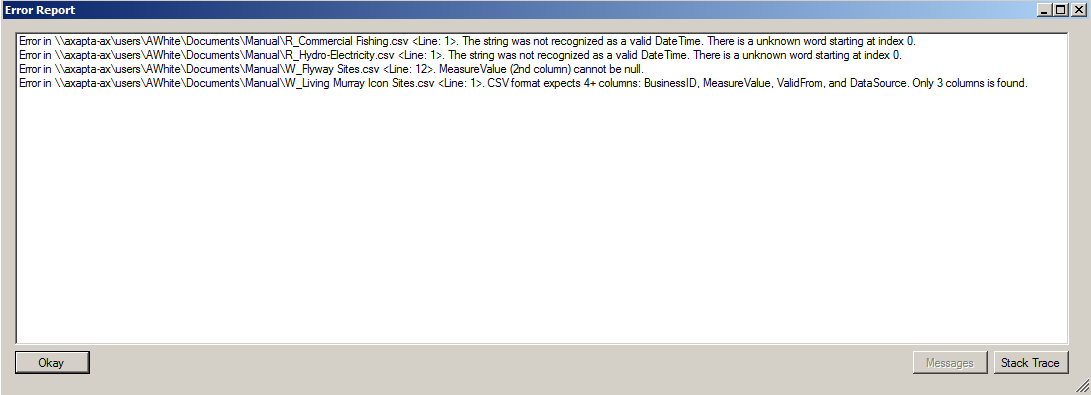
* Data descriptior errors: If there is a mismatch between the data descriptors in the CSV file and the software, user will be prompted to pick the best match.



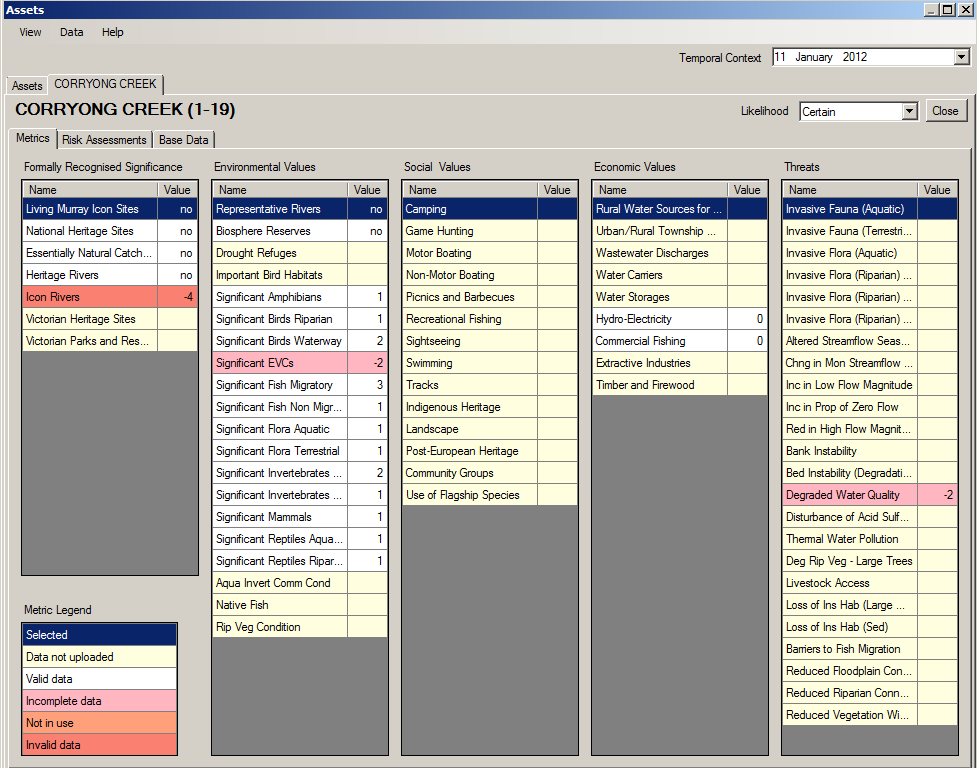




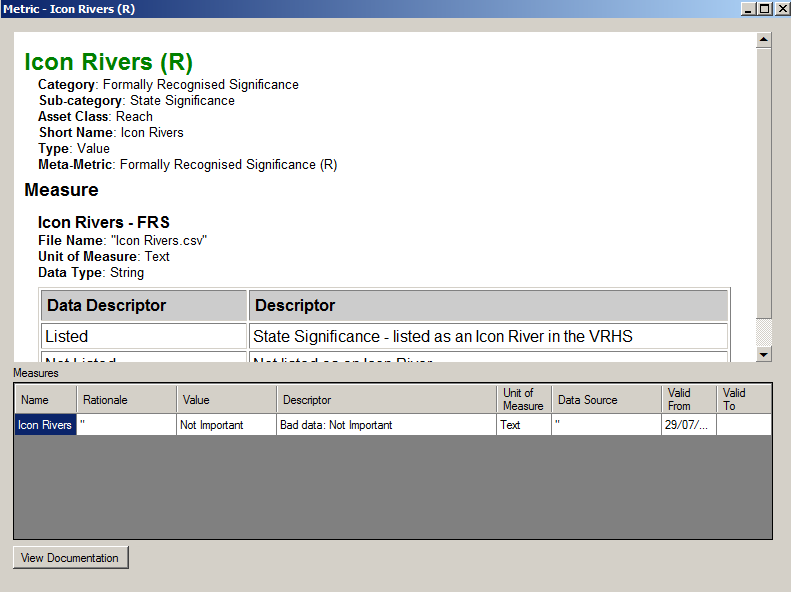
* **Formatting error**: If CSV file contains formatting errors they will appear in the Error Report and the file will not load. The file should be fixed (using the error report as a guide – see below for example) and the complete data file uploaded again.



* **Other errors**: There are some errors that may not be recognised by AVIRA (e.g. when an incorrect data descriptor is used but is not picked up by the software). These files will upload and errors will only be detected when viewing assets; these will appear as invalid data (see red box below).



* You can double click on the individual metric to access further detail about these errors (see red box below). The file should be fixed and the complete data file uploaded again. The file will remain in a temporary staging area until the administrator as approved it. The administrator does not get a notification that approvals are pending, except when the software is first launched (usually at the start of the day). If you wish to have the data approved straight away email the administrator to let them know you are waiting on approvals.

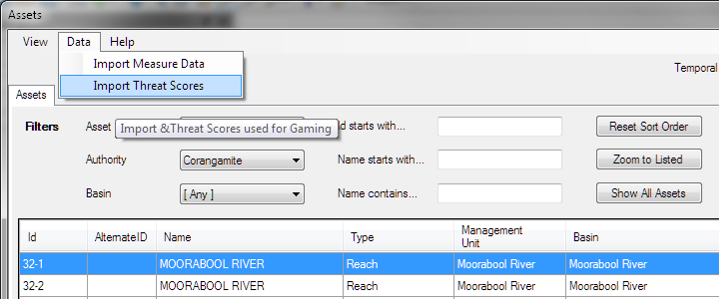


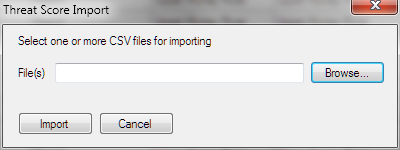
**4.4 Import Threat Scores**

**Note:** The **Threat Score Import** tool is **not currently functional**.

**Purpose:** Allows import of threat scores to reflect **Possible** scenarios, as opposed to Certain (i.e. current) scenarios, using the Likelihood drop-down (the ‘gaming’ function).

To open the **Import Threat Scores** dialog box, click **Data > Import Threat Scores**, from the main toolbar on the **Assets** form.





**4.5 Spatial Layer View**

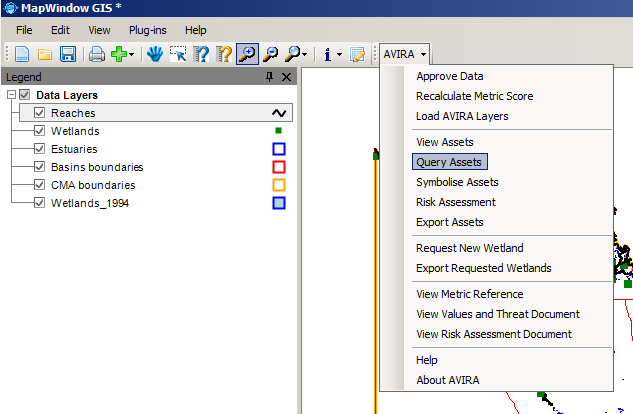
**Note:** This tool is **not functional** and has been replaced by the **Risk Assessment Mapping Tool** (see Section 7).

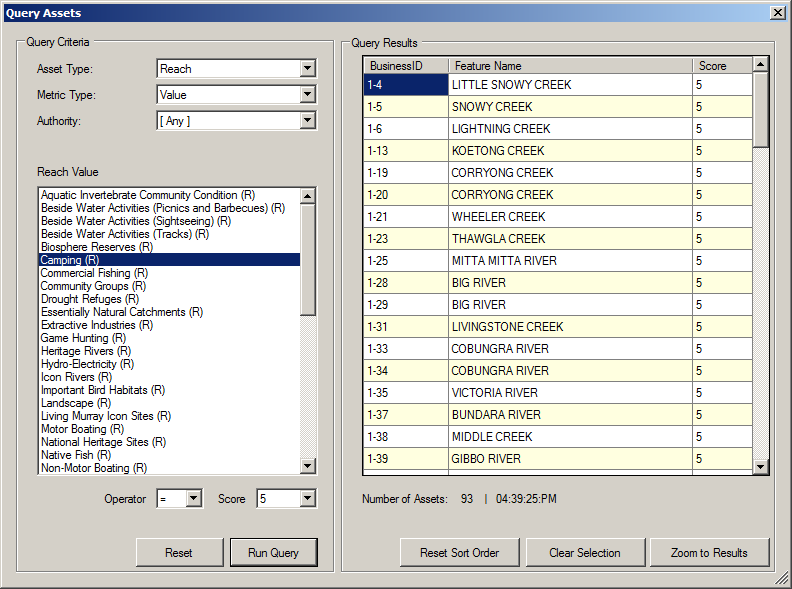
To open the **Spatial Layer View** from, click **View > Spatial Layer View**, from the main toolbar on the **Assets** form.

1. **Query Assets**

**Purpose:** Use **Query Asset** to search asset based on its metric score.

To open the Query Assets form, click AVIRA > Query Assets.



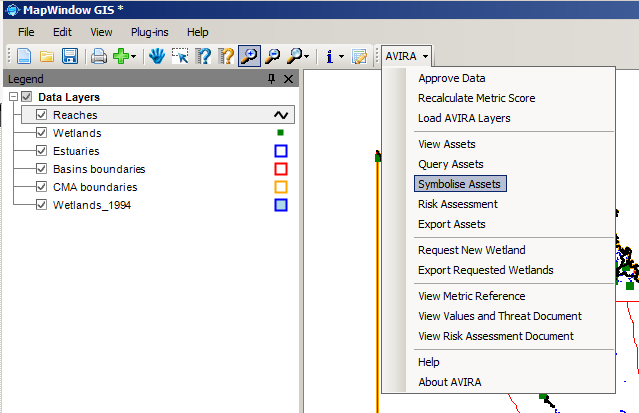


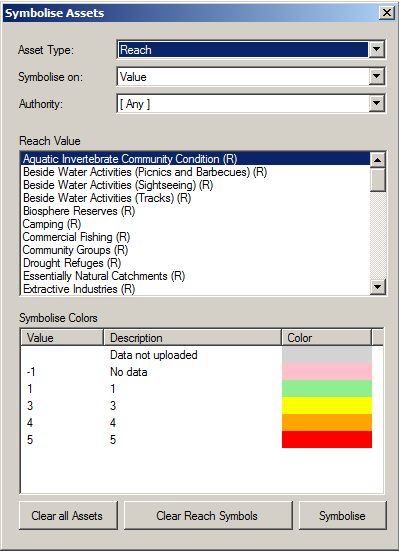
* **Query Criteria –** Use the controls in the **Query Criteria** Panel to build the desired query. The value in the **Score** drop-down will be automatically repopulated with valid values according to the selected metric value.
* **Run Query** – Click to execute the defined query. Results will be shown in the **Query Results** Panel, and selected in the mapping view.
* **Reset** – Click to reset the controls in the **Query Criteria** Panel.
* **Sort** – Click on the table header to sort the column alphabetically.
* **Reset Sort Order –** Reset default display order.
* **Clear Selection –** Clear selected features on the map view.
* **Zoom to Results –** Zoom to the extent of the selected features on the map view.
* **Export results** – If you would like to export the query results, close the query tool and open the **Export Assets** tool, select **Map Selections** choose files types to export (shape file, values and/or threats) and then export.

1. **Symbolise Assets**

**Purpose:** Use the **Symbolise Assets** form to symbolise asset based on metric scores.

To open the Symbolise Assets form, click AVIRA > Symbolise Assets.



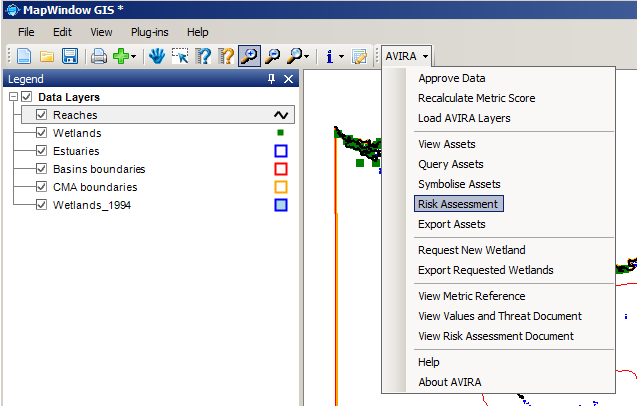


* **Clear All Assets** – Removes all symbolised layers from the map view, and deletes the **Symobolise** folder and its contents. **Clear all Assets should be used whenever a new query is executed**. If you would like to keep the symbolised layers then you can save them in another folder (i.e. remove them from the Symbolise folder).
* **Clear Asset Symbols** – Similar to Clear All Assets except that it only removes the symbolise files for that asset type (not all asset types). For the currently selected **Asset Type**, this will remove any associated symbolised layers from the map view, and delete from the **Symobolise** Directory**.**
* **Symbolise –** Click to symbolise according to selected value or threat. The system will **export** a copy of the asset shapefile and **append** the metric score to it. This shapefile is then symbolised and added to the map view. The source of the shapefiles is saved to the SymoboliseDirectory, and will be found at **V: \Symbolise**.

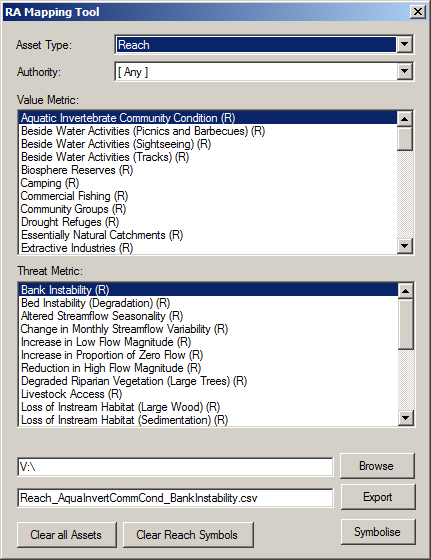
1. **Risk Assessment Mapping Tool**

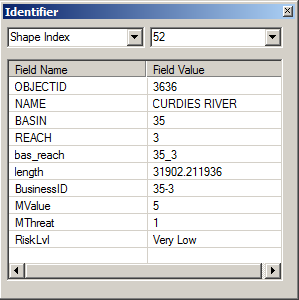
**Purpose:** Use the **Risk Assessment Mapping Tool** to symbolise, map and export risk assessment results.

To open the Risk Assessment Mapping Tool, click **AVIRA > Risk Assessment**



* Threat-value combination – Use the controls in the **RA Mapping Tool** panel to choose the asset type and the desired threat-value combination (see below).
* **Symbolise** – Click symbolise to view risk assessment results on the mapping interface.
* To export the risk assessment results click **Export**. An export directory can be selected by clicking on **Browse**; otherwise files will be automatically exported to the **V:** directory. Risk assessment results can then be imported to another GIS program.

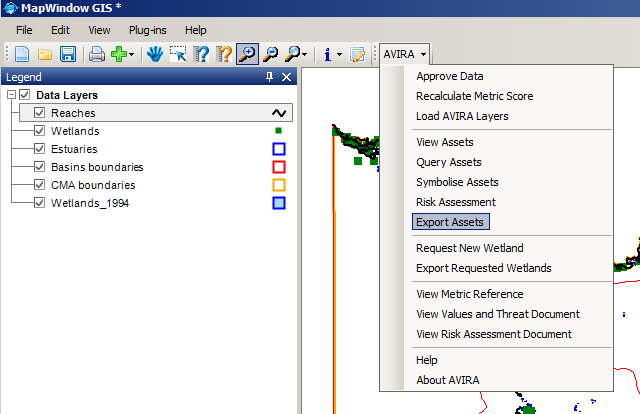


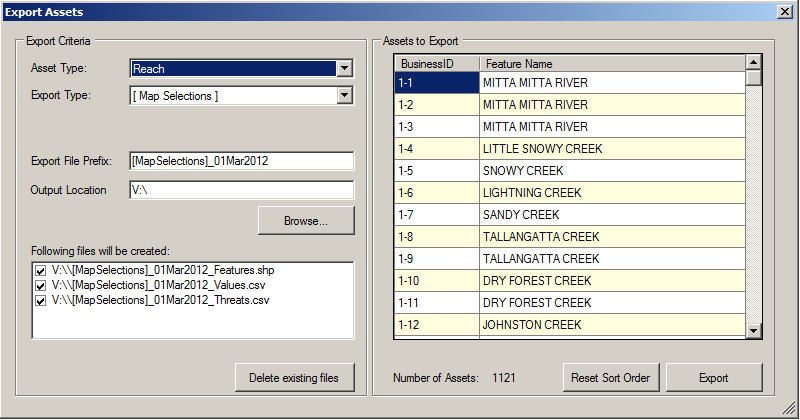
* **Clear All Assets** – Removes all symbolised layers from the map view, and deletes the **Symobolise** folder and its contents. **Clear all Assets should be used whenever a new RA is executed**. If you would like to keep the symbolised layers then you can save them in another folder (i.e. remove them from the Symbolise folder).
* **Clear Asset Symbols** – Similar to Clear All Assets except that it only removes the symbolise files for that asset type (not all asset types). For the currently selected **Asset Type**, this will remove any associated symbolised layers from the map view, and delete from the **Symobolise** Directory**.**
* The risk assessment results can be queried in the mapping interface using the **Identifier** (this is accessed using the drop down menu of the Identifier tool). This will indicate the risk level and the threat and value scores that were used to calculate the risk level (see below).
* 

1. **Export Assets**

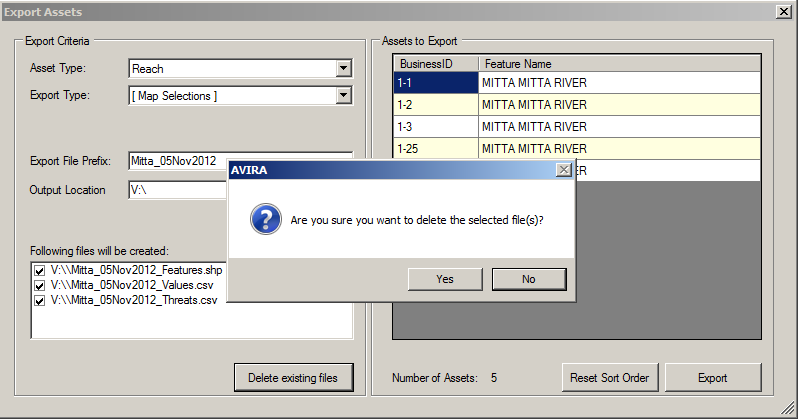
**Purpose:** Use the **Export Assets** form to export asset shapefiles, and the associated threats and values, in csv format.

To open the Export Assets form, click AVIRA > Export Assets.

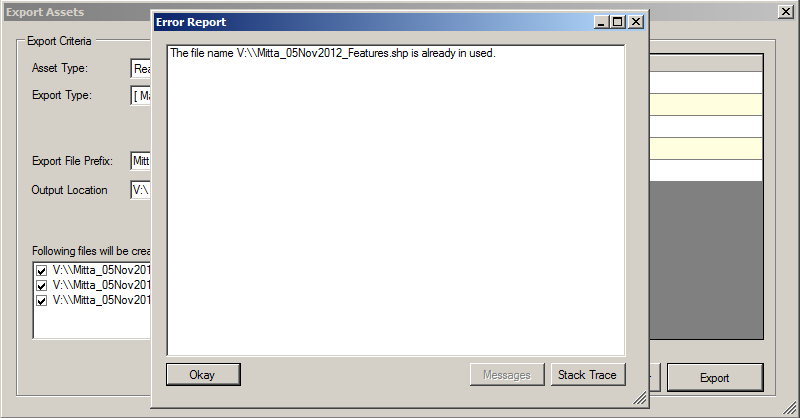




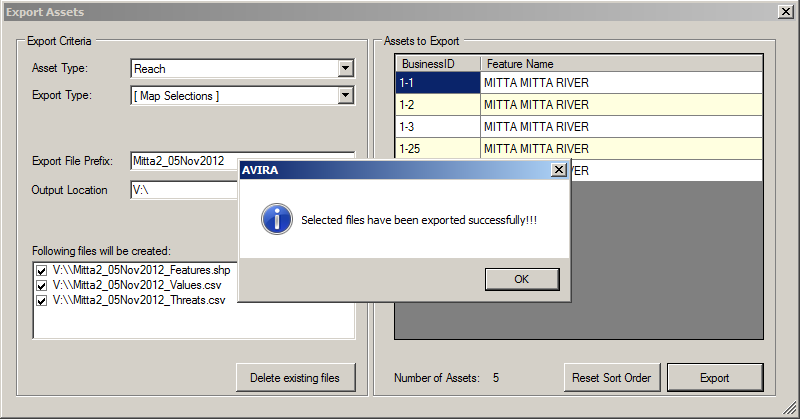
* **Asset Type –** Select which asset you would like to export.
* **Export Type -** All Assets or **Map Selections** (you would have selected the assets before opening the Export Assets Form).
* **Export to folder** – Use the **Browse** button to select an output folder. The default directory is **V:\**
* **Delete existing files** – Delete the listed files if you don’t need them anymore. You will be prompted to confirm the delete.



* If you export a file with the same name and error will alert you, you will need to manually change the name of the file to export successfully (see below).



* **Reset Sort Order –** Reset default display order.
* **Export** – Export the requested output based on the export criteria. You will be alerted at the end of the export process.

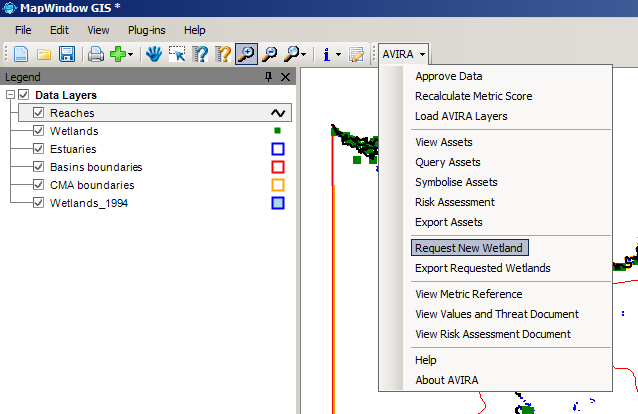


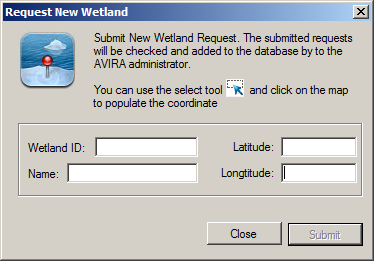
**Note:** Export is a time consuming process. On a Dell Precision T1500 machine with 2.96GB RAM, it takes around 1 second for each asset to be exported into shapefile, and quarter of a second into CSV.

1. **Upload New Wetland**

**Purpose:** To add new wetlandsto AVIRA, using the **Request a Wetland** tool.

To open the Request a Wetland form, click AVIRA > Request New Wetland.





* Enter the Wetland ID from the **Wetland 2012** spatial layer.
* Enter the name of the wetland (could be your local name for the wetland, does not need to be included in the Wetland 2012 spatial layer).
* Use the cursor to locate a point roughly in the centre of the wetland, click to populate the Latitude and Longitude, and then submit the information.
* The AVIRA administrator will check the entry and add it to the database.

Appendix D - AVIRA Data File Creation

AVIRA requires information from DELWP and CMAs on a standard set of values and threats for river, estuary and wetland assets. There are three types of values (environmental, social and economic) to reflect Victoria’s triple bottom line approach to managing waterway health.

Each individual value and threat in AVIRA has one or more **measures** that are used to provide data for the value or threat. Each individual value and threat also has a **metric** that assigns a descriptive AND numerical score to the value or threat. Most metrics have been developed using one measure, although some metrics combine multiple measures to arrive at a final description and numerical score.

Scores for values and threats range from 5 (very high) to 1 (very low). A score of zero is sometimes used and signifies ‘no value’ or ‘not applicable/suitable’. There is also a category for ‘No Data’ which is applied in cases where we don’t know if a particular threat or value is associated with a particular waterway. The values and threats in AVIRA are also grouped into categories to indicate similar types of values or threats.

DATA COLLECTION REQUIREMENTS

The waterways included in AVIRA that require information on values and threats are as follows:

* river reaches assessed by the Index of Stream Condition
* estuary reaches assessed by the Index of Estuary Condition and other important estuaries
* wetlands assessed by the Index of Wetland Condition and other wetlands uploaded by CMAs
* major water storages

Major water storages were assessed as a wetland asset. Where there is an on-river weir it was considered a part of the river reach for the purposes of assigning values and threats.

CREATING DATA FILES

As with other software, AVIRA is built with coded scripts. This means it anticipates data in a particular order and data uploads will fail if the data is not in the correct order. It is important that the file format, file name and data format follow the rules outlined below.

FILE FORMAT

Data files need to be created for each **measure** in AVIRA. For metrics that that have multiple measures, individual files for each measure need to be created, once uploaded to AVIRA the software will automatically compute the metric score.

The files need to be saved as comma separated value files (.csv). This file type uses commas to determine where each column starts. That means **commas cannot be used** in the data files *within* the cells. Please note that **every measure in AVIRA requires a separate .csv file**. You can find this file type when you click ‘Save As’ and then look through the options contained in the drop-down ‘Save As Type’ until you find ‘CSV (comma delimited) (\*.csv)’.

You can set up individual .csv files for each measure in Excel from the start of your data collection process, or collect information in workbooks saved as .xls files until all the data entry is complete. The .xls files are a useful format for keeping all your information together when you are collating the data, but when the data is finalised, separate .csv files for each measure are required.

When saving as .csv files you will get the following message:

“the selected file format does not support work books that contain multiple sheets”

To save all the sheets as .csv files, you need to save them individually using a different name for each. Name the file using the exact term as supplied in the tables below. You can save each tab individually as a .csv file and still retain your whole workbook as a .xls file. When the data file is complete and you are ready to save it as a .csv file the **header row must be removed**.

FILE NAMES

The file name must be the *exact* name of the **measure** as supplied in the tables below.

Please note that the data files names for each asset have a prefix, as follows:

* River data has the ‘R\_’ prefix
* Wetland data has the ‘W\_’ prefix
* Estuary data has the ‘E\_’ prefix

DATA FORMAT

Each .csv file should contain a minimum of four columns and maximum of six columns. The first four columns will contain compulsory information about the data:

1) Asset Identification, 2) Data Descriptor, 3) Start Date and 4) Data Source

When the data file is complete and you are ready to save it as a .csv file you need to remove the header row or the file will fail to load. Each row in the file represents an individual asset.

**Column 1: Asset Identification** **(compulsory)**

* Rivers: the unique basin and reach number as per the Index of Stream Condition spatial layer e.g. 25~1
* Wetlands: 5-digit wetland identification numbers as per the Wetland\_Current spatial layer e.g. 18651
* Estuaries: the unique basin and estuary number as per the estuary spatial layer e.g. 36~201

Note for rivers and estuaries that the separator between the basin and reach is a tilde (~) and not a dash.

**Column 2: Data Descriptor (Compulsory)**

= the description of the value or threat that AVIRA uses to assign the score.

This will be a string of words (see text in blue in table below) or a number. Where it is a string of words the data descriptor column needs to contain the *exact* term as it appears in the measure tables throughout the AVIRA Threats and Values report.

|  |  |  |
| --- | --- | --- |
| High Value Waterway | Descriptor | Data Descriptor |
| Yes | State Significance - key feature of a park or reserve listed within Park Groups A1 or A2 \* | Park A1 or A2 |
| No | Not a key feature of a park or reserve listed within Park Groups A1 or A2 | Not Park A1 or A2 |

**Column 3: Date** **(Compulsory)**

= the start date from when the data becomes valid.

* Format: dd/mm/yyyy. It must not be in US date format.
* Do not use dates that are in the future, the file will not upload.
* If the day is unknown, assume the first day of the month (e.g. 01/11/2004).
* If the month is unknown, assume the first day of the year (e.g. 01/01/2004).
* If you are overwriting data make sure the new data file has a date later than the data to be overwritten (AVIRA will always use the data with the most recent date).
* If the threat or value score is ‘No Value’ or ‘Not Applicable’ (or there is ‘No Data’) then the date on which the data file was created can be used. This indicates that at this point in time this is true for a *particular metric at a particular asset.*

**Column 4: Data Source** **(Compulsory)**

= the source the data has been obtained from.

Data sources for each metric are listed in the report on values and threats. Some metrics require ‘local knowledge’. Suggested sources include: reports, input from Parks Victoria and Local Councils, spatial layers, GIS analysis, workshops, surveys, targeted discussions with locals who have personal observations or expertise, and/or literature reviews. Once the data is collected/collated a line describing where it has come from (e.g. for the metric ‘Non-motor boating’ the data source may be ‘Canoeing Victoria’) should be included. It is vital that **commas are not used** in the description.

As stated above, there may be some measures for which CMAs do not have the information described in the data source; if this is the case other information can be used. The expectation was that existing data/information/resources be used to make the AVIRA data files, not that new studies will be undertaken.

***Optional information (2 columns)***

The fifth and sixth columns are optional and provide additional information that may be useful:

5) Rationale and 6) References.

**Column 5: Rationale** **(Optional except where data is being overwritten)**

A sentence is required in this cell whenever statewide data is changed using more up-to-date or more appropriate local information.This column should contain a sentence outlining why the data has been changed. Again, it is vital that you **commas are not used** in the sentence.

In addition, there are some metrics where extra information should be added to the rationale column, e.g. when specific species are present, as follows:

* Significant flora or fauna species or significant EVCs
* Use of Flagship species (enter the name of the flagship species present)
* Invasive Flora Shrub layer (record the name of the high threat species present)
* Invasive Flora Ground layer (record the name of the high threat species present)
* Invasive Fauna Terrestrial (record the name of the invasive fauna species present)
* Invasive Fauna Aquatic (record the name of the invasive fauna species present)

Any other information that you would like to have access to while viewing data in AVIRA can also be included in the rationale column.

**Column 6: References (Optional)**

= a reference source for the data.

More detailed information on the source for the data can be provided here. For example: a website, the author of a report and/or the page number the data is from, personal communication from *X*, an expert workshop held. Note that this information is **not viewable in AVIRA** only in your data file.

**AVIRA Import Data File Names**

|  |  |  |
| --- | --- | --- |
| Values | | |
| Measure | Asset Types | Import File Name |
| Formally recognised significance | | |
| Ramsar Sites | W | W\_Ramsar.csv |
| Ramsar Sites | E | E\_Ramsar.csv |
| EAA Flyway Sites | W | W\_Flyway sites.csv |
| EAA Flyway Sites | E | E\_Flyway sites.csv |
| Nationally Important Wetlands | W | W\_DIWA.csv |
| Nationally Important Wetlands | E | E\_DIWA.csv |
| Living Murray Icon Sites | R | R\_Living Murray Icon Sites.csv |
| Living Murray Icon Sites | W | W\_Living Murray Icon Sites.csv |
| National Heritage Sites | R | R\_National Heritage Sites.csv |
| National Heritage Sites | W | W\_National Heritage Sites.csv |
| National Heritage Sites | E | E\_National Heritage Sites.csv |
| Heritage Rivers | R | R\_Heritage Rivers.csv |
| Heritage Rivers | E | E\_Heritage Rivers.csv |
| Heritage Rivers | W | W\_Heritage Rivers.csv |
| Icon Rivers | R | R\_Icon Rivers.csv |
| Icon Rivers | E | E\_Icon Rivers.csv |
| Essentially Natural Catchments | R | R\_Essentially Natural Catchments.csv |
| Essentially Natural Catchments | W | W\_Essentially Natural Catchments.csv |
| Essentially Natural Catchments | E | E\_Essentially Natural Catchments.csv |
| Victorian Parks and Reserves | R | R\_Victorian Parks and Reserves.csv |
| Victorian Parks and Reserves | W | W\_Victorian Parks and Reserves.csv |
| Victorian Parks and Reserves | E | E\_Victorian Parks and Reserves.csv |
| Victorian Heritage Sites | R | R\_Victorian Heritage Sites.csv |
| Victorian Heritage Sites | W | W\_Victorian Heritage Sites.csv |
| Victorian Heritage Sites | E | E\_Victorian Heritage Sites.csv |
| Representativeness | | |
| Representative Rivers | R | R\_Representative Rivers.csv |

|  |  |  |
| --- | --- | --- |
| Values | | |
| Measure | Asset Types | Import File Name |
| Rare or threatened species and communities | | |
| Significant Fish Migratory (ABC) | R | R\_ABC\_Fish Migratory.csv |
| Significant Fish Migratory (IUCN) | R | R\_IUCN\_Fish Migratory.csv |
| Significant Fish Migratory (EPBC) | R | R\_EPBC\_Fish Migratory.csv |
| Significant Fish Migratory (ALTVFV) | R | R\_ALTVFV\_Fish Migratory.csv |
| Significant Fish Non Migratory (ABC) | R | R\_ABC\_Fish Non Migratory.csv |
| Significant Fish Non Migratory (IUCN) | R | R\_IUCN\_Fish Non Migratory.csv |
| Significant Fish Non Migratory (EPBC) | R | R\_EPBC\_Fish Non Migratory.csv |
| Significant Fish Non Migratory (ALTVFV) | R | R\_ALTVFV\_Fish Non Migratory.csv |
| Significant Birds Riparian (ABC) | R | R\_ABC\_Birds Riparian.csv |
| Significant Birds Riparian (IUCN) | R | R\_IUCN\_Birds Riparian.csv |
| Significant Birds Riparian (EPBC) | R | R\_EPBC\_Birds Riparian.csv |
| Significant Birds Riparian (ALTVFV) | R | R\_ALTVFV\_Birds Riparian.csv |
| Significant Birds Waterway (ABC) | R | R\_ABC\_Birds Waterway.csv |
| Significant Birds Waterway (IUCN) | R | R\_IUCN\_Birds Waterway.csv |
| Significant Birds Waterway (EPBC) | R | R\_EPBC\_Birds Waterway.csv |
| Significant Birds Waterway (ALTVFV) | R | R\_ALTVFV\_Birds Waterway.csv |
| Significant Amphibians (ABC) | R | R\_ABC\_Amphibians.csv |
| Significant Amphibians (IUCN) | R | R\_IUCN\_Amphibians.csv |
| Significant Amphibians (EPBC) | R | R\_EPBC\_Amphibians.csv |
| Significant Amphibians (ALTVFV) | R | R\_ALTVFV\_Amphibians.csv |
| Significant Invertebrates Aquatic (ABC) | R | R\_ABC\_Invertebrates Aquatic.csv |
| Significant Invertebrates Aquatic (IUCN) | R | R\_IUCN\_Invertebrates Aquatic.csv |
| Significant Invertebrates Aquatic (EPBC) | R | R\_EPBC\_Invertebrates Aquatic.csv |
| Significant Invertebrates Aquatic (ALTIFV) | R | R\_ALTIFV\_Invertebrates Aquatic.csv |
| Significant Invertebrates Riparian (ABC) | R | R\_ABC\_Invertebrates Riparian.csv |
| Significant Invertebrates Riparian (IUCN) | R | R\_IUCN\_Invertebrates Riparian.csv |
| Significant Invertebrates Riparian (EPBC) | R | R\_EPBC\_Invertebrates Riparian.csv |
| Significant Invertebrates Riparian (ALTIFV) | R | R\_ALTIFV\_Invertebrates Riparian.csv |

|  |  |  |
| --- | --- | --- |
| Values | | |
| Measure | Asset Types | Import File Name |
| Significant Reptiles Aquatic (ABC) | R | R\_ABC\_Reptiles Aquatic.csv |
| Significant Reptiles Aquatic (IUCN) | R | R\_IUCN\_Reptiles Aquatic.csv |
| Significant Reptiles Aquatic (EPBC) | R | R\_EPBC\_Reptiles Aquatic.csv |
| Significant Reptiles Aquatic (ALTVFV) | R | R\_ALTVFV\_Reptiles Aquatic.csv |
| Significant Reptiles Riparian (ABC) | R | R\_ABC\_Reptiles Riparian.csv |
| Significant Reptiles Riparian (IUCN) | R | R\_IUCN\_Reptiles Riparian.csv |
| Significant Reptiles Riparian (EPBC) | R | R\_EPBC\_Reptiles Riparian.csv |
| Significant Reptiles Riparian (ALTVFV) | R | R\_ALTVFV\_Reptiles Riparian.csv |
| Significant Mammals (ABC) | R | R\_ABC\_Mammals.csv |
| Significant Mammals (IUCN) | R | R\_IUCN\_Mammals.csv |
| Significant Mammals (EPBC) | R | R\_EPBC\_Mammals.csv |
| Significant Mammals (ALTVFV) | R | R\_ALTVFV\_Mammals.csv |
| Significant Fish (ABC) | W | W\_ABC\_Fish.csv |
| Significant Fish (IUCN) | W | W\_IUCN\_Fish.csv |
| Significant Fish (EPBC) | W | W\_EPBC\_Fish.csv |
| Significant Fish (ALTVFV) | W | W\_ALTVFV\_Fish.csv |
| Significant Birds (ABC) | W | W\_ABC\_Birds.csv |
| Significant Birds (IUCN) | W | W\_IUCN\_Birds.csv |
| Significant Birds (EPBC) | W | W\_EPBC\_Birds.csv |
| Significant Birds (ALTVFV) | W | W\_ALTVFV\_Birds.csv |
| Significant Amphibians (ABC) | W | W\_ABC\_Amphibians.csv |
| Significant Amphibians (IUCN) | W | W\_IUCN\_Amphibians.csv |
| Significant Amphibians (EPBC) | W | W\_EPBC\_Amphibians.csv |
| Significant Amphibians (ALTVFV) | W | W\_ALTVFV\_Amphibians.csv |
| Significant Invertebrates (ABC) | W | W\_ABC\_Invertebrates.csv |
| Significant Invertebrates (IUCN) | W | W\_IUCN\_Invertebrates.csv |
| Significant Invertebrates (EPBC) | W | W\_EPBC\_Invertebrates.csv |
| Significant Invertebrates (ALTIFV) | W | W\_ALTIFV\_Invertebrates.csv |
| Significant Reptiles Aquatic (ABC) | W | W\_ABC\_Reptiles Aquatic.csv |

|  |  |  |
| --- | --- | --- |
| Values | | |
| Measure | Asset Types | Import File Name |
| Significant Reptiles Aquatic (IUCN) | W | W\_IUCN\_Reptiles Aquatic.csv |
| Significant Reptiles Aquatic (EPBC) | W | W\_EPBC\_Reptiles Aquatic.csv |
| Significant Reptiles Aquatic (ALTVFV) | W | W\_ALTVFV\_Reptiles Aquatic.csv |
| Significant Reptiles Riparian (ABC) | W | W\_ABC\_Reptiles Riparian.csv |
| Significant Reptiles Riparian (IUCN) | W | W\_IUCN\_Reptiles Riparian.csv |
| Significant Reptiles Riparian (EPBC) | W | W\_EPBC\_Reptiles Riparian.csv |
| Significant Reptiles Riparian (ALTVFV) | W | W\_ALTVFV\_Reptiles Riparian.csv |
| Significant Mammals (ABC) | W | W\_ABC\_Mammals.csv |
| Significant Mammals (IUCN) | W | W\_IUCN\_Mammals.csv |
| Significant Mammals (EPBC) | W | W\_EPBC\_Mammals.csv |
| Significant Mammals (ALTVFV) | W | W\_ALTVFV\_Mammals.csv |
| Significant Fish Resident (ABC) | E | E\_ABC\_Fish Resident.csv |
| Significant Fish Resident (IUCN) | E | E\_IUCN\_Fish Resident.csv |
| Significant Fish Resident (EPBC) | E | E\_EPBC\_Fish Resident.csv |
| Significant Fish Resident (ALTVFV) | E | E\_ALTVFV\_Fish Resident.csv |
| Significant Fish Dependent (ABC) | E | E\_ABC\_Fish Dependent.csv |
| Significant Fish Dependent (IUCN) | E | E\_IUCN\_Fish Dependent.csv |
| Significant Fish Dependent (EPBC) | E | E\_EPBC\_Fish Dependent.csv |
| Significant Fish Dependent (ALTVFV) | E | E\_ALTVFV\_Fish Dependent.csv |
| Significant Birds (ABC) | E | E\_ABC\_Birds.csv |
| Significant Birds (IUCN) | E | E\_IUCN\_Birds.csv |
| Significant Birds (EPBC) | E | E\_EPBC\_Birds.csv |
| Significant Birds (ALTVFV) | E | E\_ALTVFV\_Birds.csv |
| Significant Reptiles (ABC) | E | E\_ABC\_Reptiles.csv |
| Significant Reptiles (IUCN) | E | E\_IUCN\_Reptiles.csv |
| Significant Reptiles (EPBC) | E | E\_EPBC\_Reptiles.csv |
| Significant Reptiles (ALTVFV) | E | E\_ALTVFV\_Reptiles.csv |
| Significant Flora Aquatic (ABC) | R | R\_ABC\_Flora Aquatic.csv |
| Significant Flora Aquatic (IUCN) | R | R\_IUCN\_Flora Aquatic.csv |

|  |  |  |
| --- | --- | --- |
| Values | | |
| Measure | Asset Types | Import File Name |
| Significant Flora Aquatic (EPBC) | R | R\_EPBC\_Flora Aquatic.csv |
| Significant Flora Aquatic (ALRTPV) | R | R\_ALRTPV\_Flora Aquatic.csv |
| Significant Flora Terrestrial (ABC) | R | R\_ABC\_Flora Terrestrial.csv |
| Significant Flora Terrestrial (IUCN) | R | R\_IUCN\_Flora Terrestrial.csv |
| Significant Flora Terrestrial (EPBC) | R | R\_EPBC\_Flora Terrestrial.csv |
| Significant Flora Terrestrial (ALRTPV) | R | R\_ALRTPV\_Flora Terrestrial.csv |
| Significant Flora Wetland (ABC) | W | W\_ABC\_Flora.csv |
| Significant Flora Wetland (IUCN) | W | W\_IUCN\_Flora.csv |
| Significant Flora Wetland (EPBC) | W | W\_EPBC\_Flora.csv |
| Significant Flora Wetland (ALRTPV) | W | W\_ALRTPV\_Flora.csv |
| Significant Flora Aquatic (ABC) | E | E\_ABC\_Flora Aquatic.csv |
| Significant Flora Aquatic (IUCN) | E | E\_IUCN\_Flora Aquatic.csv |
| Significant Flora Aquatic (EPBC) | E | E\_EPBC\_Flora Aquatic.csv |
| Significant Flora Aquatic (ALRTPV) | E | E\_ALRTPV\_Flora Aquatic.csv |
| Significant Flora Terrestrial (ABC) | E | E\_ABC\_Flora Terrestrial.csv |
| Significant Flora Terrestrial (IUCN) | E | E\_IUCN\_Flora Terrestrial.csv |
| Significant Flora Terrestrial (EPBC) | E | E\_EPBC\_Flora Terrestrial.csv |
| Significant Flora Terrestrial (ALRTPV) | E | E\_ALRTPV\_Flora Terrestrial.csv |
| EVC Conservation Status | R | R\_EVC\_Conservation Status.csv |
| Riparian vegetation condition | R | R\_EVC\_Vegetation Condition.csv |
| EVC Conservation Status | W | W\_EVC\_Conservation Status.csv |
| Wetland vegetation condition | W | W\_EVC\_Vegetation Condition.csv |
| EVC Conservation Status | E | E\_EVC\_Conservation Status.csv |
| Naturalness | | |
| Aquatic Invertebrate Community Condition | R | R\_Aquatic Invert Comm Condition.csv |
| Native Fish | R | R\_Native Fish.csv |
| Riparian Vegetation Condition | R | R\_Riparian Vegetation Condition.csv |
| Wetland Vegetation Condition | W | W\_Wetland Vegetation Condition.csv |

|  |  |  |
| --- | --- | --- |
| Values | | |
| Measure | Asset Types | Import File Name |
| Landscape features | | |
| Drought Refuges | R | R\_Drought Refuges.csv |
| Drought Refuges | W | W\_Drought Refuges.csv |
| Drought Refuges | E | E\_Drought Refuges.csv |
| Important Bird Areas | R | R\_Important Bird Areas.csv |
| Important Bird Areas | W | W\_Important Bird Areas.csv |
| Important Bird Areas | E | E\_Important Bird Areas.csv |
| Migratory Shorebird Sites | R | R\_Migratory Shorebird Sites.csv |
| Migratory Shorebird Sites | W | W\_Migratory Shorebird Sites.csv |
| Migratory Shorebird Sites | E | E\_Migratory Shorebird Sites.csv |
| Colonial Nesting Bird Sites | R | R\_Colonial Nesting Bird Sites.csv |
| Colonial Nesting Bird Sites | W | W\_Colonial Nesting Bird Sites.csv |
| Colonial Nesting Bird Sites | E | E\_Colonial Nesting Bird Sites.csv |
| Biosphere Reserves | R | R\_Biosphere Reserves.csv |
| Biosphere Reserves | W | W\_Biosphere Reserves.csv |
| Biosphere Reserves | E | E\_Biosphere Reserves.csv |
| Activity | | |
| Recreational Fishing | R | R\_Recreational Fishing.csv |
| Recreational Fishing | W | W\_Recreational Fishing.csv |
| Recreational Fishing | E | E\_Recreational Fishing.csv |
| Non-Motor Boating | R | R\_Non-Motor Boating.csv |
| Non-Motor Boating | W | W\_Non-Motor Boating.csv |
| Non-Motor Boating | E | E\_Non-Motor Boating.csv |
| Motor Boating | R | R\_Motor Boating.csv |
| Motor Boating | W | W\_Motor Boating.csv |
| Motor Boating | E | E\_Motor Boating.csv |
| Camping | R | R\_Camping.csv |
| Camping | W | W\_Camping.csv |
| Camping | E | E\_Camping.csv |

|  |  |  |
| --- | --- | --- |
| Values | | |
| Measure | Asset Types | Import File Name |
| Swimming | R | R\_Swimming.csv |
| Swimming | W | W\_Swimming.csv |
| Swimming | E | E\_Swimming.csv |
| Tracks | R | R\_Tracks.csv |
| Tracks | W | W\_Tracks.csv |
| Tracks | E | E\_Tracks.csv |
| Sightseeing | R | R\_Sightseeing.csv |
| Sightseeing | W | W\_Sightseeing.csv |
| Sightseeing | E | E\_Sightseeing.csv |
| Picnics and Barbecues | R | R\_Picnics and Barbecues.csv |
| Picnics and Barbecues | W | W\_Picnics and Barbecues.csv |
| Picnics and Barbecues | E | E\_Picnics and Barbecues.csv |
| Game Hunting | R | R\_Game Hunting.csv |
| Game Hunting | W | W\_Game Hunting.csv |
| Game Hunting | E | E\_Game Hunting.csv |
| Place | | |
| Indigenous Heritage | R | R\_Pre-European Heritage.csv |
| Indigenous Heritage | W | W\_Pre-European Heritage.csv |
| Indigenous Heritage | E | E\_Pre-European Heritage.csv |
| Post-European Heritage | R | R\_Post-European Heritage.csv |
| Post-European Heritage | W | W\_Post-European Heritage.csv |
| Post-European Heritage | E | E\_Post-European Heritage.csv |
| Landscape | R | R\_Landscape.csv |
| Landscape | W | W\_Landscape.csv |
| Landscape | E | E\_Landscape.csv |
| People | | |
| Community Groups | R | R\_Community Groups.csv |
| Community Groups | W | W\_Community Groups.csv |
| Community Groups | E | E\_Community Groups.csv |

|  |  |  |
| --- | --- | --- |
| Values | | |
| Measure | Asset Types | Import File Name |
| Use of Flagship Species | R | R\_Flagship Species.csv |
| Use of Flagship Species | W | W\_Flagship Species.csv |
| Use of Flagship Species | E | E\_Flagship Species.csv |
| Water | | |
| Township Water Sources | R | R\_Township Water Source.csv |
| Township Water Sources | W | W\_Township Water Source.csv |
| Township Water Sources | E | E\_Township Water Source.csv |
| Rural Water Sources for Production | R | R\_Production Water Source.csv |
| Rural Water Sources for Production | W | W\_Production Water Source.csv |
| Rural Water Sources for Production | E | E\_Production Water Source.csv |
| Water Storages | R | R\_Water Storages.csv |
| Water Storages | W | W\_Water Storages.csv |
| Water Carriers | R | R\_Water Carriers.csv |
| Water Carriers | W | W\_Water Carriers.csv |
| Wastewater Discharges | R | R\_Wasterwater Discharges.csv |
| Wastewater Discharges | W | W\_Wasterwater Discharges.csv |
| Wastewater Discharges | E | E\_Wasterwater Discharges.csv |
| Power generation | | |
| Hydro-Electricity Capacity | R | R\_Hydro-Electricity.csv |
| Hydro-Electricity Capacity | W | W\_Hydro-Electricity.csv |
| Other resources | | |
| Commercial Fishing | R | R\_Commercial Fishing.csv |
| Commercial Fishing | W | W\_Commercial Fishing.csv |
| Commercial Fishing | E | E\_Commercial Fishing.csv |
| Extractive Industries | R | R\_Extractive Industries.csv |
| Extractive Industries | W | W\_Extractive Industries.csv |
| Extractive Industries | E | E\_Extractive Industries.csv |
| Timber and Firewood | R | R\_Timber and Firewood.csv |
| Timber and Firewood | W | W\_Timber and Firewood.csv |
| Timber and Firewood | E | E\_Timber and Firewood.csv |

**AVIRA Import Data File Names - Threats**

|  |  |  |  |
| --- | --- | --- | --- |
| Threats | | | |
| Measure | | Asset Types | Import File Name |
| Altered water regimes | | | |
| Low Flow Index Score | | R | R\_Increased Low Flow.csv |
| High Flow Index Score | | R | R\_Decreased High Flow.csv |
| Zero Flow Index Score | | R | R\_Increased Zero Flow.csv |
| Variability Index Score | | R | R\_Changed Variability.csv |
| Seasonality Index Score | | R | R\_Changed Seasonality.csv |
| Changed Water Regime | | W | W\_Changed Water Regime.csv |
| Low Flow Index Score | | E | E\_Increased Low Flow.csv |
| High Flow Index Score | | E | E\_Decreased High Flow.csv |
| Zero Flow Index Score | | E | E\_Increased Zero Flow.csv |
| Variability Index Score | | E | E\_Changed Variability.csv |
| Seasonality Index Score | | E | E\_Changed Seasonality.csv |
| Altered Marine Exchange (Intermittently Open Estuaries) | | E | E\_Altered Marine Exchange\_Intermittent.csv |
| Altered Marine Exchange (Permanently Open Estuaries) | | E | E\_Altered Marine Exchange\_Permanent.csv |
| Altered physical form | | | |
| Bank Instability | | R | R\_Bank Instability.csv |
| Bed Instability (Degradation) | | R | R\_Bed Instability.csv |
| Reduced Wetland Area (IWC Physical Form Sub-Index) | | W | W\_Reduced Area.csv |
| Altered Wetland Form (IWC Physical Form Sub-Index) | | W | W\_Altered Form.csv |
| Bank Instability | | E | E\_Bank Instability.csv |
| Barrier Characteristics | | E | E\_Barrier Characteristics.csv |
| Barrier Proximity | | E | E\_Barrier Proximity.csv |
| Poor water quality | | | |
| SIGNAL Objectives | R | | R\_Signal.csv |
| VWQMN Sites | R | | R\_VWQMN Sites.csv |

|  |  |  |  |
| --- | --- | --- | --- |
| Threats | | | |
| Measure | | Asset Types | Import File Name |
| Waterwatch Data | R | | R\_Waterwatch.csv |
| Algal Blooms | R | | R\_Algal Blooms.csv |
| Fish Deaths | R | | R\_Fish Deaths.csv |
| Excessive Instream Macrophyte Growth | R | | R\_Excessive Instream Macrophytes.csv |
| IWC Water Properties Score | W | | W\_Degraded Water Quality.csv |
| EPA Water Quality Guideline Values for Estuaries | E | | E\_EPA guideline values.csv |
| Algal Blooms | E | | E\_Algal Blooms.csv |
| Fish Deaths | E | | E\_Fish Deaths.csv |
| Excessive Instream Macrophyte Growth | E | | E\_Excessive Instream Macrophytes.csv |
| Thermal Impact from Dam Releases (Evidence Based) | R | | R\_Dam Release Impact Evidence.csv |
| Thermal Impact from Industrial Coolant | R | | R\_Industrial Coolant Impact.csv |
| Thermal Impact from Dam Releases (Suspected) | R | | R\_Dam Release Impact Suspected.csv |
| Disturbance of Acid Sulfate Soils | R | | R\_Acid Sulfate Soils.csv |
| Disturbance of Acid Sulfate Soils | W | | W\_Acid Sulfate Soils.csv |
| Disturbance of Acid Sulfate Soils | E | | E\_Acid Sulfate Soils.csv |
| Degraded habitats | | | |
| Large Trees | R | | R\_Large Trees.csv |
| Loss of Instream Habitat (Large Wood) | R | | R\_Large Wood.csv |
| Loss of Instream Habitat (Sedimentation) | R | | R\_Sedimentation.csv |
| Livestock Access | R | | R\_Livestock Access.csv |
| Livestock Access | W | | W\_Livestock Access.csv |
| Livestock Access | E | | E\_Livestock Acess.csv |
| Soil Disturbance | W | | W\_Soil Disturbance.csv |
| Degraded buffer vegetation | W | | W\_Degraded Buffer.csv |
| Invasive flora and fauna | | | |
| Total Cover of Invasive Flora (Tree) | R | | R\_Invasive Flora Cover Tree.csv |
| Presence of High Threat Weeds (Tree) | R | | R\_Invasive Flora High Threat Tree.csv |

|  |  |  |  |
| --- | --- | --- | --- |
| Threats | | | |
| Measure | | Asset Types | Import File Name |
| Total Cover of Invasive Flora (Shrub) | R | | R\_Invasive Flora Cover Shrub.csv |
| Presence of High Threat Weeds (Shrub) | R | | R\_Invasive Flora High Threat Shrub.csv |
| Total Cover of Invasive Flora (Ground) | R | | R\_Invasive Flora Cover Ground.csv |
| Presence of High Threat Weeds (Ground) | R | | R\_Invasive Flora High Threat Ground.csv |
| Invasive Flora (Aquatic) | R | | R\_Invasive Aquatic Flora.csv |
| Presence of Invasive Fauna (Terrestrial) | R | | R\_Invasive Terrestrial Fauna Presence.csv |
| Type of Impact (Terrestrial) | R | | R\_Invasive Terrestrial Fauna Impact.csv |
| Presence of Invasive Fauna (Aquatic) | R | | R\_Invasive Aquatic Fauna Presence.csv |
| Type of Impact (Aquatic) | R | | R\_Invasive Aquatic Fauna Impact.csv |
| IWC Presence of Weeds Score | W | | W\_Invasive Flora.csv |
| Presence of Invasive Fauna (Terrestrial) | W | | W\_Invasive Terrestrial Fauna Presence.csv |
| Type of Impact (Terrestrial) | W | | W\_Invasive Terrestrial Fauna Impact.csv |
| Presence of Invasive Fauna (Aquatic) | W | | W\_Invasive Aquatic Fauna Presence.csv |
| Type of Impact (Aquatic) | W | | W\_Invasive Aquatic Fauna Impact.csv |
| Total Cover of Invasive Flora (Tree) | E | | E\_Invasive Flora Cover Tree.csv |
| Presence of High Threat Weeds (Tree) | E | | E\_Invasive Flora High Threat Tree.csv |
| Total Cover of Invasive Flora (Shrub) | E | | E\_Invasive Flora Cover Shrub.csv |
| Presence of High Threat Weeds (Shrub) | E | | E\_Invasive Flora High Threat Shrub.csv |
| Total Cover of Invasive Flora (Ground) | E | | E\_Invasive Flora Cover Ground.csv |
| Presence of High Threat Weeds (Ground) | E | | E\_Invasive Flora High Threat Ground.csv |
| Invasive Flora (Aquatic) | E | | E\_Invasive Aquatic Flora.csv |
| Presence of Invasive Fauna (Terrestrial) | E | | E\_Invasive Terrestrial Fauna Presence.csv |
| Type of Impact (Terrestrial) | E | | E\_Invasive Terrestrial Fauna Impact.csv |

|  |  |  |  |
| --- | --- | --- | --- |
| Threats | | | |
| Measure | | Asset Types | Import File Name |
| Presence of Invasive Fauna (Aquatic) | E | | E\_Invasive Aquatic Fauna Presence.csv |
| Type of Impact (Aquatic) | E | | E\_Invasive Aquatic Fauna Impact.csv |
| Reduced connectivity | | | |
| Barriers to fish migration | R | | R\_Fish Barriers.csv |
| Fragmentation of Woody Vegetation | R | | R\_Fragmentation Woody Vegetation.csv |
| Vegetation Overhang | R | | R\_Vegetation Overhang.csv |
| Reduced vegetation width | R | | R\_Vegetation Width.csv |
| Reduced Floodplain Connectivity | R | | R\_Reduced Floodplain Connectivity.csv |
| Barriers to Estuarine Biota | E | | E\_Barriers to Biota.csv |
| Presence of Artificial Structures | E | | E\_Artificial Structures.csv |
| Degree of Connectivity | E | | E\_Degree of Connectivity.csv |

Appendix E - High Priority Victorian Parks and Reserves (A1 and A2)

The following information has been determined from Parks Victoria’s Level of Protection framework.

Park Group A1

* Alpine National Park
* Black Range State Park
* Chiltern-Mt Pilot National Park
* Coopracambra National Park
* Croajingolong National Park
* Discovery Bay Coastal Park
* Errinundra National Park
* Grampians National Park
* Great Otway National Park
* Hattah - Kulkyne National Park
* Little Desert National Park
* Lower Glenelg National Park
* Mitchell River National Park
* Mount Arapiles-Tooan State Park
* Mount Buffalo National Park
* Murray - Sunset National Park
* Snowy River National Park
* Wilsons Promontory National Park
* Wyperfeld National Park
* Yarra Ranges National Park

Park Group A2

* Barmah National Park
* Belfast Coastal Reserve Coastal Reserve
* Brisbane Ranges National Park
* Burrowa - Pine Mountain National Park
* Cape Conran Coastal Park
* Cape Liptrap Coastal Park
* Corner Inlet Marine and Coastal Park
* Dergholm State Park
* French Island National Park
* Heathcote-Graytown National Park
* Jilpanger Nature Conservation Reserve
* Kinglake National Park
* Kings Billabong Park
* Koorangie (The Marshes & Avoca Floodway) Wildlife Reserve
* Lake Albacutya Park
* Lake Connewarre Wildlife Reserve
* Lake Tyers
* Mornington Peninsula National Park
* Mount Lawson State Park
* Nooramunga Marine & Coastal Park
* Plenty Gorge Parklands
* Point Cook Coastal Park
* Port Campbell National Park
* Reef Hills State Park
* Terrick Terrick National Park
* Tooloy-Lake Mundi Wildlife Reserve
* Warby-Ovens National Park

Appendix F - Representative Rivers for Victoria (Doeg 2001)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| River Region | | Representative River | LCC Recommendations | | Basin Number | ISC Reach Number |
| Number | Name | Heritage River | Representative River |
| 1 | Alps | Dargo River |  | C3 | 24 | 26, 27 |
| Wonnangatta River | A12 |  | 24 | 13, 14, 15 |
| 2 | North-east uplands | Snowy Creek |  | C2 | 1 | 5, 6 |
| 3 | North-east floodplains | Koetong Creek |  |  | 1 | 13 |
| 4 | North Central uplands | Ovens River |  |  | 3 | 5, 6, 7 |
| Acheron |  |  | 5 | 62, 63 |
| Yea |  |  | 5 | 54, 55, 56, 57 |
| Murrindindi |  |  | 5 | 58, 59 |
| 5 | North Central midlands | Ovens River |  |  | 3 | 3, 4 |
| 6 | North Central floodplains | Ovens River | A2 |  | 3 | 1, 2 |
| 7 | Northern-west uplands | Avoca River (upper) |  | C9 | 8 | 7, 8 |
| Axe Creek |  |  | 6 | 12 |
| 8 | North-west floodplains | Avoca River (lower) |  |  | 8 | 1, 2, 3, 4, 5, 6 |
| 9 | Grampians | Upper Glenelg River |  |  | 38 | 12, 13 |
| Jimmy Creek |  |  | 38 | - |
| 10 | Glenelg catchment | Glenelg River (estuarine section) | A17 |  | 38 | 1 |
| Glenelg River b/n Mathers Creek & Harrow |  |  | 38 | 10, 11 |
| 11 | Otway Ranges | Aire River | A16 |  | 35 | 27, 28 |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| River Region | | Representative River | LCC Recommendations | | Basin Number | ISC Reach Number |
| Number | Name | Heritage River | Representative River |
| 12 | South west floodplains | Hopkins River between Blind Creek and Grey Creek |  |  | 36 | 6 |
| 13 | South Central | Lerderderg River | A15 | C10 | 31 | 14, 15 |
| Curdies Creek |  |  | 35 | - |
| 14a | East Gippsland east of the Snowy River - uplands | Thurra River (upper) |  | C6 | 21 | 25 |
| 14b | South-central uplands | Latrobe River catchment |  |  | 26 | 6, 7 |
| 15 | South-eastern slopes | Wonnangatta River | A12 |  | 24 | 8, 9, 10, 11, 12 |
| 16a | East Gippsland east of the Snowy River - lowlands | Thurra River (lower) |  | C6 | 21 | 24 |
| 16b | Strzelecki’s | Tarra River |  | C13 | 27 | 34, 35 |
| 17 | South-eastern plains | Mitchell River | A12 |  | 24 | 4, 5 |
| 18 | Wilsons Promontory | Mt. Vereker Creek |  |  | 27 | - |
| 19 | South-central lowlands | Bunyip River (lower) |  |  |  | - |

Source: DNRE (2002a)

Appendix G - Waterway Dependent Significant Fauna

Waterway Dependent Significant Fauna was identified through GIS query of the Victorian Biodiversity Atlas (VBA). Only Post 1980 records were included. Fauna species were recorded for:

* Rivers
* Wetlands
* Estuaries

The following buffers were used for mapping purposes:

* Wetlands: 200 metres from mapped boundary
* Estuaries: 300 metres from mapped boundary
* Rivers: pre-1788 EVC boundaries and within 200 metres of river centre line

**Conservation Status**

EX – Extinct

CE - Critically Engandered

EN – Endangered

VU – Vulnerable

NT – Near Threatened

DD – Data Deficient

L refers to listing under the provisions of Part 3 of the Victorian ***Flora and Fauna Guarantee Act 1988.*** A taxon may be listed as threatened if it has been nominated, assessed by the Scientific Advisory Committee and approved by the Minister.

Table 7 - Waterway Dependent Significant Fauna – Rivers

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Taxon Code | Common Name | Scientific Name | IUCN Listed | EPBC Listed | Advisory List |
| Bird - Riparian | | |  |  |  |
| 60196 | Black Bittern | Ixobrychus flavicollis australis |  |  | L - VU |
| 10187 | Great Egret | Ardea alba |  |  | L - VU |
| 10212 | Australasian Shoveler | Anas rhynchotis |  |  | VU |
| 60555 | Brown Treecreeper | Climacteris picumnus victoriae |  |  | NT |
| 10031 | Diamond Dove | Geopelia cuneata |  |  | L – NT |
| 10519 | Eastern Bristlebird | Dasyornis brachypterus brachypterus | EN | EN | L – EN |
| 60618 | Helmeted Honeyeater | Lichenostomus melanops cassidix |  | EN | L – CE |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Taxon Code | Common Name | Scientific Name | IUCN Listed | EPBC Listed | Advisory List |
| 10012 | King Quail | Coturnix chinensis victoriae |  |  | L - EN |
| 10045 | Lewin's Rail | Rallus pectoralis pectoralis |  |  | L - VU |
| 10195 | Australian Little Bittern | Ixobrychus dubius |  |  | L - EN |
| 10199 | Magpie Goose (reintroduced) | Anseranas semipalmata |  |  | L - NT |
| 10264 | Red-tailed Black-Cockatoo | Calyptorhynchus banksii graptogyne |  | EN | L – EN |
| 10278 | Regent Parrot | Polytelis anthopeplus monarchoides |  | VU | L - VU |
| 10230 | Square-tailed Kite | Lophoictinia isura |  |  | L - VU |
| 10277 | Superb Parrot | Polytelis swainsonii | VU |  | L - EN |
| Bird - Waterway | | |  |  |  |
| 60196 | Black Bittern | Ixobrychus flavicollis australis |  |  | L - VU |
| 10187 | Great Egret | Ardea alba |  |  | L - VU |
| 10197 | Australasian Bittern | Botaurus poiciloptilus | EN | EN | L - EN |
| 10319 | Azure Kingfisher | Alcedo azurea |  |  | NT |
| 10112 | Caspian Tern | Sterna caspia |  |  | L - NT |
| 10192 | Nankeen Night Heron | Nycticorax caledonicus hillii |  |  | NT |
| 10099 | Pied Cormorant | Phalacrocorax varius |  |  | NT |
| 10226 | White-bellied Sea-Eagle | Haliaeetus leucogaster |  |  | L - VU |
| Fish - Non-migratory | | |  |  |  |
|  | Agassiz's Chanda Perch | Ambassis agassizii |  |  | L – RE |
|  | Southern Purple-spotted Gudgeon | Mogurnda adspersa |  |  | L – RE |
|  | Barred Galaxias | Galaxias fuscus | CE | EN | L – CE |
|  | River Blackfish upper Wannon R form | Gadopsis marmoratus upper Wannon |  |  | CE |
|  | Trout Cod | Maccullochella macquariensis | EN | EN | L – CE |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Taxon Code | Common Name | Scientific Name | IUCN Listed | EPBC Listed | Advisory List |
|  | Variegated Pigmy Perch | Nannoperca variegata |  | VU | L – VU |
|  | Dwarf Galaxias | Galaxiella pusilla | VU | VU | L – EN |
|  | Yarra Pigmy Perch | Nannoperca obscura |  | VU | L – VU |
| Fish - Migratory | | |  |  |  |
|  | Freshwater Herring | Potamalosa richmondia |  |  | L – RC |
|  | Australian Mudfish | Neochanna cleaveri |  |  | L – CE |
|  | Australian Whitebait | Lovettia sealii |  |  | L – CE |
|  | Murray Hardyhead | Craterocephalus fluviatilis | EN | EN | L – CE |
|  | Silver Perch | Bidyanus bidyanus | VU |  | L – VU |
|  | Cox's Gudgeon | Gobiomorphus coxii |  |  | L - EN |
|  | Freshwater Catfish | Tandanus tandanus |  |  | L – EN |
|  | Macquarie Perch | Macquaria australasica | DD | EN | L – EN |
|  | Murray Cod | Maccullochella peelii peelii | CE | VU | L - VU |
|  | Australian Grayling | Prototroctes maraena | VU | VU | L – VU |
|  | Empire Gudgeon | Hypseleotris compressa |  |  | L – VU |
|  | Golden Perch (natural populations) | Macquaria ambigua |  |  | IN |
|  | Unspecked Hardyhead | Craterocephalus stercusmuscarum fulvus |  |  | L[[4]](#footnote-4) |
|  | Striped Gudgeon | Gobiomorphus australis |  |  | NT |
|  | Flat-headed Galaxias | Galaxias rostratus | VU |  | I- VU |
|  | Pale Mangrove Goby | Mugiligobius platynotus |  |  | L – VU |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Taxon Code | Common Name | Scientific Name | IUCN Listed | EPBC Listed | Advisory List |
|  | Crimson-spotted Rainbowfish (Murray-Darling Rainbowfish) | Melanotaenia fluviatilis |  |  | L – VU |
| Mammal | | |  |  |  |
| 11357 | Southern Myotis | Myotis macropus |  |  | NT |
| 11280 | Grey-headed Flying Fox | Pteropus poliocephalus | VU | VU | L – VU |
| 11034 | Swamp Antechinus | Antechinus minimus |  |  | L – NT |
| 11438 | Broad-toothed Rat | Mastacomys fuscus | NT |  | N – EN |
| 11050 | Gile’s Planigale | Planigale gilesi |  |  | L - NT |
| Reptile - Aquatic | | |  |  |  |
|  | Broad-shelled Turtle | Macrochelodina expansa |  |  | L – EN |
|  | Murray River Tortoise | Emydura macquarii |  |  | V |
| 12557 | Eastern Water Skink | Eulamprus quoyii |  |  | NT[[5]](#footnote-5) |
| Reptile - Riparian | | |  |  |  |
| 12550 | Alpine Water Skink | Eulamprus kosciuskoi |  |  | L - CE |
| 62958 | Corangamite Water Skink | Eulamprus tympanum marnieae |  | EN | L - CE |
| 12992 | Alpine Bog Skink | Pseudemoia cryodroma |  |  | L - EN |
| 62969 | Carpet Python | Morelia spilota metcalfei |  |  | L – EN |
| 19001 | De Vis’ Banded Snake | Denisonia devisi |  |  | CE |
| 12283 | Lace Monitor | Varanus varius |  |  | EN |
| 12669 | Red-naped Snake | Furina diadema |  |  | L – VU |
| 12407 | Swamp Skink | Lissolepis (formerly Egernia) coventryi |  |  | L - VU |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Taxon Code | Common Name | Scientific Name | IUCN Listed | EPBC Listed | Advisory List |
| Amphibian | | |  |  |  |
| 63907 | Alpine Tree Frog | Litoria verreauxii alpina |  | VU | L – CE |
| 13106 | Baw Baw Frog | Philoria frosti | CE | EN | L – CE |
| 13168 | Booroolong Tree Frog | Litoria booroolongensis |  | EN | L – CE |
| 13060 | Giant Bullfrog | Limnodynastes interioris |  |  | L – CE |
| 13073 | Southern Barred Frog | Mixophyes balbus | VU | VU | L – CE |
| 13195 | Spotted Tree Frog | Litoria spenceri |  | EN | L – CE |
| 13117 | Brown Toadlet | Pseudophryne bibronii | NT |  | L - EN |
| 13207 | Growling Grass Frog | Litoria raniformis | EN | VU | L – EN |
| 13042 | Giant Burrowing Frog | Heleioporus australiacus | VU | VU | L – CE |
| 13166 | Green and Golden Bell Frog | Litoria aurea |  | VU | I - VU |
| 13151 | Rugose Toadlet | Uperoleia rugosa |  |  | L – EN |
| 13125 | Southern Toadlet | Pseudophryne semimarmorata |  |  | VU |
| 13120 | Dendy’s Toadlet | Pseudophryne dendyi |  |  | DD |
| 13936 | Large Brown Tree Frog | Litoria littlejohni |  | VU | L – EN |
| 13930 | Martin’s Toadlet | Uperoleia martini | DD |  | CE |
| 13931 | Tyler’s Toadlet | Uperoleia tyleri |  |  | DD |
| 13158 | Smooth Toadlet | Uperoleia laevigata |  |  | DD |
| 13059 | Barking Marsh Frog | Limnodynastes fletcheri |  |  | DD[[6]](#footnote-6) |
| Invertebrate - Aquatic | | |  |  |  |
|  | Alpine Darner | Austroaeschna flavomaculata |  |  | VU |
|  | Alpine Redspot | Austropetalia tonyana |  |  | NT |
|  | Alpine Stonefly | Thaumatoperla alpina |  |  | L - VU |
|  | Ancient Greenling | Hemiphlebia mirabilis |  |  | L - EN |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Taxon Code | Common Name | Scientific Name | IUCN Listed | EPBC Listed | Advisory List |
|  | Aquatic Beetle | Hygrobia australasiae |  |  | L - VU |
|  | Aquatic Beetle | Notomicrus tenellus |  |  | VU |
|  | Caddisfly | Tanjistomella verna |  |  | CE |
|  | Caddisfly | Triaenodes vespertina |  |  | CE |
|  | Caddisfly | Ecnomus neboissi |  |  | VU |
|  | Caddisfly | Ecnomus nibbor |  |  | VU |
|  | Caddisfly | Leptocerus souta |  |  | VU |
|  | Caddisfly | Notoperata sparsa |  |  | VU |
|  | Caddisfly | Plectrotarsus gravenhorstii |  |  | VU |
|  | Caddisfly | Ramiheithrus virgatus |  |  | VU |
|  | Caddisfly | Tamasia furcilla |  |  | VU |
|  | Caddisfly | Taskiria otwayensis |  |  | L - VU |
|  | Caddisfly | Triaenodes cuspiosa |  |  | VU |
|  | Caddisfly | Triaenodes resima |  |  | VU |
|  | Caddisfly | Triaenodes uvida |  |  | VU |
|  | Caddisfly | Westriplectes pedderensis |  |  | VU |
| 15015 | Caddisfly | Orphinotrichia justini |  |  | NT |
|  | Caddisfly | Archaeophylax canarus |  |  | L - DD |
|  | Caddisfly | Ecnomus karakoi |  |  | DD |
|  | Caddisfly | Ecnomus karawalla |  |  | DD |
|  | Caddisfly | Notalina gungarra |  |  | DD |
|  | Caddisfly | Oecetis asmanista |  |  | DD |
|  | Grey-chested Flatwing Dragonfly | Griseargiolestes eboracus |  |  | DD |
|  | Inland Ringtail | Austrolestes aridus |  |  | NT |
|  | Kallista Flightless Stonefly | Leptoperla kallistae |  |  | L - CE |
|  | Large Riverdamsel | Caliagrion billinghursti |  |  | EN |
|  | Mayfly | Pseudocloeon hypodelum |  |  | VU |
|  | Mayfly | Wundacaenis flabellum |  |  | VU |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Taxon Code | Common Name | Scientific Name | IUCN Listed | EPBC Listed | Advisory List |
|  | Mount Donna Buang Stonefly | Riekoperla darlingtoni | VU |  | L - CE |
|  | Mt Stirling Stonefly | Thaumatoperla flaveola |  |  | VU |
|  | Murray River Hunter | Archaeophylax canarus |  |  | DD |
|  | Otway Stonefly | Eusthenia nothofagi | DD | D | NT |
|  | Stonefly | Riekoperla isosceles | VU |  | L - CE |
|  | Stonefly | Riekoperla intermedia |  |  | L - EN |
|  | Stonefly | Dinotoperla walkeri |  |  | VU |
|  | Stonefly | Thaumatoperla robusta |  |  | DD |
|  | Stonefly | Thaumatoperla timmsi |  |  | DD |
|  | Swamp Bluet | Coenagrion lyelli |  |  | NT |
|  | Wide-faced Darner | Dendroaeschna conspersa |  |  | DD |
|  | Alpine Spiny Cray | Euastacus crassus | EN |  | L - EN |
|  | Calanoid copepod | Calamoecia australica |  |  | VU |
|  | Clayton’s Spiny Cray | Euastacus claytoni |  |  | VU |
|  | Common Yabby subspecies | Cherax destructor albidus |  |  | DD |
|  | Dairy Creek Austropyrgus Snail | Austropyrgus grampianensis |  |  | L - CE |
|  | Dandenong Freshwater Amphipod | Austrogammarus australis | EX |  | L – CE |
|  | East Gippsland Spiny Cray | Euastacus bidawalus |  |  | VU |
|  | Eastern Freshwater Shrimp | Australatya striolata |  |  | L - VU |
|  | Flatworm | Spathula tryssa |  |  | VU |
|  | Glenelg Freshwater Mussel | Hyridella glenelgensis |  |  | L - CE |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Taxon Code | Common Name | Scientific Name | IUCN Listed | EPBC Listed | Advisory List |
|  | Harpactacoid copepod | Canthocamptus longipes, C. mammillifurca, C. sublaevis | VU |  | DD |
|  | Harpactacoid copepod | Fibulacamptus gracilior | VU |  | DD |
|  | Murray River Spiny Cray | Euastacus armatus | VU |  | L - NT |
|  | Otways Cray | Geocharax gracilis |  |  | EN |
|  | Phreatoicid isopod | Naiopegia xiphagrostis, Gariwerdeus beehivensis, G. ingletonensis, G. turretensis |  |  | VU |
| 15107 | River snail | Notopala sublineata | EN |  | L - CE |
|  | Sherbrooke Amphipod | Austrogammarus haasei |  |  | L - VU |
| 1637 | South Gippsland Spiny Cray | Euastacus neodiversus | VU |  | L - EN |
|  | Variable Spiny Cray | Euastacus yanga |  |  | VU |
|  | Western Cray | Geocharax falcata |  |  | EN |
|  | Brackish Jellyfish | Australonmedusa baylii |  |  | VU |
| Invertebrate - Riparian | | |  |  |  |
| 1679 | Curve-tail Burrowing Cray | Engaeus curvisuturus | EN |  | L - EN |
| 1685 | Dandenong Burrowing Cray | Engaeus urostrictus | EN |  | L - CE |
| 1678 | Gippsland Burrowing Cray | Engaeus hemicirratulus |  |  | L - EN |
| 15004 | Gippsland Giant Earthworm | Megascolides australis | VU | VU | L - EN |
| 1646 | Glenelg River Spiny Cray | Euastacus bispinosis |  |  | L – EN |
| 1692 | Hairy Burrowing Cray | Engaeus sericatus |  |  | VU |
| 1686 | Lilly Pilly Burrowing Cray | Engaeus australis | EN |  | I |
| 1694 | Mallacoota Burrowing Cray | Engaeus mallacoota | EN |  | L -VU |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Taxon Code | Common Name | Scientific Name | IUCN Listed | EPBC Listed | Advisory List |
|  | Narracan Burrowing Cray | Engaeus phyllocercus | VU |  | L - EN |
| 1675 | South Gippsland Burrowing Cray | Engaeus karnanga |  |  | EN |
| 1683 | Strzelecki Burrowing Cray | Engaeus rostrogaleatus | EN |  | L - EN |
| 1693 | Warragul Burrowing Cray | Engaeus sternalis | EN |  | L - CE |
| 1684 | Western Burrowing Cray | Engaeus merosetosus |  |  | EN |
|  | Western Swamp Cray | Gramastacus insolitus |  |  | L - CE |

Table 8 - Waterway Dependent Fauna – Wetlands

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Taxon Code | Common Name | Scientific Name | IUCN Listed | EPBC Listed | FFG Advisory List |
| Amphibian | | |  |  |  |
| 63907 | Alpine Tree Frog | Litoria verreauxii alpina |  |  | L – CE |
| 13059 | Barking Marsh Frog | Limnodynastes fletcheri |  |  | DD[[7]](#footnote-7) |
| 13106 | Baw Baw Frog | Philoria frosti | CE |  | L - CE |
| 13168 | Booroolong Tree Frog | Litoria booroolongensis |  |  | L - CE |
| 13117 | Brown Toadlet | Pseudophryne bibronii | NT |  | L –EN |
| 13166 | Green and Golden Bell Frog | Litoria aurea |  | VU | IN |
| 13207 | Growling Grass Frog | Litoria raniformis | EN |  | L - EN |
| 13060 | Giant Bullfrog | Limnodynastes interioris |  |  | L – CE |
| 13936 | Large Brown Tree Frog | Litoria littlejohni |  |  | L – EN |
| 13930 | Martin's Toadlet | Uperoleia martini | DD |  | CE |
| 13125 | Southern Toadlet | Pseudophryne semimarmorata |  |  | VU |
| 13195 | Spotted Tree Frog | Litoria spenceri |  |  | L – CE |
| 13931 | Tyler's Toadlet | Uperoleia tyleri |  |  | DD |
| Bird | | |  |  |  |
| 10197 | Australasian Bittern | Botaurus poiciloptilus | EN | EN | L - EN |
| 10212 | Australasian Shoveler | Anas rhynchotis |  |  | VU |
| 10170 | Australian Painted-Snipe | Rostratula benghalensis |  | VU | L - CE |
| 10173 | Australian Pratincole | Stiltia isabella |  |  | NT |
| 10319 | Azure Kingfisher | Alcedo azurea |  |  | NT |
| 10050 | Baillon's Crake | Porzana pusilla |  |  | L - VU |
| 60196 | Black Bittern | Ixobrychus flavicollis australis |  |  | L – VU |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Taxon Code | Common Name | Scientific Name | IUCN Listed | EPBC Listed | Advisory List |
| 10098 | Black-faced Cormorant | Phalacrocorax fuscescens |  |  | NT |
|  | Black-tailed Godwit | Limosa limosa |  |  | VU |
| 10216 | Blue-billed Duck | Oxyura australis |  |  | L - EN |
| 10177 | Brolga | Grus rubicunda |  |  | L - VU |
| 10198 | Cape Barren Goose | Cereopsis novaehollandiae |  |  | L - NT[[8]](#footnote-8) |
| 10112 | Caspian Tern | Sterna caspia |  |  | L – NT |
| 10157 | Common Sandpiper | Actitis hypoleucos |  |  | VU |
| 10149 | Eastern Curlew | Numenius madagascariensis |  |  | VU |
| 10118 | Fairy Tern | Sterna nereis |  | VU | L - EN |
| 10214 | Freckled Duck | Stictonetta naevosa |  |  | L - EN |
| 10178 | Glossy Ibis | Plegadis falcinellus |  |  | NT |
| 10187 | Great Egret | Ardea alba |  |  | L – VU |
| 10165 | Great Knot | Calidris tenuirostris |  |  | L - EN |
| 10141 | Greater Sand Plover | Charadrius leschenaultii |  |  | CE |
| 10136 | Grey Plover | Pluvialis squatarola |  |  | EN |
| 10155 | Grey-tailed Tattler | Heteroscelus brevipes |  |  | L - CE |
| 10111 | Gull-billed Tern | Sterna nilotica |  |  | L - EN |
|  | Hardhead | Aythya australis |  |  | VU |
| 10138 | Hooded Plover | Thinornis rubricollis |  |  | L - VU |
| 10145 | Inland Dotterel | Charadrius australis |  |  | VU |
| 10186 | Intermediate Egret | Ardea intermedia |  |  | L - EN |
| 10168 | Latham's Snipe | Gallinago hardwickii |  |  | N - NT |
| 10139 | Lesser Sand Plover | Charadrius mongolus |  |  | CE |
| 10045 | Lewin's Rail | Rallus pectoralis |  |  | L – VU |
| 10195 | Little Bittern | Ixobrychus minutus |  |  | L – EN |
| Taxon Code | Common Name | Scientific Name | IUCN Listed | EPBC Listed | Advisory List |
| 10185 | Little Egret | Egretta garzetta |  |  | EN |
| 10117 | Little Tern | Sterna albifrons |  |  | L - VU |
| 10199 | Magpie Goose | Anseranas semipalmata |  |  | L – NT |
| 10217 | Musk Duck | Biziura lobata |  |  | VU |
| 10192 | Nankeen Night Heron | Nycticorax caledonicus |  |  | NT |
| 10305 | Orange-bellied Parrot | Neophema chrysogaster |  | CR | L – CE |
|  | Pacific Golden Plover | Pluvialis fulva |  |  | VU |
| 60126 | Pacific Gull | Larus pacificus |  |  | NT |
| 10978 | Pectoral Sandpiper | Calidris melanotos |  |  | NT |
| 10099 | Pied Cormorant | Phalacrocorax varius |  |  | NT |
| 10164 | Red Knot | Calidris canutus |  |  | EN |
| 10278 | Regent Parrot | Polytelis anthopeplus |  | VU | L – VU |
| 10181 | Royal Spoonbill | Platalea regia |  |  | NT |
| 10166 | Sanderling | Calidris alba |  |  | NT |
| 10131 | Sooty Oystercatcher | Haematopus fuliginosus |  |  | NT |
| 10277 | Superb Parrot | Polytelis swainsonii | VU |  | L - EN |
| 10160 | Terek Sandpiper | Xenus cinereus |  |  | L - EN |
| 10150 | Whimbrel | Numenius phaeopus |  |  | VU |
| 10110 | Whiskered Tern | Chlidonias hybridus |  |  | NT |
| 10226 | White-bellied Sea-Eagle | Haliaeetus leucogaster |  |  | L – VU |
| 10109 | White-winged Black Tern | Chlidonias leucopterus |  |  | NT |
| 10154 | Wood Sandpiper | Tringa glareola |  |  | VU |
| Fish | | |  |  |  |
|  | Australian Grayling | Prototroctes maraena | VU | VU | L – VU |
|  | Golden Perch | Macquaria ambigua |  |  | IN |

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Taxon Code | Common Name | | Scientific Name | | | IUCN Listed | EPBC Listed | | | Advisory List |
|  | | Murray Hardyhead | | Craterocephalus fluviatilis | EN | | | EN | L – CE | |
|  | | Agassiz's Chanda Perch | | Ambassis agassizii |  | | |  | L – RE | |
|  | | Australian Mudfish | | Neochanna cleaveri |  | | |  | L – CE | |
|  | | Crimson-spotted Rainbowfish (Murray-Darling Rainbowfish) | | Melanotaenia fluviatilis |  | | |  | L - VU | |
|  | | Freshwater Catfish | | Tandanus tandanus |  | | |  | L – EN | |
|  | | River Blackfish upper Wannon R form | | Gadopsis marmoratus upper Wannon |  | | |  | CE | |
|  | | Southern Purple-spotted Gudgeon | | Mogurnda adspersa |  | | |  | L – RE | |
|  | | Striped Gudgeon | | Gobiomorphus australis |  | | |  | NT | |
|  | | Unspecked Hardyhead | | Craterocephalus stercusmuscarum fulvus |  | | |  | DD[[9]](#footnote-9) | |
|  | | Variegated Pigmy Perch | | Nannoperca variegata |  | | | VU | L – VU | |
|  | | Yarra Pigmy Perch | | Nannoperca obscura |  | | | VU | L – VU | |
| Reptile - Riparian | | | | |  | | |  |  | |
| 12992 | | Alpine Bog Skink | | Pseudemoia cryodroma |  | | |  | L – EN | |
| 12550 | | Alpine Water Skink | | Eulamprus kosciuskoi |  | | |  | L – CE | |
| 62969 | | Carpet Python | | Morelia spilota metcalfei |  | | |  | L – EN | |
| 62958 | | Corangamite Water Skink | | Eulamprus tympanum marnieae |  | | | EN | L - CE | |
| 12557 | | Eastern Water Skink | | Eulamprus quoyii |  | | |  | NT[[10]](#footnote-10) | |
| 12407 | | Swamp Skink | | Egernia coventryi |  | | |  | L - VU | |

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Taxon Code | Common Name | | Scientific Name | | | IUCN Listed | EPBC Listed | | | Advisory List |
| Reptile - Aquatic | | | | |  | | |  |  | |
|  | | Broad-shelled Turtle | | Macrochelodina expansa |  | | |  | L - EN | |
| Invertebrates | | | | |  | | |  |  | |
|  | | Swamp Bluet | | Coenagrion lyelli |  | | |  | NT | |
|  | | Ancient Greenling | | Hemiphlebia mirabilis | EN | | |  | L – EN | |
|  | | Caddisfly | | Triaenodes vespertina |  | | |  | CE | |
|  | | Harpactacoid copepod | | Fibulacamptus gracilior | VU | | |  | DD | |
| 75167 | | Isopod | | Phreatoicopsis raffae |  | | |  | VU | |
|  | | Western Swamp Cray | | Gramastacus insolitus | NT | | |  | L - CE | |
| Mammals | | | | |  | | |  |  | |
| 11357 | | Southern Myotis | | Myotis macropus |  | | |  | NT | |

Table 9 - Waterway Dependent Fauna – Estuaries

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Taxon Code | Common Name | Scientific Name | IUCN Listed | EPBC Listed | FFG Advisory List |
| Bird | | |  |  |  |
| 10197 | Australasian Bittern | Botaurus poiciloptilus | EN | EN | L - EN |
| 10319 | Azure Kingfisher | Alcedo azurea |  |  | NT |
| 60196 | Black Bittern | Ixobrychus flavicollis australis |  |  | L - VU |
|  | Black-tailed Godwit | Limosa limosa |  |  | VU |
| 10149 | Eastern Curlew | Numenius madagascariensis |  |  | VU |
| 10118 | Fairy Tern | Sterna nereis nereis |  | VU | L – EN |
| 10187 | Great Egret | Ardea alba |  |  | L – VU |
| 10165 | Great Knot | Calitris tenuirostris |  |  | L – EN |
| 10136 | Grey Plover | Pluvialis squatarolaulva |  |  | EN |
| 10155 | Grey-tailed Tattler | Heteroscelus brevipes |  |  | L – CE |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Taxon Code | Common Name | Scientific Name | IUCN Listed | EPBC Listed | Advisory List |
| 10111 | Gull-billed Tern | Sterna nilotica macrotarsa |  |  | L – EN |
| 10186 | Intermediate Egret | Ardea intermedia |  |  | L – EN |
| 10185 | Little Egret | Egretta garzetta nigripes |  |  | EN |
| 10117 | Little Tern | Sterna albifrons sinensis |  |  | L – VU |
| 10192 | Nankeen Night Heron | Nycticorax caledonicus hillii |  |  | NT |
|  | Pacific Golden Plover | Pluvialis fulva |  |  | VU |
| 10164 | Red Knot | Calitris canutus |  |  | EN |
| 10181 | Royal Spoonbill | Platalea regia |  |  | NT |
| 10131 | Sooty Oystercatcher | Haematopus fuliginosus |  |  | NT |
| 10160 | Terek Sandpiper | Xenus cinereus |  |  | L – EN |
| 10150 | Whimbrel | Numenius phaeopus |  |  | VU |
| 10110 | Whiskered Tern | Chlidonias hybridus javanicus |  |  | NT |
| 10109 | White-winged Black Tern | Chlidonias leucopterus |  |  | NT |
| Fish - Resident | | |  |  |  |
|  | Pale Mangrove Goby | Mugilogobius platynotus |  |  | L – VU |
| Fish - Dependent | | |  |  |  |
|  | Empire Gudgeon | Hypseleotris compressa |  |  | L – VU |
|  | Freshwater Herring | Potamalosa richmondia |  |  | L - RE |
|  | Cox's Gudgeon | Gobiomorphus coxii |  |  | L – EN |
|  | Australian Grayling | Prototroctes maraena | VU | VU | L – VU |
|  | Australian Mudfish | Neochanna cleaveri |  |  | L – CE |
|  | Australian Whitebait | Lovettia sealii |  |  | L – CE |
| Reptile | | |  |  |  |
| 12407 | Swamp Skink | Lissolepis (formerly Egernia) coventryi |  |  | L – VU |
| 12683 | Glossy Grass Skink | Pseudemoia rawlinsoni |  |  | VU |

Appendix H - Waterway Dependent Significant Flora

Waterway Dependent Significant Flora was identified through GIS query of the Victorian Biodiversity Atlas. Only post-1980 records were included. Flora species were divided into groups which were:

* River Terrestrial
* River Aquatic
* Wetland
* Estuary Terrestrial
* Estuary Aquatic

The following buffers were used for mapping purposes:

* Wetlands: 100 metres from mapped boundary
* Estuaries: 200 metres from mapped boundary
* Rivers: pre-1788 EVC boundaries and within 200 metres of river centre line

Table 10 - Waterway Dependent Significant Flora - River Terrestrial

|  |  |  |
| --- | --- | --- |
| River Terrestrial | | |
| Sp No | Scientific Name | Common Name |
| 4199 | Abutilon oxycarpum var. malvaefolium | Mallow-leaf Lantern-flower |
| 0010 | Acacia amoena | Boomerang Wattle |
| 0016 | Acacia boormanii | Snowy River Wattle |
| 0023 | Acacia dallachiana | Catkin Wattle |
| 3631 | Acacia irrorata subsp. irrorata | Green Wattle |
| 5092 | Acacia lanigera var. gracilipes | Woolly Wattle |
| 0070 | Acacia oswaldii | Umbrella Wattle |
| 0073 | Acacia pendula | Weeping Myall |
| 0093 | Acacia subporosa | Bower Wattle |
| 0096 | Acacia trineura | Three-nerve Wattle |
| 0116 | Acronychia oblongifolia | Yellow-wood |
| 0130 | Adiantum capillus-veneris | Venus-hair Fern |
| 0131 | Adiantum diaphanum | Filmy Maidenhair |
| 0132 | Adiantum formosum | Black Stem |
| 0133 | Adiantum hispidulum | Rough Maidenhair |

|  |  |  |
| --- | --- | --- |
| River Terrestrial | | |
| Sp No | Scientific Name | Common Name |
| 5449 | Adiantum hispidulum var. hispidulum | Rough Maidenhair |
| 5450 | Adiantum hispidulum var. hypoglaucum | Rough Maidenhair |
| 0135 | Adriana urticoides var. urticoides | Eastern Bitter-bush |
| 4218 | Adriana urticoides var. urticoides (glabrous form) | Eastern Bitter-bush |
| 4217 | Adriana urticoides var. urticoides (pubescent form) | Eastern Bitter-bush |
| 0170 | Alchemilla sp. 1 | Lady's Mantle |
| 0171 | Alectryon subcinereus | Native Quince |
| 5096 | Alternanthera sp. 1 (Plains) | Plains Joyweed |
| 0195 | Amaranthus macrocarpus var. macrocarpus | Dwarf Amaranth |
| 0202 | Ammannia multiflora | Jerry-jerry |
| 0204 | Ammobium alatum | Winged Everlasting |
| 5168 | Amyema pendula subsp. longifolia | Drooping Mistletoe |
| 4148 | Aphanopetalum resinosum | Gum Vine |
| 0250 | Arabidella nasturtium | Yellow Cress |
| 0277 | Asperula ambleia | Stiff Woodruff |
| 0280 | Asperula gemella | Twin-leaf Bedstraw |
| 0296 | Astelia australiana | Tall Astelia |
| 0333 | Atriplex holocarpa | Pop Saltbush |
| 0322 | Atriplex limbata | Spreading Saltbush |
| 4231 | Atriplex lindleyi subsp. conduplicata | Baldoo |
| 4243 | Atriplex lindleyi subsp. lindleyi | Flat-top Saltbush |
| 4233 | Atriplex nummularia subsp. omissa | Dwarf Old-man Saltbush |
| 0330 | Atriplex pseudocampanulata | Mealy Saltbush |
| 0331 | Atriplex rhagodioides | Silver Saltbush |
| 4245 | Atriplex vesicaria subsp. minor | Bladder Saltbush |
| 4257 | Australina pusilla subsp. pusilla | Small Shade-nettle |
| 4179 | Austrodanthonia setacea var. breviseta | Short-bristle Wallaby-grass |
| 0352 | Babingtonia crenulata | Fern-leaf Baeckea |
| 0368 | Barbarea grayi | Native Wintercress |

|  |  |  |
| --- | --- | --- |
| River Terrestrial | | |
| Sp No | Scientific Name | Common Name |
| 0372 | Bauera sessiliflora | Grampians Bauera |
| 0386 | Bergia ammannioides | Jerry Water-fire |
| 0387 | Bergia trimera | Small Water-fire |
| 0389 | Bertya cunninghamii subsp. pubiramula | Sticky Bertya |
| 0390 | Bertya findlayi | Mountain Bertya |
| 5951 | Bertya grampiana | Grampians Bertya |
| 5953 | Bertya tasmanica subsp. vestita (fine-haired variant) | Mitchell Bertya (fine-haired variant) |
| 5954 | Bertya tasmanica subsp. vestita (glabrous ovary variant) | Mitchell Bertya (glabrous ovary variant) |
| 3165 | Berula erecta | Water Parsnip |
| 0393 | Beyeria lasiocarpa | Wallaby-bush |
| 0396 | Beyeria viscosa | Pinkwood |
| 0412 | Blechnum vulcanicum | Mountain Water-fern |
| 4669 | Bolboschoenus fluviatilis | Tall Club-sedge |
| 0426 | Boronia ledifolia | Showy Boronia |
| 0441 | Bossiaea riparia | River Leafless Bossiaea |
| 5217 | Brachyscome aff. gracilis (Kings Billabong) | Billabong Daisy |
| 3654 | Brachyscome chrysoglossa | Yellow-tongue Daisy |
| 0459 | Brachyscome gracilis | Dookie Daisy |
| 0465 | Brachyscome muelleroides | Mueller Daisy |
| 0476 | Brachyscome riparia | Snowy River Daisy |
| 4395 | Brachyscome sp. aff. readeri | Murray Daisy |
| 0561 | Callistemon brachyandrus | Prickly Bottlebrush |
| 4684 | Callistemon forresterae | Forrester's Bottlebrush |
| 5208 | Callistemon genofluvialis | Genoa River Bottlebrush |
| 4571 | Callistemon kenmorrisonii | Betka Bottlebrush |
| 0567 | Callistemon subulatus | Dwarf Bottlebrush |
| 5098 | Calostemma luteum | Yellow Garland-lily |
| 0592 | Calostemma purpurea s.l. | Garland Lily |

|  |  |  |
| --- | --- | --- |
| River Terrestrial | | |
| Sp No | Scientific Name | Common Name |
| 5936 | Calostemma purpureum s.s. | Garland Lily |
| 0594 | Calotis cuneifolia | Blue Burr Daisy |
| 5028 | Cardamine lineariloba | Western Bitter-cress |
| 5029 | Cardamine microthrix | Eastern Bitter-cress |
| 5032 | Cardamine moirensis | Riverina Bitter-cress |
| 5034 | Cardamine papillata | Forest Bitter-cress |
| 5035 | Cardamine paucijuga s.s. | Annual Bitter-cress |
| 0617 | Cardamine tenuifolia | Slender Bitter-cress |
| 5445 | Cardamine tenuifolia (large-flower form) | Slender Bitter-cress |
| 5444 | Cardamine tenuifolia (small-flower form) | Slender Bitter-cress |
| 0622 | Carex alsophila | Forest Sedge |
| 0632 | Carex chlorantha | Green-top Sedge |
| 4673 | Carex gunniana var. brevior | Swamp Sedge |
| 0650 | Carex tasmanica | Curly Sedge |
| 0682 | Casuarina obesa | Swamp Sheoak |
| 5616 | Centipeda nidiformis | Cotton Sneezeweed |
| 0709 | Centipeda thespidioides s.l. | Desert Sneezeweed |
| 5617 | Centipeda thespidioides s.s. | Desert Sneezeweed |
| 2094 | Cephalomanes caudatum | Jungle Bristle-fern |
| 0738 | Chenopodium carinatum | Keeled Goosefoot |
| 0742 | Chenopodium erosum | Papery Goosefoot |
| 0768 | Christella dentata | Binung |
| 0802 | Commersonia rossii | Blackfellow's Hemp |
| 5887 | Convolvulus recurvatus subsp. recurvatus | Recurved Bindweed |
| 0828 | Correa aemula | Hairy Correa |
| 5466 | Correa lawrenceana var. cordifolia | Pink Mountain-correa |
| 4365 | Correa lawrenceana var. genoensis | Genoa River Correa |
| 0835 | Corybas aconitiflorus | Spurred Helmet-orchid |
| 0841 | Corybas hispidus | Bristly Helmet-orchid |

|  |  |  |
| --- | --- | --- |
| River Terrestrial | | |
| Sp No | Scientific Name | Common Name |
| 5622 | Corybas sp. aff. diemenicus 4 (Mountains) | Mountain Helmet-orchid |
| 4646 | Craspedia haplorrhiza | Plains Billy-buttons |
| 0874 | Crinum flaccidum | Darling Lily |
| 7177 | Ctenopteris heterophylla X Grammitis billardierei | Gipsy X Finger Fern hybrid |
| 2769 | Cullen australasicum | Native Scurf-pea |
| 2770 | Cullen cinereum | Hoary Scurf-pea |
| 2773 | Cullen parvum | Small Scurf-pea |
| 2776 | Cullen tenax | Tough Scurf-pea |
| 5241 | Cuscuta australis | Australian Dodder |
| 0896 | Cyathea cunninghamii | Slender Tree-fern |
| 0897 | Cyathea leichhardtiana | Prickly Tree-fern |
| 0898 | Cyathea X marcescens | Skirted Tree-fern |
| 4149 | Cynodon dactylon var. pulchellus | Native Couch |
| 0913 | Cyperus bifax | Downs Nutgrass |
| 0915 | Cyperus concinnus | Trim Flat-sedge |
| 0920 | Cyperus flaccidus | Lax Flat-sedge |
| 0921 | Cyperus flavidus | Yellow Flat-sedge |
| 4620 | Cyperus fulvus | Sticky Sedge |
| 3678 | Cyperus gracilis | Slender Flat-sedge |
| 0927 | Cyperus nervulosus | Annual Flat-sedge |
| 0929 | Cyperus pygmaeus | Dwarf Flat-sedge |
| 0930 | Cyperus rigidellus | Curly Flat-sedge |
| 0934 | Cyperus squarrosus | Bearded Flat-sedge |
| 0939 | Cyperus victoriensis | Yelka |
| 0949 | Dactyloctenium radulans | Finger Grass |
| 0313 | Deparia petersenii subsp. congrua | Japanese Lady-fern |
| 1007 | Desmodium brachypodum | Large Tick-trefoil |
| 4425 | Desmodium varians | Slender Tick-trefoil |
| 4611 | Deyeuxia nudiflora | Climbing Bent-grass |

|  |  |  |
| --- | --- | --- |
| River Terrestrial | | |
| Sp No | Scientific Name | Common Name |
| 4266 | Dianella porracea | Riverine Flax-lily |
| 7399 | Dianella sp. aff. longifolia (Riverina) | Pale Flax-lily |
| 5786 | Dichondra sp. 1 (s.l.) | Silky Kidney-weed |
| 1041 | Digitaria ammophila | Silky Umbrella-grass |
| 1045 | Digitaria divaricatissima | Umbrella Grass |
| 1071 | Discaria nitida | Shining Anchor Plant |
| 1072 | Discaria pubescens | Australian Anchor Plant |
| 1512 | Diuris ochroma | Pale Golden Moths |
| 1003 | Dockrilla striolata subsp. striolata | Streaked Rock-orchid |
| 1091 | Dodonaea rhombifolia | Broad-leaf Hop-bush |
| 1105 | Drosera indica | Flycatcher |
| 4674 | Eleocharis macbarronii | Grey Spike-sedge |
| 5619 | Eleocharis obicis | Striate Spike-sedge |
| 1143 | Eleocharis pallens | Pale Spike-sedge |
| 1583 | Elymus multiflorus | Short-awned Wheat-grass |
| 1158 | Enneapogon gracilis | Slender Bottle-washers |
| 1172 | Epaltes cunninghamii | Tall Nut-heads |
| 5252 | Eragrostis exigua | Slender Love-grass |
| 1190 | Eragrostis lacunaria | Purple Love-grass |
| 5253 | Eragrostis leptocarpa | Drooping Love-grass |
| 1195 | Eragrostis setifolia | Bristly Love-grass |
| 1198 | Eremophila bignoniiflora | Bignonia Emu-bush |
| 1200 | Eremophila divaricata subsp. divaricata | Spreading Emu-bush |
| 1204 | Eremophila maculata var. maculata | Spotted Emu-bush |
| 1206 | Eremophila polyclada | Twiggy Emu-bush |
| 3706 | Eriochloa crebra | Tall Cup-grass |
| 1238 | Eryngium paludosum | Long Eryngium |
| 1244 | Eucalyptus aggregata | Black Gum |
| 4892 | Eucalyptus alligatrix subsp. alligatrix | Silver Stringybark |

|  |  |  |
| --- | --- | --- |
| River Terrestrial | | |
| Sp No | Scientific Name | Common Name |
| 1256 | Eucalyptus brookeriana | Brooker's Gum |
| 3707 | Eucalyptus cadens | Warby Range Swamp-gum |
| 1265 | Eucalyptus crenulata | Buxton Gum |
| 5175 | Eucalyptus fulgens | Green Scentbark |
| 4491 | Eucalyptus globulus subsp. globulus | Southern Blue-gum |
| 1284 | Eucalyptus globulus subsp. maidenii | Maiden's Gum |
| 5176 | Eucalyptus ignorabilis s.s. | Grey Scentbark |
| 1301 | Eucalyptus neglecta | Omeo Gum |
| 1309 | Eucalyptus perriniana | Spinning Gum |
| 4558 | Eucalyptus strzeleckii | Strzelecki Gum |
| 1326 | Eucalyptus yarraensis | Yarra Gum |
| 1475 | Euchiton umbricola | Cliff Cudweed |
| 1327 | Eucryphia moorei | Eastern Leatherwood |
| 1333 | Euphorbia planiticola | Plains Spurge |
| 4468 | Euphrasia collina subsp. muelleri | Purple Eyebright |
| 4472 | Euphrasia collina subsp. trichocalycina | Purple Eyebright |
| 1343 | Euphrasia scabra | Rough Eyebright |
| 1344 | Eupomatia laurina | Bolwarra |
| 1364 | Ficus coronata | Sandpaper Fig |
| 1367 | Fimbristylis aestivalis | Summer Fringe-sedge |
| 1369 | Fimbristylis velata | Veiled Fringe-sedge |
| 1390 | Gahnia grandis | Brickmakers' Sedge |
| 1396 | Gahnia subaequiglumis | Bog Saw-sedge |
| 4678 | Gentianella gunniana | Gunn's Forest-gentian |
| 1429 | Geranium neglectum | Red-stem Cranesbill |
| 5337 | Geranium solanderi var. solanderi s.s. | Austral Cranesbill |
| 1456 | Glycine latrobeana | Clover Glycine |
| 1514 | Goodenia stelligera | Spiked Gooodenia |
| 4600 | Goodia lotifolia var. pubescens | Silky Golden-tip |

|  |  |  |
| --- | --- | --- |
| River Terrestrial | | |
| Sp No | Scientific Name | Common Name |
| 3742 | Grammitis magellanica subsp. nothofageti | Beech Finger-fern |
| 1521 | Grammitis poeppigiana | Alpine Finger-fern |
| 1523 | Gratiola pedunculata | Stalked Brooklime |
| 3753 | Gratiola pumilo | Dwarf Brooklime |
| 1529 | Grevillea barklyana | Gully Grevillea |
| 1543 | Grevillea miqueliana | Oval-leaf Grevillea |
| 4922 | Grevillea neurophylla | Granite Grevillea |
| 5772 | Grevillea neurophylla subsp. fluviatilis | Granite Grevillea |
| 5773 | Grevillea neurophylla subsp. neurophylla | Granite Grevillea |
| 3745 | Grevillea obtecta | Fryerstown Grevillea |
| 4550 | Grevillea parvula | Genoa Grevillea |
| 5490 | Grevillea polychroma | Tullach Ard Grevillea |
| 4066 | Grevillea rosmarinifolia subsp. rosmarinifolia | Rosemary Grevillea |
| 4551 | Grevillea victoriae s.s. | Royal Grevillea |
| 1554 | Grevillea willisii | Rock Grevillea |
| 3756 | Gynatrix macrophylla | Gippsland Hemp Bush |
| 1582 | Haloragis exalata subsp. exalata var. exalata | Square Raspwort |
| 4655 | Helichrysum aff. rutidolepis (Lowland Swamps) | Pale Swamp Everlasting |
| 1685 | Hibiscus brachysiphonius | Low Hibiscus |
| 3767 | Hovea corrickiae | Glossy Hovea |
| 4929 | Hovea pannosa s.s. [notably rheophytic Omeo form] | Rusty Velvet-pods |
| 3787 | Hovea purpurea | Tall Hovea |
| 2084 | Huperzia varia | Long Clubmoss |
| 3776 | Hypolepis elegans subsp. elegans | Elegant Ground-fern |
| 3777 | Hypoxis exilis | Swamp Star |
| 1757 | Hypsela tridens | Hypsela |
| 1771 | Isolepis australiensis | Inland Club-sedge |
| 5265 | Isolepis cernua var. setiformis | Bristle Club-sedge |
| 1773 | Isolepis congrua | Slender Club-sedge |

|  |  |  |
| --- | --- | --- |
| River Terrestrial | | |
| Sp No | Scientific Name | Common Name |
| 1789 | Isolepis wakefieldiana | Tufted Club-sedge |
| 4435 | Juncus bassianus | Bass Rush |
| 1832 | Juncus phaeanthus | Dark-flower Rush |
| 1836 | Juncus psammophilus | Sand Rush |
| 7040 | Kunzea leptospermoides | Yarra Burgan |
| 4687 | Kunzea peduncularis X phylicoides | River Burgan |
| 7063 | Kunzea phylicoides | Slender Burgan |
| 4220 | Lachnagrostis filifolia var. 2 | Wetland Blown-grass |
| 0159 | Lachnagrostis scabra | Ruddy Blown-grass |
| 1877 | Lastreopsis decomposita | Trim Shield-fern |
| 1878 | Lastreopsis hispida | Bristly Shield-fern |
| 1879 | Lastreopsis microsora subsp. microsora | Creeping Shield-fern |
| 3782 | Leiocarpa leptolepis | Pale Plover-daisy |
| 1799 | Leiocarpa tomentosa | Woolly Plover-daisy |
| 1901 | Lepidium fasciculatum | Bundled Peppercress |
| 1903 | Lepidium hyssopifolium | Basalt Peppercress |
| 1905 | Lepidium monoplocoides | Winged Peppercress |
| 1906 | Lepidium papillosum | Warty Peppercress |
| 1908 | Lepidium pseudohyssopifolium | Native Peppercress |
| 1060 | Leptochloa fusca subsp. fusca | Brown Beetle-grass |
| 1941 | Leptorhynchos elongatus | Lanky Buttons |
| 1944 | Leptorhynchos orientalis | Annual Buttons |
| 1953 | Leptospermum emarginatum | Twin-flower Tea-tree |
| 4799 | Leptospermum glabrescens s.s. | Smooth Tea-tree |
| 1967 | Lepyrodia flexuosa | Twisting Scale-rush |
| 1970 | Lespedeza juncea subsp. sericea | Chinese Lespedeza |
| 1990 | Leucopogon riparius | River Beard-heath |
| 2000 | Libertia paniculata | Branching Grass-flag |
| 2020 | Lipocarpha microcephala | Button Rush |

|  |  |  |
| --- | --- | --- |
| River Terrestrial | | |
| Sp No | Scientific Name | Common Name |
| 2023 | Livistona australis | Cabbage Fan-palm |
| 2032 | Logania ovata | Oval-leaf Logania |
| 2057 | Lotus australis | Austral Trefoil |
| 2096 | Maireana aphylla | Leafless Bluebush |
| 3865 | Maireana microphylla | Small-leaf Bluebush |
| 2117 | Malacocera tricornis | Goat Head |
| 0399 | Marianthus bignoniacea | Orange Bell-climber |
| 1892 | Marsdenia australis | Doubah |
| 2124 | Marsdenia flavescens | Yellow Milk-vine |
| 2145 | Melaleuca armillaris subsp. armillaris | Giant Honey-myrtle |
| 4925 | Melicytus sp. aff. dentatus (East Gippsland variant) | Montane Shrub-violet |
| 4734 | Menkea crassa | Fat Spectacles |
| 2196 | Mimulus prostratus | Small Monkey-flower |
| 2199 | Minuria cunninghamii | Bush Minuria |
| 2200 | Minuria denticulata | Woolly Minuria |
| 2201 | Minuria integerrima | Smooth Minuria |
| 4055 | Mollugo verticillata | Indian Chickweed |
| 3859 | Monotoca glauca | Currant-wood |
| 2226 | Muehlenbeckia axillaris | Matted Lignum |
| 2229 | Muehlenbeckia gracillima | Slender Lignum |
| 2240 | Myoporum montanum | Waterbush |
| 3881 | Neobassia proceriflora | Soda Bush |
| 2347 | Ophioglossum polyphyllum | Upright Adder's-tongue |
| 2346 | Ophioglossum reticulatum | Stalked Adder's-tongue |
| 2385 | Oxalis magellanica | Snowdrop Wood-sorrel |
| 2397 | Pachycornia triandra | Desert Glasswort |
| 2428 | Paspalidium gracile | Slender Panic |
| 4902 | Pellaea calidirupium | Inland Sickle-fern |
| 4812 | Pellaea nana | Dwarf Sickle-fern |

|  |  |  |
| --- | --- | --- |
| River Terrestrial | | |
| Sp No | Scientific Name | Common Name |
| 5287 | Persicaria attenuata | Velvet Knotweed |
| 5476 | Phebalium glandulosum subsp. 2 (Snowy River) | Snowy River Phebalium |
| 2499 | Phyllanthus australis | Pointed Spurge |
| 3924 | Phyllanthus lacunellus | Sandhill Spurge |
| 5659 | Picris barbarorum | Plains Picris |
| 4827 | Picris squarrosa | Squat Picris |
| 4533 | Pimelea curviflora var. aff. subglabrata | Curved Rice-flower |
| 2519 | Pimelea drupacea | Cherry Rice-flower |
| 2528 | Pimelea pauciflora | Poison Rice-flower |
| 2542 | Pittosporum revolutum | Rough-fruit Pittosporum |
| 2574 | Plectorrhiza tridentata | Tangle Orchid |
| 2578 | Pneumatopteris pennigera | Lime Fern |
| 4868 | Poa labillardierei var. (Volcanic Plains) | Basalt Tussock-grass |
| 4867 | Poa sp. aff. tenera (Hairy) | Soft Slender Tussock-grass |
| 2623 | Polygala japonica | Dwarf Milkwort |
| 2642 | Polyscias murrayi | Pencil Cedar |
| 2644 | Polystichum formosum | Broad Shield-fern |
| 2647 | Pomaderris andromedifolia subsp. andromedifolia | Andromeda Pomaderris |
| 2649 | Pomaderris apetala subsp. apetala | Grampians Pomaderris |
| 2652 | Pomaderris betulina subsp. betulina | Birch Pomaderris |
| 3942 | Pomaderris brunnea | Rufous Pomaderris |
| 2653 | Pomaderris costata | Veined Pomaderris |
| 2655 | Pomaderris discolor | Eastern Pomaderris |
| 2657 | Pomaderris eriocephala | Woolly-head Pomaderris |
| 3944 | Pomaderris halmaturina subsp. continentis | Glenelg Pomaderris |
| 2659 | Pomaderris helianthemifolia | Blunt-leaf Pomaderris |
| 5426 | Pomaderris helianthemifolia subsp. helianthemifolia | Blunt-leaf Pomaderris |
| 5427 | Pomaderris helianthemifolia subsp. hispida | Blunt-leaf Pomaderris |
| 5428 | Pomaderris helianthemifolia subsp. minor | Blunt-leaf Pomaderris |

|  |  |  |
| --- | --- | --- |
| River Terrestrial | | |
| Sp No | Scientific Name | Common Name |
| 2662 | Pomaderris ligustrina subsp. ligustrina | Privet Pomaderris |
| 3945 | Pomaderris oblongifolia | Snowy River Pomaderris |
| 2713 | Pomaderris oraria | Bassian Pomaderris |
| 3946 | Pomaderris oraria subsp. calcicola | Limestone Pomaderris |
| 2667 | Pomaderris pauciflora | Mountain Pomaderris |
| 4836 | Pomaderris phylicifolia subsp. ericoides | Slender Pomaderris |
| 4837 | Pomaderris phylicifolia subsp. phylicifolia | Slender Pomaderris |
| 2669 | Pomaderris pilifera | Striped Pomaderis |
| 2672 | Pomaderris sericea | Bent Pomaderris |
| 2674 | Pomaderris subcapitata | Convex Pomaderris |
| 2706 | Prasophyllum diversiflorum | Gorae Leek-orchid |
| 2722 | Prasophyllum niphopedium | Marsh Leek-orchid |
| 5443 | Prasophyllum sp. aff. frenchii 3 / B | Summer Leek-orchid |
| 3925 | Prostanthera incisa | Cut-leaf Mint-bush |
| 2571 | Prostanthera lasianthos X spinosa (Cultivation Creek) | Victoria Range Mint-bush |
| 2760 | Pseudanthus orbicularis | Tangled Pseudanthus |
| 2778 | Pteris comans | Netted brake |
| 2781 | Pteris vittata | Chinese Brake |
| 2782 | Pterostylis aestiva | Long-tongue Summer-greenhood |
| 3916 | Pterostylis cheraphila | Floodplain Rustyhood |
| 5912 | Pterostylis cucullata subsp. sylvicola | Tall Leafy Greenhood |
| 2798 | Pterostylis grandiflora | Cobra Greenhood |
| 2794 | Pterostylis oreophila | Blue-tongue Greenhood |
| 2819 | Pterostylis tenuissima | Swamp Greenhood |
| 4727 | Pterostylis X aenigma | Enigmatic Greenhood |
| 2800 | Pterostylis X ingens | Sharp Greenhood |
| 2828 | Ptilotus nobilis var. nobilis | Yellow Tails |
| 2830 | Ptilotus polystachyus var. polystachyus | Long Tails |
| 2836 | Pultenaea altissima | Tall Bush-pea |

|  |  |  |
| --- | --- | --- |
| River Terrestrial | | |
| Sp No | Scientific Name | Common Name |
| 2858 | Pultenaea luehmannii | Thready Bush-pea |
| 2866 | Pultenaea polifolia | Dusky Bush-pea |
| 4909 | Ranunculus pumilio var. politus | Ferny Small-flower Buttercup |
| 2915 | Ranunculus undosus | Swamp Buttercup |
| 2929 | Rhagodia parabolica | Fragrant Saltbush |
| 1649 | Rhodanthe polygalifolia | Milkwort Sunray |
| 1651 | Rhodanthe stricta | Slender Sunray |
| 2935 | Rhynchospora brownii | Grassy Beak-sedge |
| 2940 | Ripogonum album | White Supplejack |
| 2944 | Rorippa eustylis | Dwarf Bitter-cress |
| 4908 | Rumex crystallinus s.s. | Glistening Dock |
| 3962 | Rumex stenoglottis | Tongue Dock |
| 1242 | Rytidosperma australe | Southern Sheep-grass |
| 2995 | Salvia plebeia | Austral Sage |
| 2998 | Sambucus australasica | Yellow Elderberry |
| 3002 | Samolus valerandii | Water Pimpernel |
| 3005 | Santalum leptocladum | Southern Sandalwood |
| 3007 | Santalum obtusifolium | Blunt Sandalwood |
| 3015 | Sauropus trachyspermus | Slender Spurge |
| 3010 | Sarcochilus falcatus | Orange-blossom Orchid |
| 3026 | Schelhammera undulata | Lilac Lily |
| 3049 | Schoenus melanostachys | Black Bog-sedge |
| 3058 | Scirpus polystachyus | Large-head Club-sedge |
| 3071 | Sclerolaena decurrens | Green Copperburr |
| 3073 | Sclerolaena divaricata | Tangled Copperburr |
| 3074 | Sclerolaena intricata | Poverty Bush |
| 3075 | Sclerolaena lanicuspis | Woolly Copperburr |
| 4974 | Sclerolaena muricata var. muricata | Black Roly-poly |
| 4975 | Sclerolaena muricata var. semiglabra | Dark Roly-poly |

|  |  |  |
| --- | --- | --- |
| River Terrestrial | | |
| Sp No | Scientific Name | Common Name |
| 3079 | Sclerolaena patenticuspis | Spear-fruit Copperburr |
| 3083 | Sclerolaena ventricosa | Salt Copperburr |
| 3090 | Scutellaria mollis | Soft Skullcap |
| 7136 | Senecio campylocarpus | Floodplain Fireweed |
| 3103 | Senecio diaschides | Shingle Fireweed |
| 7028 | Senecio distalilobatus | Distal-lobe Fireweed |
| 7144 | Senecio glomeratus subsp. longifructus | Annual Fireweed |
| 7163 | Senecio lanibracteus | Branching Groundsel |
| 3139 | Sicyos australis | Star Cucumber |
| 3143 | Sida intricata | Twiggy Sida |
| 3180 | Solanum lacunarium | Lagoon Nightshade |
| 3170 | Solanum silvestre | Violet Nightshade |
| 3220 | Sphaerolobium acanthos | Grampians Globe-pea |
| 3227 | Sporobolus caroli | Yakka Grass |
| 3228 | Sporobolus creber | Western Rat-tail Grass |
| 5333 | Stellaria sp. 2 | Rangeland Starwort |
| 4984 | Stemodia glabella s.s. | Smooth Blue-rod |
| 3261 | Sticherus flabellatus var. flabellatus | Shiny Fan-fern |
| 5334 | Sticherus tener s.s. | Tasman Fan-fern |
| 3319 | Swainsona adenophylla | Violet Swainson-pea |
| 3316 | Swainsona greyana | Hairy Darling-pea |
| 4048 | Swainsona luteola | Dwarf Darling-pea |
| 3321 | Swainsona murrayana | Slender Darling-pea |
| 3323 | Swainsona phacoides | Dwarf Swainson-pea |
| 4945 | Swainsona reticulata | Kneed Swainson-pea |
| 3330 | Symplocos thwaitesii | Buff Hazelwood |
| 3334 | Taraxacum aristum | Mountain Dandelion |
| 4981 | Tetragonia eremaea s.s. | Desert Spinach |
| 5002 | Teucrium albicaule | Scurfy Germander |

|  |  |  |
| --- | --- | --- |
| River Terrestrial | | |
| Sp No | Scientific Name | Common Name |
| 3383 | Thelymitra circumsepta | Naked Sun-orchid |
| 3386 | Thelypteris confluens | Swamp Fern |
| 3389 | Thesium australe | Austral Toad-flax |
| 3390 | Thismia rodwayi | Fairy Lanterns |
| 3403 | Tmesipteris elongata | Slender Fork-fern |
| 3404 | Tmesipteris ovata | Oval Fork-fern |
| 3405 | Tmesipteris parva | Small Fork-fern |
| 3419 | Trema tomentosa var. viridis | Peach-leaf Poison-bush |
| 3452 | Trigonella suavissima | Sweet Fenugreek |
| 3473 | Uncinia nemoralis | River Hook-sedge |
| 5048 | Verbena officinalis var. gaudichaudii | Native Verbena |
| 7222 | Verbena officinalis var. montana | Mountain Verbena |
| 5700 | Veronica grosseserrata | Eastern Speedwell |
| 3527 | Viola caleyana | Swamp Violet |
| 4060 | Wahlenbergia tumidifructa | Mallee Annual-bluebell |
| 3570 | Westringia glabra | Violet Westringia |
| 3576 | Wittsteinia vacciniacea | Baw Baw Berry |
| 3603 | Zieria cytisoides | Downy Zieria |
| 3604 | Zieria robusta | Round-leaf Zieria |
| 3605 | Zieria smithii subsp. smithii | Sandfly Zieria |

Table 11 - Waterway Dependent Significant Flora - River Aquatic

|  |  |  |
| --- | --- | --- |
| River Aquatic | | |
| Sp No | Scientific Name | Common Name |
| 0185 | Alternanthera nodiflora | Common Joyweed |
| 3623 | Amphibromus fluitans | River Swamp Wallaby-grass |
| 0487 | Brasenia schreberi | Water-shield |
| 0568 | Callitriche brachycarpa | Short Water-starwort |
| 0569 | Callitriche cyclocarpa | Western Water-starwort |

|  |  |  |
| --- | --- | --- |
| River Aquatic | | |
| Sp No | Scientific Name | Common Name |
| 0572 | Callitriche palustris | Swamp Water-starwort |
| 0723 | Ceratophyllum demersum | Common Hornwort |
| 1450 | Glossostigma cleistanthum | Small-flower Mud-mat |
| 3874 | Myriophyllum lophatum | Crested Water-milfoil |
| 2262 | Najas tenuifolia | Water Nymph |
| 2687 | Potamogeton australiensis | Thin Pondweed |
| 4840 | Potamogeton perfoliatus s.s. | Perfoliate Pondweed |
| 3210 | Sparganium subglobosum | Floating Bur-reed |
| 5010 | Triglochin dubia | Slender Water-ribbons |
| 4537 | Triglochin microtuberosa | Eastern Water-ribbons |

Table 12 - Waterway Dependent Significant Flora – Wetland

|  |  |  |
| --- | --- | --- |
| Wetland | | |
| Sp No | Scientific Name | Common Name |
| 0001 | Abrotanella nivigena | Snow-wort |
| 0034 | Acacia farinosa | Mealy Wattle |
| 0125 | Actinotus bellidioides | Tiny Flannel-flower |
| 0150 | Agrostis australiensis | Tiny Bent |
| 0157 | Agrostis muelleriana | Mueller's Bent |
| 5879 | Agrostis propinqua | Mountain Bent |
| 5877 | Agrostis thompsoniae | Alpine Bent |
| 1049 | Almaleea capitata | Slender Parrot-pea |
| 2862 | Almaleea paludosa | Marsh Bush-pea |
| 5096 | Alternanthera sp. 1 (Plains) | Plains Joyweed |
| 0202 | Ammannia multiflora | Jerry-jerry |
| 3623 | Amphibromus fluitans | River Swamp Wallaby-grass |
| 3624 | Amphibromus pithogastrus | Plump Swamp Wallaby-grass |
| 3625 | Amphibromus sinuatus | Wavy Swamp Wallaby-grass |
| 0227 | Angianthus brachypappus | Spreading Angianthus |

|  |  |  |
| --- | --- | --- |
| Wetland | | |
| Sp No | Scientific Name | Common Name |
| 1615 | Argentipallium dealbatum | Silver Everlasting |
| 1467 | Argyrotegium nitidulum | Shining Cudweed |
| 1475 | Argyrotegium poliochlorum | Grey-green Cudweed |
| 3627 | Asperula charophyton | Elongate Woodruff |
| 0280 | Asperula gemella | Twin-leaf Bedstraw |
| 0282 | Asperula minima | Mossy Woodruff |
| 5640 | Asperula wimmerana | Wimmera Woodruff |
| 4233 | Atriplex nummularia subsp. omissa | Dwarf Old-man Saltbush |
| 0327 | Atriplex papillata | Coral Saltbush |
| 0330 | Atriplex pseudocampanulata | Mealy Saltbush |
| 4244 | Atriplex vesicaria subsp. macrocystidia | Bladder Saltbush |
| 4938 | Austrodanthonia aff. caespitosa (South-west Swamp) | Porphyry Wallaby-grass |
| 3297 | Austrostipa tuckeri | Tucker's Spear-grass |
| 4267 | Baeckea latifolia | Subalpine Baeckea |
| 0355 | Baeckea linifolia | Swamp Baeckea |
| 5466 | Banksia croajingolensis | Gippsland Banksia |
| 0378 | Baumea laxa | Lax Twig-sedge |
| 3722 | Baumea planifolia | Rough Twig-sedge |
| 3165 | Berula erecta | Water Parsnip |
| 4669 | Bolboschoenus fluviatilis | Tall Club-sedge |
| 5213 | Boronia anemonifolia subsp. variabilis | Coast Boronia |
| 0468 | Brachyscome obovata | Baw Baw Daisy |
| 0473 | Brachyscome radicans | Marsh Daisy |
| 0474 | Brachyscome readeri | Reader's Daisy |
| 5612 | Brachyscome sp. 1 | Peat Daisy |
| 3656 | Brachyscome tadgellii | Tadgell's Daisy |
| 0480 | Brachyscome trachycarpa | Inland Daisy |
| 0487 | Brasenia schreberi | Water-shield |
| 0513 | Burnettia cuneata | Lizard Orchid |

|  |  |  |
| --- | --- | --- |
| Wetland | | |
| Sp No | Scientific Name | Common Name |
| 0771 | Caladenia insularis | French Island Spider-orchid |
| 0544 | Caladenia pumila | Dwarf Spider-orchid |
| 0556 | Calandrinia volubilis | Twining Purslane |
| 0569 | Callitriche cyclocarpa | Western Water-starwort |
| 0572 | Callitriche palustris | Swamp Water-starwort |
| 0575 | Callitriche umbonata | Winged Water-starwort |
| 0591 | Calorophus elongatus | Long Rope-rush |
| 5025 | Cardamine astoniae | Spreading Bitter-cress |
| 5026 | Cardamine franklinensis | Franklin Bitter-cress |
| 5033 | Cardamine gunnii s.s. | Tuberous Bitter-cress |
| 5027 | Cardamine lilacina s.s. | Lilac Bitter-cress |
| 5028 | Cardamine lineariloba | Western Bitter-cress |
| 5029 | Cardamine microthrix | Eastern Bitter-cress |
| 0617 | Cardamine tenuifolia | Slender Bitter-cress |
| 5445 | Cardamine tenuifolia (large-flower form) | Slender Bitter-cress |
| 5444 | Cardamine tenuifolia (small-flower form) | Slender Bitter-cress |
| 5448 | Cardamine trysa (sp. aff. franklinensis) | Small-seed Bitter-cress |
| 0624 | Carex archeri | Archer's Sedge |
| 0626 | Carex blakei | Alpine Sedge |
| 0633 | Carex canescens | Short Sedge |
| 0630 | Carex capillacea | Hair Sedge |
| 0631 | Carex cephalotes | Wire-head Sedge |
| 0637 | Carex echinata | Star Sedge |
| 4618 | Carex hypandra | Alpine Fen-sedge |
| 0644 | Carex jackiana | Carpet Sedge |
| 0646 | Carex paupera | Dwarf Sedge |
| 0649 | Carex raleighii | Raleigh Sedge |
| 0650 | Carex tasmanica | Curly Sedge |
| 0652 | Carpha alpina | Small Flower-rush |

|  |  |  |
| --- | --- | --- |
| Wetland | | |
| Sp No | Scientific Name | Common Name |
| 0653 | Carpha nivicola | Broad-leaf Flower-rush |
| 4358 | Cassinia rugata | Wrinkled Cassinia |
| 0682 | Casuarina obesa | Swamp Sheoak |
| 0693 | Celmisia sericophylla | Silky Snow-daisy |
| 4637 | Celmisia tomentella | Silver Snow-daisy |
| 5618 | Centipeda crateriformis subsp. compacta | Compact Sneezeweed |
| 5616 | Centipeda nidiformis | Cotton Sneezeweed |
| 0723 | Ceratophyllum demersum | Common Hornwort |
| 0766 | Chorizandra australis | Southern Bristle-sedge |
| 0767 | Chorizandra sphaerocephala | Roundhead Bristle-sedge |
| 0793 | Colobanthus affinis | Alpine Colobanth |
| 0806 | Conospermum taxifolium | Variable Smoke-bush |
| 5888 | Convolvulus clementii | Desert Bindweed |
| 5887 | Convolvulus recurvatus subsp. recurvatus | Recurved Bindweed |
| 0818 | Coprosma moorei | Turquoise Coprosma |
| 0821 | Coprosma perpusilla subsp. perpusilla | Creeping Coprosma |
| 5248 | Coprosma pumila | Dwarf Coprosma |
| 2040 | Corunastylis ciliata | Fringed Midge-orchid |
| 2700 | Corunastylis nuda | Tiny Midge-orchid |
| 2727 | Corunastylis pumila | Green Midge-orchid |
| 5263 | Corunastylis nudiscapa (Otways) | Brownish Midge-orchid |
| 0840 | Corybas fordhamii | Swamp Pelican-orchid |
| 5249 | Corybas sp. aff. diemenicus 1 (Coastal) | Late Helmet-orchid |
| 0856 | Craspedia alba | White Billy-buttons |
| 4643 | Craspedia canens | Grey Billy-buttons |
| 5935 | Craspedia lamicola | Bog Billy-buttons |
| 3675 | Cryptandra ericoides | Heathy Cryptandra |
| 0881 | Cryptostylis erecta | Bonnet Orchid |
| 0882 | Cryptostylis hunteriana | Leafless Tongue-orchid |

|  |  |  |
| --- | --- | --- |
| Wetland | | |
| Sp No | Scientific Name | Common Name |
| 2769 | Cullen australasicum | Native Scurf-pea |
| 2770 | Cullen cinereum | Hoary Scurf-pea |
| 5241 | Cuscuta australis | Australian Dodder |
| 0920 | Cyperus flaccidus | Lax Flat-sedge |
| 0927 | Cyperus nervulosus | Annual Flat-sedge |
| 0930 | Cyperus rigidellus | Curly Flat-sedge |
| 0935 | Cyperus subulatus | Pointed Flat-sedge |
| 0938 | Cyperus vaginatus | Stiff Flat-sedge |
| 0983 | Darwinia micropetala | Small Darwinia |
| 3508 | Derwentia nivea | Milfoil Speedwell |
| 1006 | Deschampsia caespitosa | Tufted Hair-grass |
| 1009 | Deyeuxia affinis | Allied Bent-Grass |
| 1012 | Deyeuxia carinata | Keeled Bent-Grass |
| 1015 | Deyeuxia decipiens | Devious Bent-grass |
| 4422 | Deyeuxia parviseta var. boormanii | Fine Bent-grass |
| 5484 | Deyeuxia quadriseta (slender flaccid variant) | Slender Reed Bent-grass |
| 3785 | Deyeuxia talariata | Skirted Bent-grass |
| 5086 | Dianella callicarpa | Swamp Flax-lily |
| 5786 | Dichondra sp. 1 (s.l.) | Silky Kidney-weed |
| 1064 | Diplaspis nivis | Snow Pennywort |
| 1074 | Dissocarpus biflorus var. biflorus | Twin-flower Saltbush |
| 1082 | Diuris palustris | Swamp Diuris |
| 1084 | Diuris punctata var. punctata | Purple Diuris |
| 1078 | Diuris X fastidiosa | Proud Diuris |
| 1101 | Drosera arcturi | Alpine Sundew |
| 1115 | Dysphania simulans | Spiked Pigweed |
| 3702 | Elachanthus glaber | Smooth Elachanth |
| 1135 | Elachanthus pusillis | Small Elachanth |
| 4674 | Eleocharis macbarronii | Grey Spike-sedge |

|  |  |  |
| --- | --- | --- |
| Wetland | | |
| Sp No | Scientific Name | Common Name |
| 5619 | Eleocharis obicis | Striate Spike-sedge |
| 1143 | Eleocharis pallens | Pale Spike-sedge |
| 1144 | Eleocharis plana | Flat Spike-sedge |
| 1152 | Elytrophorus spicatus | Spike Grass |
| 3790 | Entolasia stricta | Upright Panic |
| 4633 | Epacris celata | Cryptic Heath |
| 1164 | Epacris glacialis | Reddish Bog-heath |
| 5251 | Epacris microphylla s.s. | Coral Heath |
| 5250 | Epacris microphylla var. microphylla | Coast Coral Heath |
| 1163 | Epacris microphylla var. rhombifolia | Mountain Coral Heath |
| 1170 | Epacris petrophila | Snow Heath |
| 1175 | Epilobium brunnescens subsp. beaugleholei | Bog Willow-herb |
| 1177 | Epilobium curtisiae | Bald-seeded Willow-herb |
| 1182 | Epilobium tasmanicum | Snow Willow-herb |
| 1183 | Epilobium willisii | Carpet Willow-herb |
| 1184 | Eragrostis australasica | Cane Grass |
| 1190 | Eragrostis lacunaria | Purple Love-grass |
| 1195 | Eragrostis setifolia | Bristly Love-grass |
| 1197 | Eragrostis trachycarpa | Rough-grain Love-grass |
| 4483 | Erigeron tasmanicus | Tasmanian Fleabane |
| 1217 | Eriocaulon australasicum | Southern Pipewort |
| 1217 | Eriocaulon scariosum | Common Pipewort |
| 5666 | Eriochlamys behrii s.s. | Woolly Mantle |
| 3706 | Eriochloa crebra | Tall Cup-grass |
| 1238 | Eryngium paludosum | Long Eryngium |
| 1244 | Eucalyptus aggregata | Black Gum |
| 3707 | Eucalyptus cadens | Warby Range Swamp-gum |
| 1265 | Eucalyptus crenulata | Buxton Gum |
| 1275 | Eucalyptus fasciculosa | Pink Gum |

|  |  |  |
| --- | --- | --- |
| Wetland | | |
| Sp No | Scientific Name | Common Name |
| 1290 | Eucalyptus kitsoniana | Bog Gum |
| 1309 | Eucalyptus perriniana | Spinning Gum |
| 1475 | Euchiton traversii | Mat Cudweed |
| 1333 | Euphorbia planiticola | Plains Spurge |
| 1337 | Euphrasia caudata | Tailed Eyebright |
| 4468 | Euphrasia collina subsp. muelleri | Purple Eyebright |
| 4472 | Euphrasia collina subsp. trichocalycina | Purple Eyebright |
| 1340 | Euphrasia eichleri | Bogong Eyebright |
| 1343 | Euphrasia scabra | Rough Eyebright |
| 1369 | Fimbristylis velata | Veiled Fringe-sedge |
| 1372 | Frankenia crispa | Hoary Sea-heath |
| 1373 | Frankenia foliosa | Leafy Sea-heath |
| 1374 | Frankenia serpyllifolia | Bristly Sea-heath |
| 1377 | Frankenia sessilis | Small-leaf Sea-heath |
| 4760 | Gentianella bawbawensis | Baw Baw Snow-gentian |
| 4762 | Gentianella cunninghamii subsp. cunninghamii | Cunningham's Snow-gentian |
| 4764 | Gentianella muelleriana subsp. willisiana | Mt Buller Snow-gentian |
| 1429 | Geranium neglectum | Red-stem Cranesbill |
| 1433 | Geranium sessiliflorum subsp. brevicaule | Alpine Cranesbill |
| 5348 | Geranium sp. 7 | Alpine Swamp Cranesbill |
| 1436 | Gingidia harveyana | Slender Gingidia |
| 1446 | Glossodia minor | Small Wax-lip Orchid |
| 1450 | Glossostigma cleistanthum | Small-flower Mud-mat |
| 4615 | Glossostigma diandrum | Small-flower Mud-mat |
| 1448 | Glossostigma drummondii | Small-flower Mud-mat |
| 0773 | Gnephosis drummondii | Slender Cup-flower |
| 0774 | Gnephosis tenuissima | Dwarf Cup-flower |
| 4885 | Gonocarpus micranthus subsp. ramosissimus | Branching Raspwort |
| 1488 | Gonocarpus serpyllifolius | Flat Raspwort |

|  |  |  |
| --- | --- | --- |
| Wetland | | |
| Sp No | Scientific Name | Common Name |
| 1494 | Goodenia bellidifolia subsp. bellidifolia | Daisy Goodenia |
| 1513 | Goodenia macbarronii | Narrow Goodenia |
| 1514 | Goodenia stelligera | Spiked Gooodenia |
| 1522 | Gratiola nana | Matted Brooklime |
| 1523 | Gratiola pedunculata | Stalked Brooklime |
| 3753 | Gratiola pumilo | Dwarf Brooklime |
| 1173 | Haegiela tatei | Small Nut-heads |
| 3766 | Haloragis glauca f. glauca | Bluish Raspwort |
| 1585 | Haloragis myriocarpa | Prickly Raspwort |
| 3761 | Halosarcia flabelliformis | Bead Glasswort |
| 1590 | Halosarcia lylei | Wiry Glasswort |
| 1591 | Halosarcia nitida | Shining Glasswort |
| 4585 | Halosarcia pergranulata subsp. divaricata | Blackseed Glasswort |
| 1594 | Halosarcia pterygosperma subsp. pterygosperma | Whiteseed Glasswort |
| 1595 | Halosarcia syncarpa | Fused Glasswort |
| 4655 | Helichrysum aff. rutidolepis (Lowland Swamps) | Pale Swamp Everlasting |
| 1655 | Hemichroa diandra | Mallee Hemichroa |
| 1658 | Herpolirion novae-zelandiae | Sky Lily |
| 5087 | Hibbertia humifusa subsp. debilis | Dergholm Guinea-flower |
| 1676 | Hibbertia rufa | Brown Guinea-flower |
| 1679 | Hibbertia sessiliflora | Heathy Guinea-flower |
| 5080 | Hibbertia torulosa | Knobby Guinea-flower |
| 1689 | Hierochloe submutica | Alpine Holy-grass |
| 1709 | Huperzia australiana | Fir Clubmoss |
| 1712 | Hybanthus vernonii subsp. vernonii | Erect Violet |
| 1713 | Hydrilla verticillata | Hydrilla |
| 2186 | Hydrorchis orbicularis | Swamp Onion-orchid |
| 4590 | Hypoxis hygrometrica var. splendida | Golden Weather-glass |
| 1757 | Hypsela tridens | Hypsela |

|  |  |  |
| --- | --- | --- |
| Wetland | | |
| Sp No | Scientific Name | Common Name |
| 4575 | Isoetes drummondii subsp. anomala | Plain Quillwort |
| 4538 | Isoetes pusilla | Small Quillwort |
| 4675 | Isolepis alpina | Tasman Club-sedge |
| 1771 | Isolepis australiensis | Inland Club-sedge |
| 5265 | Isolepis cernua var. setiformis | Bristle Club-sedge |
| 1773 | Isolepis congrua | Slender Club-sedge |
| 4676 | Isolepis gaudichaudiana | Benambra Club-sedge |
| 1781 | Isolepis montivaga | Fog Club-sedge |
| 1804 | Juncus antarcticus | Cushion Rush |
| 1809 | Juncus brevibracteus | Alpine Rush |
| 1816 | Juncus falcatus | Sickle-leaf Rush |
| 1832 | Juncus phaeanthus | Dark-flower Rush |
| 1839 | Juncus revolutus | Creeping Rush |
| 3801 | Juncus thompsonianus | Snowfield Rush |
| 1851 | Kippistia suaedifolia | Fleshy Minuria |
| 0148 | Lachnagrostis adamsonii | Adamson's Blown-grass |
| 4220 | Lachnagrostis filifolia var. 2 | Wetland Blown-grass |
| 0156 | Lachnagrostis meionectes | Alpine Blown-grass |
| 4222 | Lachnagrostis punicea subsp. filifolia | Purple Blown-grass |
| 4206 | Lachnagrostis punicea subsp. punicea | Purple Blown-grass |
| 4223 | Lachnagrostis robusta | Salt Blown-grass |
| 0159 | Lachnagrostis scabra | Ruddy Blown-grass |
| 1889 | Laxmannia gracilis | Slender Wire-lily |
| 3099 | Lawrencia spicata | Salt Lawrencia |
| 1894 | Lemna trisulca | Ivy-leaf Duckweed |
| 1897 | Lepidium aschersonii | Spiny Peppercress |
| 1905 | Lepidium monoplocoides | Winged Peppercress |
| 1906 | Lepidium papillosum | Warty Peppercress |
| 1908 | Lepidium pseudohyssopifolium | Native Peppercress |

|  |  |  |
| --- | --- | --- |
| Wetland | | |
| Sp No | Scientific Name | Common Name |
| 1924 | Lepidosperma limicola | Razor Sword-sedge |
| 3846 | Lepilaena patentifolia | Spreading Water-mat |
| 1949 | Leptorhynchos waitzia | Button Immortelle |
| 1966 | Lepyrodia anarthria | Broom Scale-rush |
| 1967 | Lepyrodia flexuosa | Twisting Scale-rush |
| 1979 | Leucopogon esquamatus | Swamp Beard-heath |
| 1989 | Leucopogon pilifer | Thready Beard-heath |
| 3832 | Levenhookia pusilla | Midget Stylewort |
| 1998 | Levenhookia sonderi | Slender Stylewort |
| 2006 | Limonium australe | Yellow Sea-lavender |
| 2020 | Lipocarpha microcephala | Button Rush |
| 2733 | Lobelia beaugleholei | Showy Lobelia |
| 2729 | Lobelia gelida | Snow Pratia |
| 2064 | Luzula acutifolia subsp. acutifolia | Sharp-leaf Woodrush |
| 2065 | Luzula alpestris | Tussock Woodrush |
| 2066 | Luzula atrata | Slender Woodrush |
| 2083 | Lycopodiella serpentina | Bog Clubmoss |
| 2082 | Lycopodium scariosum | Spreading Clubmoss |
| 2106 | Maireana oppositifolia | Heathy Bluebush |
| 2117 | Malacocera tricornis | Goat Head |
| 2129 | Marsilea mutica | Smooth Nardoo |
| 2145 | Melaleuca armillaris subsp. armillaris | Giant Honey-myrtle |
| 2149 | Melaleuca halmaturorum subsp. halmaturorum | Salt Paperbark |
| 2180 | Microlepidium pilosulum | Hairy Shepherd's Purse |
| 4657 | Microseris scapigera s.s. (sp. 1) | Plains Yam-daisy |
| 2196 | Mimulus prostratus | Small Monkey-flower |
| 2199 | Minuria cunninghamii | Bush Minuria |
| 4056 | Montia fontana subsp. amporitana | Water Blinks |
| 4057 | Montia fontana subsp. fontana | Water Blinks |

|  |  |  |
| --- | --- | --- |
| Wetland | | |
| Sp No | Scientific Name | Common Name |
| 2230 | Muehlenbeckia horrida subsp. horrida | Spiny Lignum |
| 2234 | Mukia micrantha | Mallee Cucumber |
| 3870 | Myriophyllum alpinum | Alpine Water-milfoil |
| 4517 | Myriophyllum gracile var. lineare | Slender Water-milfoil |
| 3874 | Myriophyllum lophatum | Crested Water-milfoil |
| 2257 | Myriophyllum porcatum | Ridged Water-milfoil |
| 3869 | Myriophyllum striatum | Striped Water-milfoil |
| 2261 | Najas marina | Prickly Water-nymph |
| 2262 | Najas tenuifolia | Water Nymph |
| 3881 | Neobassia proceriflora | Soda Bush |
| 2289 | Nymphoides geminata | Open Marshwort |
| 2288 | Nymphoides montana | Entire Marshwort |
| 4894 | Nymphoides spinulosperma | Marbled Marshwort |
| 2293 | Olax stricta | Olax |
| 3903 | Olearia suffruticosa | Clustered Daisy-bush |
| 2347 | Ophioglossum polyphyllum | Upright Adder's-tongue |
| 2346 | Ophioglossum reticulatum | Stalked Adder's-tongue |
| 2356 | Oreobolus oxycarpus subsp. oxycarpus | Tuft-rush |
| 2357 | Oreobolus pumilio subsp. pumilio | Alpine Tuft-rush |
| 2362 | Oreomyrrhis pulvinifica | Cushion Caraway |
| 2373 | Oschatzia cuneifolia | Wedge Oschatzia |
| 2385 | Oxalis magellanica | Snowdrop Wood-sorrel |
| 1605 | Ozothamnus alpinus | Alpine Everlasing |
| 2408 | Panicum simile | Two-colour Panic |
| 2417 | Parantennaria uniceps | Parantennaria |
| 2447 | Pelargonium littorale | Coast Stork's-bill |
| 4679 | Pelargonium sp. 1 | Omeo Stork's-bill |
| 5287 | Persicaria attenuata | Velvet Knotweed |
| 2464 | Persoonia levis | Smooth Geebung |

|  |  |  |
| --- | --- | --- |
| Wetland | | |
| Sp No | Scientific Name | Common Name |
| 2494 | Philydrum lanuginosum | Woolly Waterlily |
| 2502 | Phyllanthus lacunarius | Lagoon Spurge |
| 2531 | Pimelea simplex subsp. simplex | Desert Rice-flower |
| 2548 | Plantago alpestris | Veined Plantain |
| 2559 | Plantago glacialis | Small Star-plantain |
| 2563 | Plantago muelleri | Star Plantain |
| 2577 | Plinthanthesis paradoxa | Wiry Wallaby-grass |
| 2585 | Poa clivicola | Fine-leaf Snow-grass |
| 4868 | Poa labillardierei var. (Volcanic Plains) | Basalt Tussock-grass |
| 3891 | Poa sallacustris | Salt-lake Tussock-grass |
| 2687 | Potamogeton australiensis | Thin Pondweed |
| 4504 | Prasophyllum aff. odoratum L | White Leek-orchid |
| 4153 | Prasophyllum appendiculatum | Tailed Leek-orchid |
| 7235 | Prasophyllum chasmogamum | Sale Plain Leek-orchid |
| 2706 | Prasophyllum diversiflorum | Gorae Leek-orchid |
| 2709 | Prasophyllum frenchii | Maroon Leek-orchid |
| 7628 | Prasophyllum gilgai (sp. aff. pyriforme 4 / D) | Gilgai Leek-orchid |
| 4564 | Prasophyllum hygrophyllum (sp. Nagambie) | Swamp Leek-orchid |
| 2722 | Prasophyllum niphopedium | Marsh Leek-orchid |
| 2719 | Prasophyllum parviflorum | Slender Leek-orchid |
| 7285 | Prasophyllum readii (sp. aff. pyriforme 3 / E) | Streatham / Painted Leek-orchid |
| 5901 | Prasophyllum sp. aff. frenchii 2 (Wilsons Promontory) | Promontory Leek-orchid |
| 5443 | Prasophyllum sp. aff. frenchii 3 / B | Summer Leek-orchid |
| 7627 | Prasophyllum sp. aff. petilum 2 | Petite Leek-orchid |
| 2763 | Pseudoraphis paradoxa | Slender Mud-grass |
| 0601 | Psychrophila introloba | Alpine Marsh-marigold |
| 2785 | Pterostylis baptistii | King Greenhood |
| 4876 | Pterostylis lustra (sp. aff. furcata (Woolly Tea-tree)) | Small / Tea-tree Sickle Greenhood |

|  |  |  |
| --- | --- | --- |
| Wetland | | |
| Sp No | Scientific Name | Common Name |
| 2794 | Pterostylis oreophila | Blue-tongue Greenhood |
| 2809 | Pterostylis pedoglossa | Prawn Greenhood |
| 2819 | Pterostylis tenuissima | Swamp Greenhood |
| 2784 | Pterostylis uliginosa | Marsh Greenhood |
| 2800 | Pterostylis X ingens | Sharp Greenhood |
| 2840 | Pultenaea capitellata | Hard-head Bush-pea |
| 2847 | Pultenaea fasciculata | Alpine Bush-pea |
| 4856 | Pultenaea juniperina s.s. | Pungent Bush-pea |
| 2858 | Pultenaea luehmannii | Thready Bush-pea |
| 2876 | Pultenaea tenella | Delicate Bush-pea |
| 2881 | Pultenaea weindorferi | Swamp Bush-pea |
| 4863 | Pultenaea williamsonii | Highland Bush-pea |
| 2885 | Quinetia urvillei | Quinetia |
| 5019 | Ranunculus amplus | Feather-leaf Buttercup |
| 2887 | Ranunculus collinus | Strawberry Buttercup |
| 4314 | Ranunculus diminutus | Brackish Plains Buttercup |
| 2888 | Ranunculus eichlerianus | Eichler's Buttercup |
| 2892 | Ranunculus gunnianus | Gunn's Alpine Buttercup |
| 2895 | Ranunculus millanii | Dwarf Buttercup |
| 2896 | Ranunculus muelleri | Felted Buttercup |
| 2900 | Ranunculus papulentus | Large River Buttercup |
| 4911 | Ranunculus sessiliflorus var. pilulifer | Annual Buttercup |
| 2915 | Ranunculus undosus | Swamp Buttercup |
| 3961 | Ranunculus victoriensis | Victorian Buttercup |
| 1649 | Rhodanthe polygalifolia | Milkwort Sunray |
| 2935 | Rhynchospora brownii | Grassy Beak-sedge |
| 3969 | Rhytidosporum inconspicuum | Alpine Marianth |
| 2937 | Richea victoriana | Victorian Richea |
| 2965 | Rulingia prostrata | Dwarf Kerrawang |

|  |  |  |
| --- | --- | --- |
| Wetland | | |
| Sp No | Scientific Name | Common Name |
| 4908 | Rumex crystallinus s.s. | Glistening Dock |
| 3962 | Rumex stenoglottis | Tongue Dock |
| 4097 | Ruppia maritima s.s. | Water Tassel |
| 2980 | Ruppia tuberosa | Tuberous Tassel |
| 1242 | Rytidosperma australe | Southern Sheep-grass |
| 0971 | Rytidosperma nivicolum | Snow Wallaby-grass |
| 4410 | Sagina namadgi | Native Pearlwort |
| 5308 | Salsola tragus subsp. pontica | Coast Saltwort |
| 2208 | Schizacme montana var. montana | Mountain Mitrewort |
| 3032 | Schizeilema fragoseum | Alpine Pennywort |
| 3034 | Schoenoplectus dissachanthus | Blunt Club-sedge |
| 3043 | Schoenus carsei | Wiry Bog-sedge |
| 3994 | Schoenus ericetorum | Heathy Bog-sedge |
| 4036 | Schoenus lepidosperma subsp. pachylepis | Slender Bog-sedge |
| 3050 | Schoenus nanus | Tiny Bog-sedge |
| 3053 | Schoenus sculptus | Gimlet Bog-sedge |
| 3082 | Sclerolaena uniflora | Two-spined Copperburr |
| 3085 | Sclerostegia moniliformis | Ruby Glasswort |
| 3101 | Senecio behrianus | Stiff Groundsel |
| 3104 | Senecio cunninghamii var. cunninghamii | Branching Groundsel |
| 7028 | Senecio distalilobatus | Distal-lobe Fireweed |
| 3122 | Senecio pectinatus var. major | Alpine Groundsel |
| 4659 | Senecio psilocarpus | Swamp Fireweed |
| 3180 | Solanum lacunarium | Lagoon Nightshade |
| 3207 | Sowerbaea juncea | Rush Lily |
| 3210 | Sparganium subglobosum | Floating Bur-reed |
| 3225 | Spirodela polyrhiza | Large Duckweed |
| 3243 | Stackhousia nuda | Wiry Stackhousia |
| 3245 | Stackhousia pulvinaris | Alpine Stackhousia |

|  |  |  |
| --- | --- | --- |
| Wetland | | |
| Sp No | Scientific Name | Common Name |
| 4970 | Stylidium calcaratum var. ecorne | Book Triggerplant |
| 4722 | Stylidium montanum | Montane Swamp Triggerplant |
| 3321 | Swainsona murrayana | Slender Darling-pea |
| 3327 | Swainsona purpurea | Purple Swainson-pea |
| 4981 | Tetragonia eremaea s.s. | Desert Spinach |
| 3349 | Tetrarrhena turfosa | Smooth Rice-grass |
| 5224 | Tetratheca procumbens | Mountain Pink-bells |
| 4007 | Thelionema umbellatum | Clustered Lily |
| 4012 | Thelymitra alpicola m.s. (erosa subsp. 2) | Alpine Sun-orchid |
| 5588 | Thelymitra atronitida | Black-hooded Sun-orchid |
| 3363 | Thelymitra azurea | Azure Sun-orchid |
| 3383 | Thelymitra circumsepta | Naked Sun-orchid |
| 3367 | Thelymitra epipactoides | Metallic Sun-orchid |
| 5012 | Thelymitra incurva m.s. (erosa subsp. 1) | Swamp Sun-orchid |
| 7204 | Thelymitra inflata | Blue-star Sun-orchid |
| 4996 | Thelymitra longiloba | Marsh Sun-orchid |
| 5913 | Thelymitra lucida | Glistening Sun-orchid |
| 3375 | Thelymitra luteocilium | Fringed Sun-orchid |
| 3380 | Thelymitra mucida | Plum Orchid |
| 4005 | Thelymitra X merraniae | Merran's Sun-orchid |
| 3386 | Thelypteris confluens | Swamp Fern |
| 5003 | Trachymene humilis subsp. breviscapa | Alpine Trachymene |
| 1476 | Trichanthodium baracchianum | Dwarf Yellow-heads |
| 1478 | Trichanthodium skirrophorum | Woolly Yellow-heads |
| 5010 | Triglochin dubia | Slender Water-ribbons |
| 3445 | Triglochin hexagona | Six-point Arrowgrass |
| 4537 | Triglochin microtuberosa | Eastern Water-ribbons |
| 3446 | Triglochin minutissima | Tiny Arrowgrass |
| 3447 | Triglochin mucronata | Prickly Arrowgrass |

|  |  |  |
| --- | --- | --- |
| Wetland | | |
| Sp No | Scientific Name | Common Name |
| 5009 | Triglochin sp. B | Spurred Arrowgrass |
| 5510 | Triglochin trichophora | Torpedo Arrowgrass |
| 3452 | Trigonella suavissima | Sweet Fenugreek |
| 5030 | Uncinia compacta | Compact Hook-sedge |
| 5031 | Uncinia sulcata | Small Hook-sedge |
| 3481 | Utricularia monanthos | Tasmanian Bladderwort |
| 4032 | Utricularia uniflora | Single Bladderwort |
| 3482 | Utricularia violacea | Violet Bladderwort |
| 5366 | Verbena officinalis var. africana | Inland Verbena |
| 4100 | Villarsia umbricola var. umbricola | Lax Marsh-flower |
| 3527 | Viola caleyana | Swamp Violet |
| 5057 | Viola fuscoviolacea | Dusky Violet |
| 4060 | Wahlenbergia tumidifructa | Mallee Annual-bluebell |
| 3576 | Wittsteinia vacciniacea | Baw Baw Berry |
| 3577 | Wolffia angusta | Narrow Duckweed |
| 5107 | Wurmbea dioica subsp. lacunaria | Swamp Early Nancy |
| 3583 | Wurmbea uniflora | One-flower Early Nancy |
| 3763 | Xerochrysum palustris | Swamp Everlasting |
| 3596 | Xyris juncea | Dwarf Yellow-eye |
| 3616 | Zygophyllum compressum | Rabbit-ears Twin-leaf |

Table 13 - Waterway Dependent - Significant Flora - Estuary Terrestrial

| Estuary Terrestrial | | |
| --- | --- | --- |
| Sp No | Scientific Name | Common Name |
| 0326 | Atriplex paludosa subsp. paludosa | Marsh Saltbush |
| 5241 | Cuscuta australis | Australian Dodder |
| 1839 | Juncus revolutus | Creeping Rush |
| 3099 | Lawrencia spicata | Salt Lawrencia |
| 1908 | Lepidium pseudohyssopifolium | Native Peppercress |
| Sp No | Scientific Name | Common Name |
| 2006 | Limonium australe | Yellow Sea-lavender |
| 2149 | Melaleuca halmaturorum subsp. halmaturorum | Salt Paperbark |
| 3446 | Triglochin minutissima | Tiny Arrowgrass |
| 3447 | Triglochin mucronata | Prickly Arrowgrass |
| 3610 | Zoysia macrantha subsp. walshii | Walsh's Couch |

Table 14 - Waterway Dependent Significant Flora - Estuary Aquatic

| Estuary Aquatic | | |
| --- | --- | --- |
| Sp No | Scientific Name | Common Name |
| 0345 | Avicennia marina subsp. australasica | Grey Mangrove |
| 2980 | Ruppia tuberosa | Tuberous Tassel |

Appendix I - Waterway-Dependent EVCs

Waterway Dependent Significant EVCs were identified through GIS query.

The following buffers were used:

* Wetlands: 100 metres from mapped boundary
* Estuaries: 600 metres from mapped boundary
* Rivers: 600 metres from river centre line

EVCs were divided into:

* Rivers
* Wetlands
* Estuaries

Table 15 - Waterway Dependent EVCs - Rivers

|  |  |
| --- | --- |
| EVC No. | EVC Name |
| 17 | Riparian Scrub/Swampy Riparian Woodland Complex |
| 18 | Riparian Forest |
| 19 | Riparian Shrubland |
| 29 | Damp Forest |
| 30 | Wet Forest |
| 31 | Cool Temperate Rainforest |
| 32 | Warm Temperate Rainforest |
| 33 | Cool Temperate Rainforest/Warm Temperate Rainforest Overlap |
| 40 | Montane Riparian Woodland |
| 41 | Montane Riparian Thicket |
| 53 | Swamp Scrub |
| 56 | Floodplain Riparian Woodland |
| 59 | Riparian Thicket |
| 67 | Alluvial Terraces Herb-rich Woodland |
| 68 | Creekline Grassy Woodland |
| 81 | Alluvial Terraces Herb-rich Woodland/Creekline Grassy Woodland Mosaic |
| 82 | Riverine Escarpment Scrub |
| 83 | Swampy Riparian Woodland |
| 84 | Riparian Forest/Swampy Riparian Woodland/Riparian Shrubland/Riverine Escarpment Scrub Mosaic |

|  |  |
| --- | --- |
| EVC No. | EVC Name |
| 103 | Riverine Chenopod Woodland |
| 106 | Grassy Riverine Forest |
| 110 | Riverine Chenopod Woodland/Plains Grassland Mosaic |
| 123 | Riparian Forest/Warm Temperate Rainforest Mosaic |
| 126 | Swampy Riparian Complex |
| 164 | Creekline Herb-rich Woodland |
| 168 | Drainage-line Aggregate |
| 191 | Riparian Scrub |
| 198 | Sedgy Riparian Woodland |
| 208 | Sub-alpine Riparian Shrubland |
| 212 | Swampy Riparian Woodland/Perched Boggy Shrubland Mosaic |
| 237 | Riparian Forest/Swampy Riparian Woodland Mosaic |
| 238 | Plains Grassy Woodland/Creekline Grassy Woodland/Floodplain Riparian Woodland Mosaic |
| 240 | Plains Grassy Woodland/Creekline Grassy Woodland/Wetland Formation Mosaic |
| 250 | Floodplain Riparian Woodland/Plains Grassy Woodland Mosaic |
| 255 | Riverine Grassy Woodland/Sedgy Riverine Forest/Wetland Formation Mosaic |
| 256 | Floodplain Riparian Woodland/Floodplain Wetland Mosaic |
| 269 | Riparian Shrubland/Swampy Riparian Woodland Mosaic |
| 272 | Swampy Riparian Woodland/Spring Soak Woodland Mosaic |
| 280 | Floodplain Thicket |
| 285 | Dry Creekline Woodland |
| 293 | Riparian Forest/Creekline Grassy Woodland Mosaic |
| 295 | Riverine Grassy Woodland |
| 321 | Riverine Chenopod Woodland/Lignum Swamp Mosaic |
| 322 | Dry Rainforest/Warm Temperate Rainforest/Gallery Rainforest/Riparian Shrubland/Riverine Escarpment Scrub/Blackthorn Scrub Complex |
| 380 | Herb-rich Foothill Forest/Sedgy Riparian Woodland Complex |
| 385 | Lowland Forest/Riparian Forest Complex |
| 386 | Lowland Forest/Riparian Scrub Complex |
| 387 | Lowland Forest/Riparian Shrubland Complex |
| 396 | Heathy Dry Forest/Sedgy Riparian Woodland Complex |

|  |  |
| --- | --- |
| EVC No. | EVC Name |
| 410 | Valley Grassy Forest/Sedgy Riparian Woodland Complex |
| 421 | Damp Sands Herb-rich Woodland/Sedgy Riparian Woodland Complex |
| 422 | Damp Sands Herb-rich Woodland/Sedgy Riparian Woodland Mosaic |
| 423 | Damp Sands Herb-rich Woodland/Dry Creekline Woodland Complex |
| 430 | Floodplain Thicket/Riparian Scrub Complex |
| 431 | Floodplain Thicket/Sedgy Riparian Woodland Complex |
| 432 | Floodplain Thicket/Shallow Freshwater Marsh Complex |
| 434 | Floodplain Thicket/Damp Heathland Complex |
| 449 | Shrubby Woodland/Riparian Scrub Complex |
| 450 | Shrubby Woodland/Sedgy Riparian Woodland Complex |
| 467 | Heathy Woodland/Riparian Scrub Complex |
| 468 | Heathy Woodland/Sedgy Riparian Woodland Complex |
| 504 | Wet Heathland/Riparian Scrub Complex |
| 505 | Damp Heathland/Riparian Scrub Complex |
| 506 | Riparian Forest/Sedgy Riparian Woodland Complex |
| 509 | Riparian Scrub/Heathland Thicket Mosaic |
| 510 | Riparian Scrub/Sedgy Riparian Woodland Complex |
| 512 | Riparian Scrub/Seasonally Inundated Shrubby Woodland Mosaic |
| 514 | Sedgy Riparian Woodland/Lowland Forest Complex |
| 515 | Sedgy Riparian Woodland/Riparian Shrubland Complex |
| 516 | Sedgy Riparian Woodland/Dry Creekline Woodland Complex |
| 519 | Shallow Freshwater Marsh/Floodplain Thicket Mosaic |
| 522 | Riparian Shrubland/Riparian Scrub Complex |
| 553 | Floodplain Thicket/Seasonally Inundated Shrubby Woodland Mosaic |
| 585 | Floodplain Thicket/Wet Heathland Complex |
| 588 | Riparian Scrub/Riparian Forest Complex |
| 596 | Riparian Scrub/Sedgy Riparian Woodland Mosaic |
| 607 | Riparian Scrub/Heathland Thicket Complex |
| 637 | Swamp Scrub/Damp Sands Herb-rich Woodland/Wet Heathland Mosaic |
| 638 | Swamp Scrub/Wet Heathland Mosaic |
| 639 | Swamp Scrub/Plains Grassy Forest Mosaic |

|  |  |
| --- | --- |
| EVC No. | EVC Name |
| 640 | Creekline Sedgy Woodland |
| 641 | Riparian Woodland |
| 654 | Creekline Tussock Grassland |
| 656 | Brackish Wetland |
| 658 | Riverine Grassy Woodland/Sedgy Riverine Forest/Aquatic Herbland Mosaic |
| 659 | Plains Riparian Shrubby Woodland |
| 666 | Riparian Shrubland/Escarpment Shrubland/Grassy Woodland Mosaic |
| 668 | Riparian Woodland/Escarpment Shrubland Mosaic |
| 674 | Sandy Stream Woodland |
| 679 | Drainage-line Woodland |
| 688 | Swampy Riparian Woodland/Swamp Scrub Mosaic |
| 690 | Floodplain Riparian Woodland/Billabong Wetland Mosaic |
| 705 | Basalt Creekline Shrubby Woodland |
| 774 | Sedgy Riparian Woodland/Damp Sands Herb-rich Woodland Mosaic |
| 775 | Floodplain Thicket/Shrubby Woodland Mosaic |
| 798 | Sedgy Riparian Woodland/Riparian Scrub Mosaic |
| 804 | Rushy Riverine Swamp |
| 809 | Floodplain Grassy Wetland |
| 810 | Floodway Pond Herbland |
| 811 | Grassy Riverine Forest/Floodway Pond Herbland Complex |
| 812 | Grassy Riverine Forest/Riverine Swamp Forest Complex |
| 814 | Riverine Swamp Forest |
| 815 | Riverine Swampy Woodland |
| 816 | Sedgy Riverine Forest |
| 817 | Sedgy Riverine Forest/Riverine Swamp Forest Complex |
| 818 | Shrubby Riverine Woodland |
| 823 | Lignum Swampy Woodland |
| 851 | Stream Bank Shrubland |
| 863 | Floodplain Reedbed |
| 869 | Creekline Grassy Woodland/Red Gum Swamp Mosaic |
| 870 | Riverine Grassy Woodland/Plains Woodland Complex |

|  |  |
| --- | --- |
| EVC No. | EVC Name |
| 871 | Riverine Grassy Woodland/Plains Woodland/Gilgai Wetland Complex |
| 872 | Riverine Grassy Woodland/Plains Woodland/Riverine Chenopod Woodland Complex |
| 873 | Riverine Grassy Woodland/Riverine Chenopod Woodland/Wetland Mosaic |
| 902 | Gully Woodland |
| 928 | Riparian Woodland/Stream-bank Shrubland Mosaic |
| 945 | Floodway Pond Herbland/Riverine Swamp Forest Complex |
| 946 | Riverine Swampy Woodland/Lignum Swamp Mosaic |
| 975 | Riverine Ephemeral Wetland |
| 1015 | Grassy Riverine Forest/Drainage-line Aggregate Mosaic |
| 1016 | Grassy Riverine Forest/Plains Grassy Woodland/Grassy Woodland Mosaic |
| 1017 | Grassy Riverine Forest/Riverine Grassy Woodland Mosaic |
| 1019 | Mosaic of Grassy Riverine Forest/Sedgy Riverine Forest-Riverine Swamp Forest Complex |
| 1020 | Mosaic of Grassy Riverine Forest/Floodway Pond Herbland-Riverine Swamp Forest Complex |
| 1021 | Mosaic of Drainage-line Aggregate/Grassy Riverine Forest-Riverine Swamp Forest Complex |
| 1022 | Drainage-line Aggregate/Riverine Swamp Forest Mosaic |
| 1023 | Drainage-line Aggregate/Sedgy Riverine Forest Mosaic |
| 1024 | Mosaic of Drainage-line Aggregate/Sedgy Riverine Forest-Riverine Swamp Forest Complex |
| 1025 | Drainage-line Aggregate/Tall Marsh Mosaic |
| 1027 | Riverine Grassy Woodland/Grassy Riverine Forest-Riverine Swamp Forest Complex |
| 1028 | Riverine Grassy Woodland/Riverine Swamp Forest Mosaic |
| 1029 | Grassy Riverine Forest/Floodway Pond Herbland Mosaic |
| 1030 | Grassy Riverine Forest/Riverine Swamp Forest Mosaic |
| 1031 | Floodplain Riparian Woodland/Grassy Riverine Forest Mosaic |
| 1032 | Floodplain Riparian Woodland/Riverine Grassy Woodland Mosaic |
| 1033 | Floodplain Riparian Woodland/Floodway Pond Herbland Mosaic |
| 1034 | Floodplain Riparian Woodland/Riverine Swamp Forest Mosaic |
| 1035 | Floodplain Riparian Woodland/Sedgy Riverine Forest Mosaic |
| 1037 | Floodplain Riparian Woodland/Tall Marsh Mosaic |

|  |  |
| --- | --- |
| EVC No. | EVC Name |
| 1040 | Riverine Grassy Woodland/Riverine Swampy Woodland Mosaic |
| 1041 | Riverine Grassy Woodland/Sedgy Riverine Forest Mosaic |
| 1042 | Mosaic of Riverine Grassy Woodland/Floodway Pond Herbland-Riverine Swamp Forest Complex |
| 1067 | Riverine Swamp Forest/Riverine Swampy Woodland Mosaic |
| 1068 | Riverine Swamp Forest/Sedgy Riverine Forest Mosaic |
| 1069 | Riverine Swamp Forest/Sedgy Riverine Forest-Riverine Swamp Forest Complex |
| 1070 | Riverine Swamp Forest/Spike-sedge Wetland Mosaic |
| 1071 | Riverine Swamp Forest/Tall Marsh Mosaic |
| 1073 | Riverine Swampy Woodland/Sedgy Riverine Forest Mosaic |
| 1074 | Mosaic of Riverine Swampy Woodland/Sedgy Riverine Forest-Riverine Swamp Forest Complex |
| 1075 | Mosaic of Sedgy Riverine Forest/Sedgy Riverine Forest-Riverine Swamp Forest Complex |
| 1076 | Sedgy Riverine Forest/Spike-sedge Wetland Mosaic |
| 1077 | Sedgy Riverine Forest/Tall Marsh Mosaic |
| 1078 | Mosaic of Sedgy Riverine Forest/Floodway Pond Herbland-Riverine Swamp Forest Complex |
| 1079 | Mosaic of Sedgy Riverine Forest-Riverine Swamp Forest Complex/Tall Marsh |
| 1080 | Mosaic of Sedgy Riverine Forest-Riverine Swamp Forest Complex/Floodway Pond Herbland-Riverine Swamp Forest Complex |
| 1082 | Tall Marsh/Riverine Swamp Forest Mosaic |
| 1085 | Mountain Valley Riparian Woodland |
| 1088 | Riverine Grassland |
| 1099 | Riverine Swampy Woodland/Plains Grassy Wetland Mosaic |

Table 16 - Waterway Dependent EVCs – Wetland

|  |  |
| --- | --- |
| EVC No. | EVC name |
| 8 | Wet Heathland |
| 9 | Coastal Saltmarsh Aggregate |
| 10 | Estuarine Wetland |
| 11 | Coastal Lagoon Wetland |
| 12 | Wet Swale Herbland |

|  |  |
| --- | --- |
| EVC No. | EVC name |
| 13 | Brackish Sedgeland |
| 40 | Montane Riparian Woodland |
| 41 | Montane Riparian Thicket |
| 49 | Swamp Heathland Aggregate |
| 53 | Swamp Scrub |
| 56 | Floodplain Riparian Woodland |
| 59 | Riparian Thicket |
| 74 | Wetland Formation |
| 80 | Spring Soak Woodland |
| 83 | Swampy Riparian Woodland |
| 101 | Samphire Shrubland |
| 103 | Riverine Chenopod Woodland |
| 104 | Lignum Swamp |
| 106 | Grassy Riverine Forest |
| 107 | Lake Bed Herbland |
| 124 | Grey Clay Drainage-line Aggregate |
| 125 | Plains Grassy Wetland |
| 136 | Sedge Wetland |
| 140 | Mangrove Shrubland |
| 148 | Montane Sedgeland |
| 171 | Alpine Fen |
| 172 | Floodplain Wetland Aggregate |
| 185 | Perched Boggy Shrubland Aggregate |
| 191 | Riparian Scrub |
| 195 | Seasonally Inundated Shrubby Woodland |
| 196 | Seasonally Inundated Sub-saline Herbland |
| 210 | Sub-alpine Wet Heathland |
| 239 | Alpine Creekline Herbland |
| 280 | Floodplain Thicket |
| 281 | Sedge-rich Wetland |
| 283 | Plains Sedgy Woodland |

|  |  |
| --- | --- |
| EVC No. | EVC name |
| 284 | Claypan Ephemeral Wetland |
| 288 | Alpine Heath Peatland |
| 291 | Cane Grass Wetland |
| 292 | Red Gum Swamp |
| 306 | Aquatic Grassy Wetland |
| 307 | Sand Heathland/Wet Heathland Mosaic |
| 308 | Aquatic Sedgeland |
| 318 | Montane Swamp |
| 334 | Billabong Wetland Aggregate |
| 369 | Black Box Wetland |
| 537 | Brackish Aquatic Herbland |
| 538 | Brackish Herbland |
| 539 | Brackish Lake Bed Herbland |
| 591 | Calcareous Wet Herbland |
| 602 | Cane Grass Wetland/Aquatic Herbland Complex |
| 606 | Cane Grass Wetland/Brackish Herbland Complex |
| 636 | Brackish Lake Aggregate |
| 647 | Plains Sedgy Wetland |
| 648 | Saline Lake-verge Aggregate |
| 651 | Plains Swampy Woodland |
| 653 | Aquatic Herbland |
| 656 | Brackish Wetland Aggregate |
| 657 | Freshwater Lignum Shrubland |
| 673 | Dune Soak Woodland |
| 676 | Salt Paperbark Woodland |
| 678 | Ephemeral Drainage-line Grassy Wetland |
| 707 | Sedgy Swamp Woodland |
| 708 | Hypersaline Inland Saltmarsh Aggregate |
| 717 | Saline Lake Aggregate |
| 718 | Freshwater Lake Aggregate |
| 721 | Fern Swamp |

|  |  |
| --- | --- |
| EVC No. | EVC name |
| 723 | Forest Bog |
| 728 | Forest Creekline Sedge Swamp |
| 755 | Plains Grassy Wetland/Aquatic Herbland Complex |
| 767 | Plains Grassy Wetland/Brackish Herbland Complex |
| 784 | Plains Swampy Woodland/Lignum Swamp Complex |
| 804 | Rushy Riverine Swamp |
| 806 | Alluvial Plains Semi-arid Grassland |
| 808 | Lignum Shrubland |
| 809 | Floodplain Grassy Wetland |
| 810 | Floodway Pond Herbland |
| 811 | Grassy Riverine Forest/Floodway Pond Herbland Complex |
| 812 | Grassy Riverine Forest/Riverine Swamp Forest Complex |
| 813 | Intermittent Swampy Woodland |
| 814 | Riverine Swamp Forest |
| 815 | Riverine Swampy Woodland |
| 816 | Sedgy Riverine Forest |
| 817 | Sedgy Riverine Forest/Riverine Swamp Forest Complex |
| 819 | Spike-sedge Wetland |
| 820 | Sub-saline Depression Shrubland |
| 821 | Tall Marsh |
| 822 | Intermittent Swampy Woodland/Riverine Grassy Woodland Complex |
| 823 | Lignum Swampy Woodland |
| 842 | Saline Aquatic Meadow |
| 845 | Sea-grass Meadow |
| 857 | Stony Rises Pond Aggregate |
| 875 | Blocked Coastal Stream Swamp |
| 883 | Sedge Wetland/Calcareous Wet Herbland Complex |
| 888 | Plains Saltmarsh |
| 905 | Alpine Short Herbland |
| 908 | Sink-hole Wetland Aggregate |

|  |  |
| --- | --- |
| EVC No. | EVC name |
| 914 | Estuarine Flats Grassland |
| 917 | Sub-alpine Wet Sedgeland |
| 918 | Submerged Aquatic Herbland |
| 920 | Sweet Grass Wetland |
| 931 | Wet Heathland/Sedge Wetland Complex |
| 932 | Wet Verge Sedgeland |
| 934 | Brackish Grassland |
| 937 | Swampy Woodland |
| 945 | Floodway Pond Herbland/Riverine Swamp Forest Complex |
| 947 | Brackish Lignum Swamp |
| 949 | Dwarf Floating Aquatic Herbland |
| 952 | Estuarine Reedbed |
| 953 | Estuarine Scrub |
| 954 | Freshwater Lignum-Cane Grass Swamp |
| 958 | Plains Grassy Wetland/Calcareous Wet Herbland Complex |
| 959 | Plains Grassy Wetland/Sedge-rich Wetland Complex |
| 960 | Plains Grassy Wetland/Spike-sedge Wetland Complex |
| 961 | Plains Rushy Wetland |
| 963 | Sedge Wetland/Aquatic Sedgeland Complex |
| 964 | Shell Beach Herbland |
| 966 | Montane Bog |
| 968 | Gahnia Sedgeland |
| 973 | Brackish Shrubland |
| 975 | Riverine Ephemeral Wetland |
| 976 | Coastal Ephemeral Wetland |
| 990 | Unvegetated (open water/bare soil/mud) |
| 999 | Unknown/Unclassified |
| 1010 | Plains Sedgy Wetland/Sedge Wetland Complex |
| 1011 | Alpine Hummock Peatland |
| 1111 | Alkaline Basaltic Wetland Aggregate |
| 1112 | Granite Rock-pool Wetland |

|  |  |
| --- | --- |
| EVC No. | EVC name |
| 1113 | Sedge Wetland/Brackish Herbland Complex |
| 1114 | Brackish Sedgy Shrubland |
| 2004 | Swamp Scrub/Gahnia Sedgeland Complex |

Table 17 - Waterway Dependent EVCs – Estuary

|  |  |
| --- | --- |
| EVC No.\* | EVC name |
| 9 | Coastal Saltmarsh |
| 10 | Estuarine Wetland |
| 13 | Brackish Sedgeland |
| 18 | Riparian Forest |
| 53 | Swamp Scrub |
| 83 | Swampy Riparian Woodland |
| 140 | Mangrove Shrubland |

\* 196, 538, 842, 845, 914, 934, 952, 953 Not mapped in EVC BCS layer

Appendix J - Rules for Applying Water Quality and Aquatic Invertebrate Community Condition Data

Naturalness: Aquatic Invertebrate Community Condition

Each site usually had at least two years of data; an average was calculated (one for the edge and one for the riffle) for each of the four measures, and it was assessed whether the Biological Objectives for Rivers and Streams (Metzeling et al 2004) were met (pass) or were not met (fail) for each measure. Where a reach crossed into another region separate averages were calculated. The following rules were applied to combine the edge and riffle information for each measure:

* Where edge and riffle both pass = pass
* Where edge and riffle both fail = fail
* Where one of edge or riffle fails = fail (and noted in the rationale)

Degraded Water Quality: Measure 1 – SIGNAL Objectives

Each site usually had at least two years of data; an average was calculated (one for the edge and one for the riffle habitats) and it was assessed whether the Biological Objectives for Rivers and Streams (Metzeling et al 2004) for SIGNAL were met (Meets SEPP) or were not met (Fails SEPP). Where a reach crossed into another region separate averages were calculated. The following rules were applied to determine the overall score for AVIRA:

Whole reach within region

* Where edge and riffle both pass = Meets SEPP (WoV)
* Where edge and riffle both fail = Fails SEPP (WoV)
* Where one of edge or riffle fails = Fails SEPP (WoV) (and noted in the rationale)

Where reach crosses 2 regions:

* If 3 pass and 1 fail = Meets SEPP (WoV)
* If 2 pass and 1 fail = Fails SEPP (WoV)
* If 2 pass and 2 fail = Fails SEPP (WoV)

Degraded Water Quality: Measure 2 – EPA Victoria Water Quality Objectives at VWQMN Sites

The data from Victorian Water Quality Monitoring Network (VWQMN) was used to populate this metric, using the following as a guide:

* Data considered for use was from the period starting January 2004 until December 2009. This time frame was used so as to be consistent with the 3ISC.
* The parameters considered were pH, turbidity, total Phosphorus and Electrical Conductivity. These parameters were used so as to be consistent with the 3ISC.
* The thresholds used to determine whether a site had met the objectives were taken from the EPA Nutrient Objectives for Rivers and Streams (Tiller and Newall 2003) and the EPA Water Qaulity Objectives for Rivers and Streams (Goudey 2003). Thresholds vary according to the region in which the reach occurs.
* If the reach crossed a region boundary an assessment was made to determine which region the majority of the reach occurred in, the thresholds for this region were then used.
* As the AVIRA metric is the number of objectives failed out of four, only sites where the four parameters were collected on a regular basis were included in the analysis.
* Only sites where a reasonable number of samples were collected were used to ensure that there was an adequate number of samples to accurately characterise the water quality at that site. Once the threshold of 24 samples over the six year period was met data was automatically accepted for use. Data with a lower sample size was sometimes accepted if it had a suitable spread across the six years and was judged to be representative.

Degraded Water Quality: Measure 3 – EPA Victoria Water Quality Objectives using Waterwatch Data

Waterwatch data was used to populate this metric, using the following as a guide:

* Data considered for use was from the period starting January 2004 until December 2009. This time frame was used so as to be consistent with the 3ISC.
* The parameters considered were pH, turbidity, total Phosphorus and Electrical Conductivity. These parameters were used so as to be consistent with the 3ISC.
* The thresholds used to determine whether a site had met the objectives were taken from the EPA Nutrient Objectives for Rivers and Streams (Tiller and Newall 2003) and the EPA Water Qaulity Objectives for Rivers and Streams (Goudey 2003). Thresholds vary according to the region in which the site occurs.
* If the reach crossed a region boundary an assessment was made to determine which region the majority of the reach occurred in, the thresholds for this region were then used.
* As the AVIRA metric is the number of objectives failed out of four, only sites where the four parameters were collected on a regular basis were included in the analysis.
* Only sites where a reasonable number of samples were collected were used to ensure that there was an adequate number of samples to accurately characterise the water quality at that site. Once the threshold of 24 samples over the six year period was met data was automatically accepted for use. Data with a lower sample size was sometimes accepted if it had a suitable spread across the six years and was judged to be representative.

Appendix K - Victorian Regional Fishery Management Plans

Bendigo Region Fisheries Management Plan

The *Bendigo Region Fisheries Management Plan* (DNRE 2002d) gives priority to the following waters:

|  |  |  |
| --- | --- | --- |
| River Reaches | Wetlands | Estuaries |
| * Campaspe River (from the outflow of Lake Eppalock to Echuca) * Jim Crow Creek * Loddon River (from the outflow of Laanecoorie Reservoir to Bridgewater) | * Upper Coliban storages * Upper Coliban Reservoir * Lauriston Reservoir * Malmsbury Reservoir) * Lake Eppalock * Cairn Curran Reservoir * Barkers Creek Reservoir * Tullaroop Reservoir | * Not applicable |

Glenelg Hopkins Fishery Management Plan

The *Glenelg Hopkins Fishery Management Plan* (DPI 2006a) indicates the following waterways as the most popular fisheries in the region:

|  |  |  |
| --- | --- | --- |
| River Reaches | Wetlands | Estuaries |
| Recreational fishing effort is considered to be:   * low to medium for most rivers of Glenelg River management unit * medium for the Wannon River * low for most of the rivers in the Moyne management unit, apart from the Moyne River * low (in upper reaches) to medium (in lower reaches) of rivers in the Hopkins River management unit\* | None cited | Recreational fishing effort is relatively high in most estuaries of the Glenelg Hopkins Region. |

\* Definition: lower reaches (0 - 200 m Above Sea Level (ASL)), upper reaches (>200 m ASL). Where an ISC river reach cuts across the 200m ASL, it will be categorised as upper or lower based on its majority stream length (ie >50% above or below 200m ASL).

North East Fishery Management Plan

The *North East Fishery Management Plan* (DPI 2006b) indicates the following waterways as the most popular fisheries in the region:

|  |  |  |
| --- | --- | --- |
| River Reaches | Wetlands | Estuaries |
| None cited | None cited | Not applicable |

Goulburn-Eildon Region Fisheries Management Plan

The *Goulburn-Eildon Region Fisheries Management Plan* (DNRE 2002e) indicates the following waterways as the most popular fisheries in the region:

|  |  |  |
| --- | --- | --- |
| River Reaches | Wetlands | Estuaries |
| * Big River * Delatite River * Goulburn River * Howqua River * Jamieson River * Rubicon River * Royston River * Acheron River * Steavenson River * Yea River * Murrindindi River * King Parrot Creek * Hughes Creek | * Lake Eildon * Eildon Pondage * Lake Nagambie | * Not applicable |

West Gippsland Fishery Management Plan

The *West Gippsland Fisheries Management Plan* (DPI 2008a) indicates the following waterways as the most popular fisheries in the region:

|  |  |  |
| --- | --- | --- |
| River Reaches | Lakes and Wetlands | Estuaries |
| * Tarwin River * Macalister River * Tanjil River * Thomson River * Latrobe River * lower reaches\* of:   + Franklin River   + Albert River   + Avon River   + Tarra River   + Merrimans Creek | * Blue Rock Lake * Lake Glenmaggie * Lake Narracan * Lake Tali Karng * Cowwarr Weir * Hazelwood Pondage * Lake Guthridge * Lake Guyatt * Heyfield Racecourse * Hyland Lake * Morwell Lake | * Avon River * Latrobe River * Powlett River * Tarwin River * Screw Creek * Merrimans Creek |

\* Definition: lower reaches (0 - 200 m ASL), upper reaches (>200 m ASL). Where an ISC river reach cuts across the 200m ASL, it will be categorised as upper or lower based on its majority stream length (ie >50% above or below 200m ASL).

Corangamite Fishery Management Plan (draft)

The *draft Corangamite Fishery Management Plan* (DPI 2008b) identifies the following waterways as the key fisheries in the region:

|  |  |  |
| --- | --- | --- |
| River Reaches | Wetlands | Estuaries |
| * Aire River * Ford River * Barham River * Gellibrand River * Curdies River * Barwon River * Carlisle River * Moorabool River | * Lake Bullen Merri * Lake Purrumbete * Wurdiboluc Reservoir * Deep Lake * West Barwon Dam * Lake Colac * Lake Murdeduke * Lake Modewarre * Lake Wendouree * Lake Tooliorook | * Barwon River * Curdies River * Thompson River * Barham River * Gellibrand River * Painkalac Creek * Anglesea River * Kennett River * Wye River * Erskine River * Aire River * Hovells Creek * Spring Creek |

Other Plans

* Anderson Inlet Fisheries Reserve Management Plan 2006 (DPI 2006c)
* Lake Tyers Fisheries Reserve Management Plan 2007 (DPI 2007b)
* Mallacoota Inlet Fisheries Reserve Management Plan 2006 (DPI 2006d)

Appendix L - Non-Motor Boating In Victoria

Canoeing/Kayaking

Canoeing/kayaking activities take a number of forms and are generally divided into two categories: white-water and flat-water. White-water activities require fast-flowing water and are usually undertaken in the upper mountainous reaches of rivers. Flat-water activities generally occur on the lower, flatter reaches of rivers, estuaries and in lakes.

Some canoeing/kayaking activities are competitive. Canoeing Victoria cites the following freshwater event types:

* white-water (slalom, wildwater, freestyle)
* flat-water (sprint, marathon, canoe polo)

An example of the key waterways for one of these event types – slalom - is described below.

Canoe/ Kayak Slalom

Canoe/kayak slalom involves a race through a series of gates suspended over a course of whitewater rapids. Slalom events are held on the following waterways:

* Yarra River (Warburton, Warrandyte, Templestowe, Eltham, Abbotsford)
* Big River (near Lake Eildon)
* King River (near Cheshunt)
* Goulburn River (below Lake Eildon)

The Victorian State Slalom Championships are held on the Goulburn River at Eildon in December each year (Canoeing Victoria ~2008).

White-Water Rafting

White-water rafting is an extreme sport requiring fast-flowing waters, usually in the upper reaches of rivers. Popular rivers for white-water rafting include:

* Mitta Mitta River;
* King River;
* Mitchell River; and
* Howqua and Delatite rivers.

Rowing

Rowing is a competitive, club-based activity involving year-round training (LCC 1991). Optimal conditions are met in the lower reaches of rivers and small open water bodies such as:

* Barwon River, Geelong
* Lake Weeroona, Bendigo
* Maribyrnong River
* Yarra River
* Lake Nagambie
* Goulburn River Warrnambool
* Lake Wendouree, Ballarat
* Lake Colac
* Albert Park Lake
* Lake Hamilton
* Murray River
* Lake Moodemere, Rutherglen
* Wimmera River, Horsham
* Mitchell River, Bairnsdale
* Thompson River, Sale
* Patterson Lakes, Carrum

Appendix M - Motor Boating in Victoria

Water-Skiing

Popular water-skiing locations include:

* Lake Eildon;
* Lower Glenelg River;
* Murray River;
* Gippsland Lakes;
* Lower Barwon River; and
* Lake Boga.

Power Boat Racing

Power boat racing events occur at:

* Lake Eppalock;
* Lake Glenmaggie; and
* Murray River.

Appendix N - Special Water Supply Catchment Areas in Victoria

The following SWSCs are listed in Schedule 5 of the *Catchment and Land Protection Act 1994*.

|  |  |  |
| --- | --- | --- |
| * Upper Barwon * Parwan * Upper Goulburn * Glenmaggie * Rocklands * Wimmera Systems * Riddells Creek * Gisborne-Sunbury * Lancefield * Romsey * Woodend * Mount Macedon * Macedon * Eppalock * Cairn Curran * Sunbury * Djerriwarrh * Tyers River * Kilmore * Bunyip River * Trawalla Creek * Lorne * Healesville * Upper Kiewa * Mirboo North * Orbost (Rocky River) * Lake Merrimu * McCraes Creek * Billys Creek * Buffalo River (Lake Buffalo) * Seven Creeks & Mountain Hut Creek (Euroa) * Fifteen Mile Creek (Glenrowan) * Lake Hume (Victorian section) * Loddon River (Laanecoorie) * Merino * Mollison Creek (Pyalong) * Bemm River * Little Bass River (Poowong–Loch–Nyora) * Brodribb River * Bellview & Ness Creeks (Korumburra) * Ruby Creek (Leongatha) * Battery Creek (Fish Creek) * Deep Creek (Foster) * Agnes River * Ovens River (Wangaratta) * Fiery Creek Tributaries (Beaufort) | * Drouin * Tarago River * Lake Nillahcootie * Lake Merrimu (Goodmans Creek) * Gellibrand River * Ryans Creek * Rosslynne Reservoir (Jacksons Creek) * Tarra River * Rosslynne Reservoir (Riddells Creek) * Micks Creek * Lal Lal Reservoir * Betka River * Thomson River (Stages 1, 1(a) & 2) * Lake Merrimu (Lerderderg River) * Avoca Town Water Supply * Nicholson River * Honeysuckle Creek * Cann River * Running Creek * Moorabool River (Sheoaks) * Stony Creek * Painkalac Creek (Aireys Inlet) * Lance Creek * Tennent Creek (Candowie Reservoir) * Nine Mile, Clear and Hurdle Creeks * Musical Gully and Troy Reservoirs (Beaufort) * Langi Ghiran Reservoir * Picnic Road (Ararat) * Crusoe Group Reservoirs (Bendigo) * Spring Gully Reservoir (Bendigo) * Teddington Reservoir * Barwon Downs Wellfield Intake Area (Geelong) * Yuppeckiar Creek Reservoir (Glenthompson) * Konong Wootong Reservoir (Coleraine) * Mortlake Spring (Mortlake) * Wannon River Tributaries (Lake Bellfield) * Mason Creek (Willaura) * Serra Range Tributaries (Dunkeld) | * Bakers Gully (Bright) * Creswick * King River (Lake William Hovell) * Buckland River * Monument Creek * Gellibrand River (South Otway) * Tanjil River * Ballarat * Tullaroop Reservoir * Britania Creek * Pennyroyal, Matthews & Gosling Creeks * Sunny Creek * Narracan Creek * Skenes Creek * Mitchell River * Rollo Creek * Bealiba * West Barham River * McCallum Creek * Walkley Creek (Boolarra) * Thomson River (Stage 3) * Tambo River * Boggy Creek (Nowa Nowa) * Buchan River (Buchan) * Diddah Diddah Creek (Springhurst) * Ovens River (Bright) * Tomahawk Creek (Gembrook) * Sunday Creek (Broadford-Kilmore) * Little Tea Tree Creek Tributaries (Hamilton) * Pykes Creek Reservoir and Werribee River * Nine Mile Creek (Longwood) * Barambogie Creek (Chiltern) * Candowie Reservoir North * Tarwin River (Meeniyan) * Merrimans Creek (Seaspray) * Deep Creek & Loch River (Noojee) * Redbank Creek (Redbank) * Forest Creek (Amphitheatre) * Learmonth Borefield * St Enochs Spring (Skipton) |

Appendix O - Irrigation Districts in Victoria

Bacchus Marsh Irrigation District

The Bacchus Marsh Irrigation District (BMID) is located around the thriving community of Bacchus Marsh, on a fertile floodplain of the Werribee River. This region which, at the time of European settlement, was a large swamp is now a highly developed agricultural district specialising in dairy farming, horticulture and market gardening (SRW ~2008).

The BMID receives its irrigation supply via a weir on the Werribee River just east of Ballan, which diverts water to Myers Creek. This creek in turn discharges to Pykes Creek Reservoir. Releases from the storage are to the Werribee River via the Korweinguboora Creek. A second Diversion Weir located west of Bacchus Marsh on the Werribee River diverts irrigation supplies into the BMID.

Central Goulburn Irrigation Area

This Area covers 173,053ha (113,106ha irrigated) and is one of the largest irrigated areas in Northern Victoria. A diverse range of irrigated agriculture can be found in Central Goulburn. Dairying is the most common enterprise along with cropping, grazing and horticulture (stone and pomme fruits) (GMW ~2008).

Water Rights in the Area are supplied mainly from Lake Eildon. Releases make a two day journey along the Goulburn River to the major diversion point at Goulburn Weir near Nagambie (GMW ~2008).

Macalister Irrigation District

The largest irrigation area south of the Great Dividing Range, the Macalister Irrigation District (MID) is located in central Gippsland, and takes its name from the Macalister River, main source of the district’s irrigation water. The MID extends around the river for 53,000ha from Lake Glenmaggie to near Sale. Approximately 33,500ha is currently used for irrigation, and of this 90% is under pasture (SRW ~2008).

Water Rights in the Area are supplied mainly from Lake Eildon. Releases make a two day journey along the Goulburn River to the major diversion point at Goulburn Weir near Nagambie (GMW ~2008).

Murray Valley Irrigation Area

The Murray Valley Irrigation Area covers 128,372ha (88,969ha irrigated) in Northern Victoria. A range of irrigated agriculture can be found in this Area, with dairying the most common enterprise around Katunga, Nathalia, Strathmerton and Waaia (47% of Area land use). Horticultural holdings (mainly stone fruits) dominate around Cobram (8% of Area land use), while cropping and grazing are carried out on broad acre farms near Katamatite and Picola (45% of Area land use) (GMW ~2008).

Water supplies are released into the River Murray at Hume Dam. Water released at Hume Dam moves downriver to Lake Mulwala, the receival point for irrigation water, behind Yarrawonga Weir. At Yarrawonga Weir, on the Victorian side, the water is diverted into the Yarrawonga Main Channel and from there into the Murray Valley channel system. Irrigation customers also pump water from the Broken/Nine Mile Creek systems. Bulk water from the system is also supplied to towns within the Area (GMW ~2008).

Pyramid - Boort Irrigation Area

The Pyramid-Boort Irrigation Area covers 166,215ha (126,400ha suitable for irrigation) in Northern Victoria. Water is released from Waranga Basin into the Waranga Western Channel to supply the Rochester and Pyramid-Boort Irrigation areas. Water can also enter the Pyramid-Boort Irrigation area from the Loddon River at Loddon Weir, Fernihurst. Pumped supplies are also drawn from the Loddon River and are managed by Diversion Operations in Kerang (GMW ~2008).

The Pyramid Hill district is traditionally renowned for wool and fat lamb production while the dairy industry remains prominent around areas such as Yarrawalla, Calivill and Dingee. The district also produces hay and includes some summer and winter cropping. There are also some diverse industries such as salt harvesting, apples and cherries. The Boort district has a diversity of industry crops including olives, tomatoes, corn and lucerne. Emerging industries within the area include aquaculture, grape growing and value adding olive products are increasingly prominent (GMW ~2008).

Rochester - Campaspe Irrigation Area

A range of irrigated agriculture can be found in the Rochester-Campaspe Area with dairying being the major enterprise. There is also a large percentage of tomato crops grown in the Rochester-Campaspe Area, with other mixed farming such as summer cropping and sheep and cattle grazing. The major sources of water supply are Lake Eildon and Lake Eppalock with supplementary supplies taken from Greens Lake (GMW ~2008).

Shepparton Irrigation Area

The Shepparton Irrigation Area covers 81,750ha (51,000ha irrigated) in Northern Victoria. Dairying and horticulture (mostly stone fruit) are the most common irrigated enterprises in this Area. However, mixed cropping and grazing enterprises make up over half of the irrigated farms, with a significant number of them being 'hobby farms', especially close to Shepparton (GMW ~2008).

Torrumbarry Irrigation Area

The Torrumbarry Irrigation Area covers 167,000ha (150,000ha suitable for irrigation) in Northern Victoria. Dairy farms dominate around Cohuna, while mixed farming is more common around Kerang where fat lambs and beef cattle are raised extensively, and cereal, fodder, lucerne and oil seed crops are also widely produced. As well as dairying, fruit and vegetables are a significant part of irrigated production around Swan Hill. The sandy hills at Tresco and along the River Murray downstream from Swan Hill to Nyah are planted to horticulture - vineyards, stonefruit and market gardening (GMW ~2008)

Water supplies for the Torrumbarry Area are released into the River Murray at Hume Dam. Water released at Hume Dam takes ten days to move downriver to the Torrumbarry Weir pool, behind Torrumbarry Weir which is the diversion point for the Area's irrigation water. A unique feature of the area is the multiple uses made of the natural water bodies that are prevalent throughout the Torrumbarry Irrigation Area (GMW ~2008).

Werribee Irrigation District

The Werribee Irrigation District (WID) is one of Melbourne’s vegetable gardens, located on the estuarine floodplain of the Werribee River. The WID receives its irrigation supply from the combination of three storages at Pykes Creek, Lake Merrimu and Melton Reservoir. These storages impound water from both the Werribee and Lerderderg River systems (SRW ~2008).

Other Districts

* First Mildura Irrigation Trust
* Wimmera Mallee Water
* Sunraysia Rural Water Authority
* Swan Hill Pumped Districts

Appendix P - Victorian Water Storages

|  |  |  |
| --- | --- | --- |
| Basin | Reservoir | Full Storage Capacity (ML) |
| Avoca | None | n/a |
| Barwon | Wurdee Boluc Reservoir | 40,431 |
| Barwon | West Barwon Dam | 21,000 |
| Barwon | White Swan Reservoir | 14,107 |
| Barwon | Gong Gong Reservoir | 1,902 |
| Broken | Lake Mokoan | 362,450 |
| Broken | Lake Nillacootie | 39,950 |
| Broken | Loombah-McCall Say | 1,813 |
| Bunyip | Tarago Reservoir | 25,000 |
| Campaspe | Lake Eppalock | 304,651 |
| Campaspe | Upper Coliban Reservoir | 37,480 |
| Campaspe | Lauriston Reservoir | 19,790 |
| Campaspe | Malmsbury Reservoir | 17,780 |
| Campaspe | Campaspe Weir | 2,624 |
| Corangamite | None | n/a |
| East Gippsland | None | n/a |
| Gippsland | Candowie Reservoir | 2,207 |
| Gippsland | Western Reservoir | 1,137 |
| Gippsland | Hyland Reservoir | 671 |
| Glenelg | Rocklands Reservoir | 348,310 |
| Glenelg | Moora Moora Reservoir | 6,300 |
| Glenelg | Hayes Reservoir | 2,700 |
| Glenelg | Konongwootong Reservoir | 1,920 |
| Goulburn | Lake Eildon | 3,334,158 |
| Goulburn | Waranga Basin | 432,632 |
| Goulburn | Greens’ Lake | 32,440 |
| Goulburn | Goulburn Weir | 25,500 |
| Goulburn | Sunday Creek Reservoir | 1,700 |
| Hopkins | None | n/a |
| Kiewa | Rocky Valley | 28,294 |
| Kiewa | Lake Guy | 1,416 |
| Kiewa | Pretty Valley Basin | 500 |

|  |  |  |
| --- | --- | --- |
| Basin | Reservoir | Full Storage Capacity (ML) |
| Kiewa | Clover Pondage | 255 |
| Latrobe | Blue Rock | 208,188 |
| Latrobe | Moondarra Reservoir | 30,300 |
| Latrobe | Lake Narracan | 8,000 |
| Loddon | Cairn Curran Reservoir | 147,130 |
| Loddon | Tullaroop Reservoir | 72,950 |
| Loddon | Laanecoorie Reservoir | 7,940 |
| Loddon | Newlyn Reservoir | 3,215 |
| Loddon | Hepburn Lagoon | 3,001 |
| Loddon | Sandhurst Reservoir | 2,590 |
| Loddon | Spring Gully Reservoir | 1,680 |
| Loddon | Evansford Reservoir | 1,351 |
| Mallee | None | n/a |
| Maribyrnong | Rosslynne Reservoir | 25,368 |
| Millicent Coast | None | n/a |
| Mitchell | None | n/a |
| Moorabool | Lal Lal Reservoir | 64,495 |
| Moorabool | Upper Stoney Creek Reservoir | 9,494 |
| Moorabool | Bostock Reservoir | 7,480 |
| Moorabool | Moorabool Reservoir | 6,738 |
| Moorabool | Korweinguboora Reservoir | 2,100 |
| Moorabool | Wilsons Reservoir | 1,010 |
| Murray | Lake Dartmouth (Victoria's share only) | 1,953,795 |
| Murray | Lake Hume (Victoria's share only) | 1,518,250 |
| Murray | Menindee Lakes (Victoria's share only)(1) | 865,500 |
| Murray | Lake Victoria (Victoria's share only) | 338,500 |
| Murray | Lake Culluleraine | 5,270 |
| Otway Coast | West Gellibrand Reservoir | 1,856 |
| Ovens | Lake Buffalo | 23,900 |
| Ovens | Lake William Hovell | 13,710 |
| Portland Coast | None | n/a |
| Snowy | None | n/a |
| South | Lance Creek Reservoir | 4,200 |
| Tambo | None | n/a |
| Thomson | Thomson Reservoir | 1,068,000 |
| Thomson | Lake Glenmaggie | 190,410 |

|  |  |  |
| --- | --- | --- |
| Basin | Reservoir | Full Storage Capacity (ML) |
| Werribee | Merrimu Reservoir | 32,516 |
| Werribee | Pykes Creek Reservoir | 22,119 |
| Werribee | Melton Reservoir | 14,364 |
| Werribee | Djerriwarrh Reservoir | 983 |
| Wimmera | Toolondo Reservoir | 92,430 |
| Wimmera | Lake Bellfield | 78,560 |
| Wimmera | Lake Lonsdale | 65,480 |
| Wimmera | Pine Lake | 62,000 |
| Wimmera | Taylors Lake | 33,700 |
| Wimmera | Wartook Reservoir | 29,300 |
| Wimmera | Fyans Lake | 18,460 |
| Wimmera | Green Lake | 5,350 |
| Wimmera | Dock Lake | 4,420 |
| Wimmera | Batyo Lake | 2,250 |
| Yarra | Cardinia Reservoir | 287,000 |
| Yarra | Upper Yarra Reservoir | 200,000 |
| Yarra | Sugarloaf Reservoir | 96,000 |
| Yarra | Silvan Reservoir | 40,000 |
| Yarra | Yan Yean Reservoir | 30,000 |
| Yarra | Greenvale Reservoir | 27,000 |
| Yarra | Maroondah Reservoir | 22,000 |
| Yarra | O'Shannassy Reservoir | 3,000 |

Source: DSE (2008c)

Appendix Q - Key Hydro-Electric Power Stations Operating in Victoria

**Dartmouth Power Station** - 180 MW single generator located at the foot of the Dartmouth Dam on the Mitta Mitta River (AGL ~2008).

**Eildon Power Station** - two 67MW generators and two 7.5MW generators (AGL ~2008).

**Banimboola Power Station** - total capacity of 12.2 MW located on the regulating pondage (Lake Banimboola) of Dartmouth Power Station (AGL ~2008).

**Kiewa Hydroelectric Scheme** - total capacity of 241MW (AGL ~2008). The three power stations in the scheme are:

* McKay Creek Power Station (150MW);
* Clover Power Station (29MW); and
* West Kiewa Power Station (62MW).

**Rubicon Power Stations** – 13MW based on the use of the waters of the Rubicon and Royston Rivers, and tributaries of the Goulburn River (AGL ~2008).

**Cairn Curran Power Station** – 2MW at the Cairn Curran Reservoir on the Loddon River (AGL ~2008).

**Blue Rock Power Station** - 2.6MW located in the Latrobe Valley.

**Cardinia Dam Power Station** - 3.5MW on Menzies Creek.

Yarrawonga Weir Power Station – 9.5MW at Lake Mulwala.

Thompson Hydroelectric Power Station.

**Lake William Hovell** – 1.6MW on the King River.

Lake Glenmaggie

**Lake Eppalock** – 2.4MW (Pacific Hydro ~2008).

Appendix R - Eel Fishery Access Licences

|  |  |  |
| --- | --- | --- |
| Access Licence No. | Allocated Waters | Basin Name (No.) |
| 1 | Tarwin River downstream from Mardon Rd Bridge (West Branch). | South Gippsland (27) |
| Albert River downstream from the railway bridge 2.4 km west of Alberton.  Gippsland Lakes. | South Gippsland (27) |
| 2 | Eumeralla River downstream from the Princes Highway Bridge, including Lake Yambuk. Shared allocation. | Portland (37) |
| 3 | Lake Purrumbete. | Otway Coast (35) |
| 4 | Lower Barwon River between Queen’s Park and Grab Hole Drain. | Barwon (33) |
| Reedy Lake Section of Lake Connewarre. | Barwon (33) |
| Lake Connewarre. | Barwon (33) |
| 5 | Lower Barwon River (inc. section of Connewarre Game reserve). | Barwon (33) |
| 6 | No specific allocation. |  |
| 7 | Tarra River downstream from Pound Rd Bridge.  Gippsland Lakes. | South Gippsland (27) |
| Lower Lake Mallacoota. | East Gippsland (21) |
| 8 | Shared allocation. |  |
| 9 | Lake Gillear. | Hopkins (36) |
| Shared allocation. |
| 10 | Merri River (inc. Kelly Swamp), downstream from the Wollaston Weir. | Hopkins (36) |
| Shared allocation. |
| 11 | No specific allocation. |  |
| 12 | Aire River downstream from the Great Ocean Road. | Otway Coast (35) |
| Lake Corangamite. | Lake Corangamite (34) |
| 13 | Hospital Swamp. | Hopkins (36) |
| Lake Learmonth. | Hopkins (36) |
| 14 | No specific allocation. |  |

|  |  |  |
| --- | --- | --- |
| Access Licence No. | Allocated Waters | Basin Name (No.) |
| 15 | Deep Lake. | Hopkins (36) |
| Lake Tooliorook. | Hopkins (36) |
| 16 | LaTrobe River downstream from Yallourn Storage Dam to the Swing Bridge at Sale. | LaTrobe (26) |
| Moe Drain downstream from the Princes Highway Bridge. | LaTrobe (26) |
| Gippsland Lakes. |
| 17 | No specific allocation. |  |
| 18 | Curdies River downstream from “The Narrows”. | Otway Coast (35) |
| Curdies Inlet. |
| Gellibrand River downstream from the Great Ocean Road. | Otway Coast (35) |

Source: DNRE (2002f)

1. Silver Perch, Barred Galaxias and the Upper Wannon form of River Blackfish could not be included in the modelling due to the lack of suitable data. However, expert opinion could be used to add reaches with a high likelihood of acting as refuge habitat during drought for these species e.g.information is available on critical habitats for Barred Galaxias. [↑](#footnote-ref-1)
2. 3ISC will not collect information on understorey lifeforms. [↑](#footnote-ref-2)
3. Diseases and pathogens are not considered within AVIRA as they are managed through existing DPI frameworks. [↑](#footnote-ref-3)
4. Taxon was listed at time the VBA was interrogated, but is no longer listed [↑](#footnote-ref-4)
5. “ [↑](#footnote-ref-5)
6. Taxon was listed at time the VBA was interrogated, but is no longer listed [↑](#footnote-ref-6)
7. Taxon was listed at time the VBA was interrogated, but is no longer listed [↑](#footnote-ref-7)
8. Taxon was listed at time the VBA was interrogated, but is no longer listed [↑](#footnote-ref-8)
9. Taxon was listed at time the VBA was interrogated, but is no longer listed. [↑](#footnote-ref-9)
10. Taxon was listed at time the VBA was interrogated, but is no longer listed. [↑](#footnote-ref-10)